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# **BMJ Open**

# Developing a core outcome set for traumatic brachial plexus injuries: a systematic review of outcomes.

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# **Title Page**

# Title of article

# Developing a core outcome set for traumatic brachial plexus injuries: a

systematic review of outcomes.

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# ABSTRACT

**Objective** This review aimed to summarize outcome reporting in traumatic brachial plexus injury research.

Method Medline (OVID), EMBASE, CINAHL, and AMED were systematically searched for studies evaluating the clinical effectiveness of interventions in traumatic brachial plexus injuries. Two authors independently screened papers. All outcomes were extracted verbatim from studies. If a patient reported or performance outcome measure was used then outcomes were extracted directly from the instrument. Variation in outcome reporting was determined by assessing the number of unique outcomes reported across all included studies. Outcomes were categorized into domains using a prespecified taxonomy. **Results** Verbatim outcomes (n= 1460) were extracted from 132 studies including 30 questionnaires. Unique outcomes (n= 157) were structured into four core areas and 11 domains. Outcomes within the musculoskeletal domain were measured in 87% of studies, physical functioning in 23%, emotional functioning in 22% and adverse events in 33%. One study measured quality of life. We identified 62 different methods for measuring muscle strength, 16 for range of movement and 63 studies did not define how they measured movement.

**Conclusion** This review of outcome reporting in traumatic brachial plexus injury research demonstrated an impairment focus and heterogeneity. A core outcome set would ensure standardized and relevant outcomes are reported to facilitate future systematic review and meta-analysis.

# Prospero registration number: CRD42018109843

# Strengths and limitations of this study

- This study is a comprehensive and systematic review of all reported clinical outcomes reported in traumatic brachial plexus studies from 2013- 2018 inclusive.
- Unique outcomes were systematically categorized into a clear taxonomy to inform the development of a core outcome set.
- Definition of unique outcomes and categorisation was conducted by researchers and clinicians to account for multidisciplinary perspectives.
- Quality assessment was not undertaken as the aim of the study was to review outcome reporting and not to synthesize data about effectiveness of interventions.

# INTRODUCTION

A traumatic brachial plexus injury (TBPI) is a major injury to the brachial plexus. It can result in significant functional, social, psychological and economic effects, [1, 2] with most occurring in young men as a result of motorbike accidents, [3]. Survival from major trauma is increasing, [4] and with this an increase in the incidence of TBPI, [5] which accounts for 1.2% of polytrauma, [6]. The complex and chronic nature of the injury is associated with significant healthcare costs, [7] in addition to indirect costs estimated at \$2.34 million (in 2017 dollars) over the lifetime of an individual with a TBPI, [8]. There are multiple strategies for managing a patient with a TBPI with recent advancements in nerve microsurgery, [9] and robotics, [10] resulting in increased treatment options. The choice of treatment should be made using upto-date, high quality scientific evidence, [11, 12].

Ideally, a meta-analysis would identify the most effective treatment for an individual with a TBPI, however, such analysis requires homogenous outcome measurement and reporting across studies to enable optimum synthesis. Indeed, despite increasing numbers of TBPI studies, outcome heterogeneity and poorly defined outcomes has been highlighted as a significant challenge to evidence synthesis in two recent systematic reviews,[13,14]. There is now international agreement that the definition of a core outcome set (COS) for TBPI is a priority,[15, 16]. A COS is a minimum agreed set of outcomes to be reported and measured in all studies and collected through routine clinical care,[17, 18]. Development of a COS has been shown to reduce heterogeneity of outcome reporting in other health conditions, with 81% of trialists in rheumatoid arthritis (RA) now measuring the COS for RA,[19].

To date a minimum set of outcomes, important to patients and professionals for reporting in TBPI studies, has not been agreed. The choice of what are important outcomes to measure in TBPI is complex due to patient heterogeneity with different mechanisms, locations and severity of injury. As a first step in the development of an international COS for TBPI we conducted a systematic review to identify outcomes reported in the literature.

The aim of this review was to:

- Identify what outcome domains are assessed in studies evaluating surgical and nonsurgical treatment for TBPI.
- 2. Compare the definitions of outcomes and time points of outcomes assessed.
- 3. Identify measurement instruments used to assess outcome domains.

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#### **METHODS**

We followed the methods described in the Cochrane Handbook for Systematic Reviews of Interventions,[20] and report in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines,[21] and Core Outcomes Sets Standards for Reporting (COS-STAR) guidelines,[22]. The systematic review protocol was prospectively registered with PROSPERO (PROSPERO registration number:

CRD42018109843).

#### **Identification of studies**

We conducted an electronic search of Medline (OVID), EMBASE (OVID), CINAHL and AMED on the 18<sup>th</sup> September 2018. Studies published between 01 Jan 2013 and 18 September 2018 were included to reflect outcomes employed in current TBPI care. An example of the search strategy for Ovid MEDLINE is presented in supplementary file 1. The thesaurus vocabulary of each database was used to adapt search terms. Boolean operators (AND, OR) were used to narrow or widen the search and no language restrictions were applied.

# **Study eligibility**

Studies were included if they met the following criteria:

*Study type:* Any controlled and uncontrolled experimental and observational studies evaluating interventions in traumatic brachial plexus injury including case reports, case series, case studies, prospective and retrospective cohort studies, randomized and nonrandomized clinical trials. We excluded conference proceedings, abstract only publications and those not involving human subjects.

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*Participants:* Studies reporting outcomes in individuals with traumatic brachial plexus injury aged 16 years or over. Studies of patients with obstetric brachial plexus injuries were excluded.

*Interventions:* Any surgical or non-surgical intervention for TBPI. *Outcomes:* All outcomes reported in the published abstract, methods or results. These

outcomes (PROs) either reported in the study or subsequently extrapolated from the PRO

included physiological and functional outcomes, adverse events and patient reported

instruments.

Language: Non-English language publications were included

#### **Study selection process**

The reference management software Mendeley was used to compile the literature, with duplicates removed. Authors (X and X) independently screened the titles and then the abstracts against the eligibility criteria. Disagreements were discussed and a third reviewer (x) was involved where required. Studies appearing to meet the inclusion criteria based on title and abstract were retrieved as full text articles, and were read to assess for eligibility with decisions on inclusion and exclusion recorded (Figure 1. PRISMA flow diagram). Disagreements in study selection were resolved by discussion within the research team (x, x,

x).

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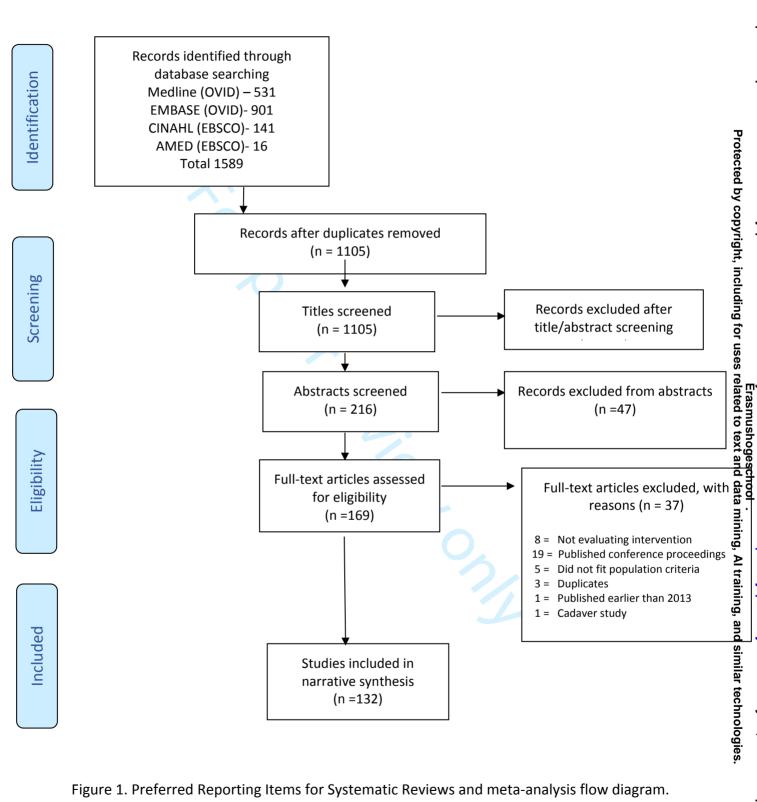


Figure 1. Preferred Reporting Items for Systematic Reviews and meta-analysis flow diagram.

#### **Quality assessment**

Quality assessment of studies was not relevant as the objective was to systematically document all outcomes reported in TBPI studies rather than synthesize the data about intervention effectiveness.

#### **Data Extraction**

Data were extracted into a piloted data extraction sheet (Microsoft Excel). General data extracted from each study included author, study design, recruiting country, publication year, number of participants, gender, mean age, level of TBPI and intervention tested. The following information was extracted regarding outcomes: each outcome reported (verbatim), area of body assessed if relevant (shoulder, elbow, wrist or hand), method of administration, name of measure, timepoints of measure and reported complications. The number of outcomes per study was also documented.

Data extraction was performed independently by X and X for the first 20% of included studies. These were compared, and disagreements discussed and resolved through debate or discussion with a third reviewer (X). Following this a further ten percent of studies had data extracted by both X and X. Due to the high level of agreement between reviewers ( 91% agreement) on outcomes extracted, at this stage, the remaining studies underwent extraction by a single reviewer (X). If an instrument was used and was composed of multiple items, including patient-reported questionnaires, the following data was extracted by the first author; verbatim name of the instrument, verbatim name for each item. The frequency of use of instruments was noted and compared between studies. The instruments were categorized as: (i) General Health (generic - for use with any patient); (ii) Upper limb physical function (region-specific); (iii) Symptom or domain specific (to assess a single symptom e.g. pain) and (iv) Condition Specific. Timepoints of measurement of all outcomes were noted. If the outcome was assessed at different timepoints then all timings were recorded.

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# Classification of outcomes into domains and defining unique outcomes

Identically worded and spelled verbatim outcomes were removed at this stage. Identical outcomes measured over different time points were noted as one outcome. Where outcomes were assessed using an instrument containing several items, each individual item was assigned an outcome name using the International Classification of Functioning and following standard linking rules, [23].

X categorized all outcomes into an outcome taxonomy developed by COMET for categorizing outcomes for core outcome set development,[24]. These included 5 core areas and 38 outcome domains. This is presented in supplementary file 2. A long list of all categorized outcomes was presented to researchers (X and X) at a face to face meeting where the categorization of all outcomes was reviewed using the recommended taxonomy. Subdomains were created within the larger taxonomy to manage the large variation in TBPI clinical outcomes extracted. Disagreements not resolved at this stage were discussed Erasmushogeschool . Protected by copyright, including for uses related to text and data mining, AI training, and similar technologies

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further with subject experts (for example, the Adverse Event domain was discussed with a surgeon).

Due to the diversity in terminology used to report outcomes, we grouped similar outcomes within each subdomain. It is recommended that outcomes with different words, phrasing, or spelling addressing the same concept should be categorized as a unique outcome,[25]. For example, active range of motion of shoulder abduction and active goniometry of shoulder abduction were named as active shoulder abduction range and grasp strength and grip strength were named as grip strength. Independent meetings were held with four subject experts to ratify and define unique outcome names within each domain.

#### Patient and public involvement

The need for a COS in TBPI care was conceived following discussions with patients and health professionals. Patients highlighted the diverse effect the injury has on their life and that often these outcomes were overlooked by professionals, such as body image. There is a patient advisory group for the COS and the systematic review was discussed at these meetings. Patients were not actively involved in data collection or analysis of this review. Dissemination will occur at the annual traumatic brachial plexus charity UK meeting where updates from the project are presented yearly and through a six monthly newsletter. Erasmushogeschool . Protected by copyright, including for uses related to text and data mining, Al training, and similar technologies

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#### Results

#### **Included studies**

The search identified 1159 studies, after removing duplicates 1105 studies remained. Titles and abstract review identified 169 potentially relevant articles. Of these, 37 studies did not meet the inclusion criteria and were excluded (PRISMA flow diagram; figure 1) thus, 132 studies formed the basis of this review. All included articles are presented in supplementary file 3.

#### **Study characteristics**

Thirty-two countries from six continents recruited 3201 participants into the 132 studies (Table 1). Of the 132 studies, 87 (66%) were retrospective case series with most studies published from Asia (n=61, 46%). The most frequently studied surgical intervention was nerve transfers (n=66, 57%).

# Table 1. Characteristics and demographics of included studies

	Study number (%)
Number of retrospective studies	87/132(66)
Number of prospective studies	21/132 (16)
Number of case studies	23/132(17)
Randomized controlled trial	1/132 (0.8)
World region recruitment	
Asia	61/132(46)
North America	20/132(15)
South America	20/132(15)
Europe	27/132(20)
Africa	3/132(2.2)
Australasia	1/132(0.8)
Year published	
2013	25/132 (19)
2014	24/132(18)
2015	15/132(11)
2016	30/132(23)
2017	27/132(20)
2018	11/132(8.3)
Gender (total 3201)	
Male	2622/3201(82)
Female	323/3201(10)
Not stated	256/3201(7.9)

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# Site of plexus injury per study (n=132)

Upper trunk	26/132(20)
Lower trunk	10/132(7.6)
Pan plexus (all avulsed)	50/132(38)
Infraclavicular	7/132(5.3)
Mixture	32/132(24)
Unclear	7/132(5.3)

# Interventions (n=132)

Surgical	115/132(87)
Electrotherapy	2/132(1.5)
Pain treatments	11/132 (8.3)
Rehabilitation	2/132(1.5)
Orthotic	1/132(0.7)
Stem cell	1/132(0.7)
Types of surgical intervention (n=115)	
Neurotisation	66/115(57)
Tendon transfer	7/115(6.1)
Free flap	16/115(14)
Multiple surgeries	12/115(10)
Contralateral C7	8/115(6.9)

# Outcomes

A total of 1460 verbatim outcomes were reported, after removing duplicates 157 different unique outcomes remained. No single outcome was reported across all 132 studies. *Outcome definition variation*. Many outcomes were not clearly defined and different terms were frequently found for the same concept. For example, shoulder abduction strength was described in eleven different ways including 'deltoid strength', 'motor function of axillary nerve', 'motor recovery of shoulder abductors', 'muscle power supraspinatus', 'motor function of Deltoid', 'motor function of Supraspinatus'.

*Outcome timing variation:* Of the 1460 verbatim outcomes, 46% (672) were measured between one and three years following intervention. For 83 outcomes the timing of the measurement was not stated. See Figure 2.

Place Figure 2 here

Figure 2. Timepoints of reported outcomes

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*Outcome domains:* The 157 different types of outcomes were categorized into four core areas (Physiological and Clinical, Life Impact, Resource Use, Adverse Events/Complications) and 11 domains according to the COMET recommendations,[24]. See supplementary file 4. The core area Physiological/Clinical included three domains: musculoskeletal and connective tissue outcomes, nervous system outcomes and general/symptom outcomes. The core area Life Impact included seven domains: physical functioning, social functioning, role functioning, emotional functioning, global quality of life, perceived health status and delivery of care. The core area Resource Use included one domain: hospital resources. The core area Adverse Events included one domain: adverse events. No outcome could be placed into the core area Death.

Tables 2 to 4 summarise the number of unique outcomes within each domain and the number of studies reporting these outcomes in each core area. The most frequently reported domains were all in the Physiological/ Clinical core area and included musculoskeletal and connective tissue (87%), nervous system (35%) and symptoms (36%). Forty-four studies (33%) reported complications/ adverse events.

# Table 2. Physiological /Clinical Core Area

Outcome Domains	Number of unique outcomes reported within domain	Examples of unique outcomes	Number of studies reporting outcomes in domain (%)
Musculoskeletal and connective tissue	18	Active range of movement, muscle strength, muscle fatigue	115/132 (87%)
Nervous system	15	Progression of nerve regeneration, ability to feel light touch, ability to feel pain	46/132 (35%)
General/ symptoms	23	Pain intensity/relief, pain duration, pain quality, pain when arm exposed to cold, stiffness, sleep, paresthesia	47/132 (36%)

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# Table 3. Life Impact Core Area

Outcome Domains	Number of unique outcomes reported within domain	Examples of unique outcomes	Number of studies reporting outcomes within domain (%)
Physical functioning	19	Reaching, fine hand movement	30/132 (23%)
Role functioning	23	Return to work, Impact on normal hobbies	33/132 (25%)
Social functioning	7	Social activities with family	30/132 (23%)
Emotional functioning	13	Body image, acceptance	29/132 (22%)
Global quality of life	1	Quality of life	1/132 (0.8%)
Perceived health Status	1	Health status rating	6/132 (4.5%)
Delivery of care	13	Patient satisfaction, quality of care, patient preference, time to surgery	11/132(8.3%)
		31	

Examples of unique outcomes	Number of studies reporting outcomes within domain
Motor weakness, sensory loss	24/132(18%)
Co -contraction, Passive movement	12/132 (9%)
Pneumothorax	6/132 (4.5%)
Hematoma	7/132 (5.3%)
Infection	3/132 (2.3%)
General complications	2/132 (1.5%)
0	
Operation time	1/132 (.75%)

# Table 4. Adverse Events and Resource Use Core Areas

Number of unique

outcomes reported

within domain

**Outcome Domains** 

**Adverse Events Core Area** 

Donor site morbidity

Musculoskeletal

Respiratory

Vascular

Infection

specified

use

General non

complications

Hospital resource

**Resource Use Core Area** 

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#### **Outcome Measurement**

Outcomes were extracted from 30 different instruments; PRO measures (n= 20), combined clinician-reported and patient-reported measures (n= 3) and performance measures (n= 7). See table 5. These measures were reported 83 times in the included publications. Most outcome measures were used once (n= 25, 30%). The most frequently reported measures were the Disabilities of the Arm Shoulder and Hand (DASH,[26]) questionnaire (n=27 studies, 32%) and the Visual Analogue Scale (n=18, 22%). The median number of items per instrument was 15 ranging from one (Visual Analogue Scale, Numerical Rating Scale and Wong Baker Faces rating scale),[27] to 54,[28]. These items mapped to 34 different outcome domains.

There was wide variation in the methods used to measure outcomes. This is presented in supplementary file 5 (Measurement instruments mapped to domains). For example; 62 different measurements were used to evaluate muscle function, including the British Medical Research Council,[29] eleven different modifications of the British Medical Council, Isokinetics, Dynanometry and Constant - Murley score,[30]. In addition, it was often not clear which instrument was used for measurement of the outcomes. For example, the instrument used to measure active range of movement was not reported in 36% of total times (63/ 174) the outcome was assessed. Finally with regards to method of measurement 55 studies employed a PRO instrument to evaluate the intervention.

Patient Reported OutcomeUpper limb physical function measures (n= 16)Disabilities of Arm Shoulder and Hand38327Disabilities of Arm Shoulder and Hand38327MeasuresUpper Extremity Functional Index2002American Shoulder and Elbow Score1501Modified American Shoulder and Elbow Score1301Simple Shoulder test1201Michigan Hand Questionnaire3701PRO & ClinRO MeasureUniversity of California Los Angelus shoulder501MAYO Performance Index401Performan ce MeasuresJebsen Taylor701Upper Limb Module Questionnaire2231Quitore Function for Unilateral Amputees (UNB)11Upper Limb Module Questionnaire2601Purdue Peg test301Activities Measure for Upper Limb Amputees2401Patient Reported Outcome36 item short form survey (SF36)3685Patient Specific Functional Score401			Numbe r of items	Numbe r of scales	Frequenc y (n=83)
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Outcome 36 item short form survey (SF36) 36 8 5	Reported Outcome	Generic questionnaires (n=2)			
		36 item short form survey (SF36)	36	8	5
		Patient Specific Functional Score	4	0	1

# Table 5: Outcome measures used in included studies

DISCUSSION

This systematic review aimed to identify what outcome domains have been reported in studies evaluating interventions for TBPI, examine outcome definitions and timepoints and identify the instruments used to assess outcomes. We found a wide variation in reported outcomes, timing of outcomes and outcome instruments used. Furthermore, a lack of standardized definition for commonly reported outcomes was observed. This heterogeneity in outcome reporting across studies hinders evidence synthesis and results in research waste,[31].

The most commonly reported core area was Physiological/ Clinical including musculoskeletal, nervous system and symptom domains. Eighty-seven percent of studies reported musculoskeletal outcomes. However, there were 21 different outcomes reported in this category making comparison between studies difficult. Furthermore, the diversity of measures used to assess the outcomes increases the difficulty with synthesis. For example, muscle function/ strength was assessed using 59 different measures, whilst 10 studies did not report what measure they used. To compound this muscle strength was assessed by both physical examination by a clinician (86%) and also by asking the patient(10%).

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Only 42% of studies (55/132) evaluated PROs and within these studies there was significant heterogeneity in the measurement instrument used. Twenty-three different instruments were used with 18 only ever used once. The DASH was the most common instrument employed, in just over half the studies evaluating a PRO. The PRO instruments also varied greatly in terms of content with some as simple as a single item whilst others included up to 54 items. Over 273 individual questionnaire items were evident from the 23 PRO instruments mapping to 34 different outcomes domains. This highlighted a lack of consistency with no domain being measured by all PRO instruments. None of the included PRO assessments were designed specifically for individuals with a TBPI. Although this may be beneficial in terms of comparison with other conditions, such instruments may not be sensitive to issues of importance to patients with TBPI. These issues combined pose major questions regarding the clinical interpretation of results from TBPI studies.

It is clear that that individuals with a TBPI suffer significant emotional and psychoscocial issues, [1, 32]. However such issues were infrequently and inconsistently measured within this review. Only one study considered Quality of Life (QoL) as an outcome, [33] using a single item PRO. Similarly, physical, role and social functioning outcomes were reported in 23%, 25% and 23% of studies respectively. This relates strongly to the use of the DASH within the studies. Indeed, emotional functioning was reported in 29 studies, 27 of these studies used the DASH which has one item on confidence and capability mapping to this

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domain. If the DASH was excluded, only seven studies would assess outcomes within the emotional functioning domain. This is surprising considering the existing literature which evidences the complex emotional and psychological factors, individuals face when adjusting to their injury, [1, 34].

Complications/adverse events were reported in 33% of studies. Documentation of complications is crucial to improve patient care and gather data for benchmarking. In 1992, the Clavien-Dindo classification,[35] was introduced to assist with classification of complications to enable comparison between studies,[36]. However, within the adverse events outcomes identified in this review there was heterogeneity. Of the 37 verbatim outcomes reported within the donor morbidity (motor) outcome 19 did not define how this was assessed.

There are some limitations. We excluded outcomes from older studies to ensure we identified outcomes relevant to contemporary TBPI care. Formal quality assessment of studies was not undertaken, however the review was designed to identify the breadth of reporting in the literature and not to examine the effectiveness of interventions. The strengths of this review are that the protocol and the data extraction form were prespecified, prospectively registered and the literature search systematic. To account for multidisciplinary perspectives, researchers and clinicians where involved in categorizing outcomes into domains. It is the first review to detail the scale of outcome heterogeneity in TBPI research using a systematic method. International and non-English publications were included to reduce the risk of selection bias.

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Variation in definitions and measurement of outcomes has been found within other areas of healthcare. Outcome heterogeneity is found in the reporting of outcomes relating to burn care,[37] breast reconstruction,[38] and spinal cord injury,[39] amongst others. A recent review of outcome reporting within burns illustrated wound healing was defined in 166 different ways across 147 studies,[37]. A solution to the variation in outcome reporting across studies in TBPI is the development of a COS,[40]. This has been shown to improve consistency of outcome reporting,[41, 19]. Development of a COS in TBPI would not restrict the range of outcomes that can be measured. Researchers and clinicians would still be free to select additional outcomes but the inclusion of such a COS would facilitate synthesis of evidence,[42, 43]. Whilst work has begun in obstetric brachial plexus injuries to develop a minimum data set,[44] there is no COS for TBPI.

Considerable work has been done by the Core Outcome Measures in Effectiveness Trials (COMET) initiative through dissemination of resources for COS development and support for methodological development. COMET recommends a five step process to develop a COS: define the scope, assess the need, develop the protocol, determine what to measure and determine how to measure,[45]. This systematic review addresses these first two steps for the development of the COS in TBPI care. This review has shown the majority of TBPI studies use only clinician reported outcomes to evaluate interventions. However they do not adequately capture patients' health related quality of life,[46] and may underestimate the impact of a condition,[47]. Concurrent qualitative work to identify outcomes which are important to individuals with a TBPI has been completed by this group. The next stage

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involves integration of all potential outcomes from this review and the qualitative work into a long list of domains. Healthcare professionals and patients will then prioritize these using a consensus process,[45]. This will strengthen the case for uptake of a COS for TBPI as it represents patients' and clinicians' perspectives on what outcomes are important.

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# CONCLUSION

This systematic review has shown that outcome reporting in TBPI care is heterogenous and impairment focused with a lack of standardized definitions for commonly reported outcomes. This makes it difficult to compare and combine data from studies to inform decision making in clinical practice. We have identified a list of potentially relevant outcomes and categorized these into a clear taxonomy. This will inform the next stage of developing a COS for TBPI where patients, surgeons and therapists will be involved in a consensus process to decide the final outcomes included in a COS for TBPI.

R. R.

#### Acknowledgements

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# **Competing Interests**

Conflicting interests: CM, CJH, JC, DMP and JOS declare no potential conflicts of interest with respect to the research, authorship and publication of this article. DGK reports grants from NIHR, grants from Innovate UK, grants from NIHR Birmingham Biomedical Research Centre, grants from NIHR SRMRC at the University of Birmingham and University Hospitals Birmingham NHS Foundation Trust, personal fees from Merck, personal fees from GSK,

 grants from Macmillan Cancer Support, grants from Kidney research UK, outside the submitted work; .

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CDRF-2017-03-039]

#### **Ethical approval**

Ethical approval was not sought for the present study because it was a systematic review

and did not involve human participation

# Informed consent

Informed consent was not sought for the present study because it was a systematic review

and did not involve human participation

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# Contributorship

CM, CJH and JC conceived and designed the review. CM and JOS reviewed the titles, abstracts and full text papers for eligibility. Authors resolved disagreements by discussion or where necessary CJH and DMP offered their view. CM and JOS were responsible for extracting data and data extraction was verified by CJH. CM, CJH and JC categorised outcomes. Categorisation was reviewed and edited by DMP and DK. CM prepared the JS rc. manuscript. CJH, JC, DMP, DK and JOS reviewed and edited the manuscript.

# REFERENCES Brito S, White J, Thomacos N, et al. The lived experience following free functioning muscle transfer for management of pan-brachial plexus injury: reflections from a long-term follow-up study. Disabil Rehabil 2019;1:1-9. 2 Morris MT, Daluiski A, Dy CJ. A Thematic Analysis of Online Discussion Boards for Brachial Plexus Injury. J Hand Surg Am 2016;41:813-818. 3 Kaiser R, Waldauf P, Ullas G, et al. Epidemiology, etiology, and types of severe adult brachial plexus injuries requiring surgical repair: systematic review and metaanalysis. Neurosurg Rev 2020;43:443-452. Moran CG, Lecky F, Bouamra O, et al. Changing the System - Major Trauma Patients and Their Outcomes in the NHS (England) 2008-17. EClinicalMedicine 2018;2-3:13-21. 5 Dy, C.J, Peacock, K, Olsen, MA, et al. Incidence of Surgically Treated Brachial Plexus Injury in Privately Insured Adults Under 65 Years of Age in the USA. HSS Jrnl 2020. Jan. https://doi.org/10.1007/s11420-019-09741-8 (accessed 12 September 2020). 6 Midha R. Epidemiology of brachial plexus injuries in a multitrauma population. Neurosurgery. 1997;40:1182-1189. Felici N, Zaami S, Ciancolini G, et al. Cost analysis of brachial plexus injuries: variability of compensation by insurance companies before and after surgery. Handchir Mikrochir Plast Chir. 2014;46:85-89. 8 Hong TS, Tian A, Sachar R, et al. Indirect Cost of Traumatic Brachial Plexus Injuries in

the United States. J Bone Joint Surg Am. 2019;101:e80.

- 9 Bhandari PS, Maurya S. Recent advances in the management of brachial plexus injuries. Indian *J Plast Surg*. 2014;47:191-198.
- 10 Kubota, S, Hara Y, Shimizu Y, et al. (2017) A newly developed upper limb single-joint HAL in a patient with elbow flexion reconstruction after traumatic brachial plexus injury: A case report. *Interdisciplinary Neurosurgery*. 2017;10:66-68.
- 11 Dickinson HD. Evidence-based decision-making: an argumentative approach. *Int J Med Inform*. 1998;51:71-81.
- 12 Sackett DL, Rosenberg WM, Gray JA, et al. Evidence based medicine: what it is and what it isn't. *BMJ*. 1996;312:71-72.
- 13 Ayhan E, Soldado F, Fontecha CG, et al. Elbow flexion reconstruction with nerve transfer or grafting in patients with brachial plexus injuries: A systematic review and comparison study. *Microsurgery*. 2020;40:79-86.
- 14 Donnelly MR, Rezzadeh KT, Vieira D, et al. Is one nerve transfer enough? A systematic review and pooled analysis comparing ulnar fascicular nerve transfer and double ulnar and median fascicular nerve transfer for restoration of elbow flexion after traumatic brachial plexus injury. *Microsurgery*. 2020;40:361-369.
- 15 Dy CJ, Garg R, Lee SK, et al. A systematic review of outcomes reporting for brachial plexus reconstruction. *J Hand Surg Am*. 2015;40:308-313.
- 16 Hill B, Williams G, Olver J, et al. Letter Regarding Outcome Reporting for Brachial Plexus Reconstruction. *J Hand Surg Am*. 2015;40:1504.
- 17 Gargon E, Gurung B, Medley N, et al. Choosing Important Health Outcomes For Comparative Effectiveness Research: A Systematic Review. *Value Health*.
  2014;17:A435.

18	Williamson P, Altman D, Blazeby J, Clarke M, Gargon E. Driving up the quality and
	relevance of research through the use of agreed core outcomes. J Health Serv Res
	Policy. 2012;17:1-2.
19	
20	Kirkham JJ, Bracken M, Hind L, et al. Industry funding was associated with increased
	use of core outcome sets. J Clin Epidemiol. 2019;115:90-97.
21	Higgins JPT, Green S. Cochrane Handbook for Systematic Reviews of Interventions. 5th
	Edn. The Cochrane Collaboration 2011. Available from www.handbook.cochrane.org.
22	Shamseer L, Moher D, Clarke M, et al. Preferred reporting items for systematic
	review and meta-analysis protocols (PRISMA-P) 2015: elaboration and explanation.
	<i>BMJ</i> . 2015;350:7647.
23	Kirkham JJ, Gorst S, Altman DG, et al. Core Outcome Set-STAndards for Reporting:
	The COS-STAR Statement. PLoS Med. 2016;13: e1002148.
24	Cieza A, Geyh S, Chatterji S, et al. ICF linking rules: an update based on lessons
	learned. J Rehabil Med. 2005;37:212-218.
25	Dodd S, Clarke M, Becker L et al. A taxonomy has been developed for outcomes in
	medical research to help improve knowledge discovery. J Clin Epidemiol. 2018,96:
	84-92.
26	Young AE, Brookes ST, Avery KNL et al. A systematic review of core outcome set
	development studies demonstrates difficulties in defining unique outcomes. J Clin
	Epidemiol. 2019a;115:14-24.
27	Hudak PL, Amadio PC, Bombardier C. Development of an upper extremity outcome
	measure: the DASH (disabilities of the arm, shoulder and hand). Am J Ind Med. 1996;
	29:602-608.
	For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

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- 28 Baker CM, Wong DL. Q.U.E.S.T.: a process of pain assessment in children (continuing education credit). Orthop Nurs. 1987; 6:11-21.
- 29 Gallagher P, MacLachlan M. Development and psychometric evaluation of the trinity amputation and prosthesis experience scales (TAPES). *Rehab Psychology*.
   2000;45:130–154.
- 30 Committee Medical. Medical Research Council [Great Britain]. Nerve Injuries Committee. Aids to the investigation of the peripheral nervous system. HM Stationary Office, 1942.
- 31 Conboy VB, Morris RW, Kiss J et al. An evaluation of the Constant-Murley shoulder assessment. J Bone Joint Surg Br. 1996;78:229-232.
- 32 Chalmers I, Glasziou P. Avoidable waste in the production and reporting of research evidence. *Lancet*. 2009;374:86-89.
- 33 McDonald J, Pettigrew J. Traumatic brachial plexus injury: the lived experience. *The British Journal of Occupational Therapy*. 2014;3:147-154.
- 34 Kim JH, Shin SH, Lee YR, et al. Ultrasound-guided peripheral nerve stimulation for neuropathic pain after brachial plexus injury: two case reports. *J Anesth.* 2017;31:453-457.
- 35 Miller C, Power D, Peek L et al. Psychological consequences of traumatic upper limb peripheral nerve injury: A systematic review. *Hand Therapy*. 2017;22:35–45.
- 36 Clavien PA, Sanabria JR, Strasberg SM. Proposed classification of complications of surgery with examples of utility in cholecystectomy. *Surgery*. 1992; 111:518-526.
- 37 Martins RS, Siqueira MG, Heise CO. A prospective study comparing single and double fascicular transfer to restore elbow flexion after brachial plexus injury. *Neurosurgery*. 2013; 72:709-715.

1			
2		20	Vering AF, Device A, Dland C, et al. Systematic review of elinical eviteeme reporting in
2		38	Young AE, Davies A, Bland S, et al. Systematic review of clinical outcome reporting in
5	5		randomized controlled trials of burn care. BMJ Open; 2019b, 9: e025135.
2	3	39	Potter S, Brigic A, Whiting PF, et al. Reporting clinical outcomes of breast
1	0		reconstruction: a systematic review. J Natl Cancer Inst. 2011;103:31-46.
1	2 3 4	40	Watzlawick R, Antonic A, Sena ES, et al. Outcome heterogeneity and bias in acute
1 1	5 6		experimental spinal cord injury: A meta-analysis. Neurology. 2019;93:e40-e51.
1	7  8  9	41	Williamson PR, Altman DG, Blazeby JM et al. The COMET (Core Outcome Measures in
	20 21		Effectiveness Trials) Initiative. Trials. 2011;12:A70.
2	22 23 24	42	Bautista-Molano W, Navarro-Compán V, Landewé RB, et al. How well are the
	25 26		ASAS/OMERACT Core Outcome Sets for Ankylosing Spondylitis implemented in
2	27 28 29		randomized clinical trials? A systematic literature review. <i>Clin Rheumatol</i> . 2014;33:
	80 81		1313-1322.
Э	32 33 34	43	Clarke M. Standardizing outcomes for clinical trials and systematic reviews. Trials.
(1) (1)	35 36		2007;8:39.
3	37 38 39	44	Clarke M, Williamson PR. Core outcome sets and systematic reviews. Syst Rev.
Z	40 41		2016;5:11.
Z	12 13 14	45	Pondaag W, Malessy MJA. Outcome assessment for Brachial Plexus birth injury.
Z	15 16		Results from the iPluto world-wide consensus survey. J Orthop Res. 2018;36:2533-
Z	17 18 19		2541.
5	50 51	46	Williamson PR, Altman DG, Bagley H, et al. The COMET Handbook: version 1.0. Trials.
5	52 53 54		2017;18(Suppl 3):280.
5	55 56	47	Pakhomov SV, Jacobsen SJ, Chute CG, et al. Agreement between patient-reported
5	57 58 59		symptoms and their documentation in the medical record. <i>Am J Manag Care</i> .
	50		2008;14:530-539.

randomized controlled trials of burn care. BMJ Open; 2019b, 9: e025135.	
Potter S, Brigic A, Whiting PF, et al. Reporting clinical outcomes of breast	
reconstruction: a systematic review. J Natl Cancer Inst. 2011;103:31-46.	
Watzlawick R, Antonic A, Sena ES, et al. Outcome heterogeneity and bias in acute	
experimental spinal cord injury: A meta-analysis. Neurology. 2019;93:e40-e51.	
Williamson PR, Altman DG, Blazeby JM et al. The COMET (Core Outcome Measures ir	ı
Effectiveness Trials) Initiative. Trials. 2011;12:A70.	
Bautista-Molano W, Navarro-Compán V, Landewé RB, et al. How well are the	
ASAS/OMERACT Core Outcome Sets for Ankylosing Spondylitis implemented in	
randomized clinical trials? A systematic literature review. <i>Clin Rheumatol</i> . 2014;33:	
1313-1322.	
Clarke M. Standardizing outcomes for clinical trials and systematic reviews. Trials.	
2007;8:39.	
Clarke M, Williamson PR. Core outcome sets and systematic reviews. Syst Rev.	
2016;5:11.	
Pondaag W, Malessy MJA. Outcome assessment for Brachial Plexus birth injury.	

- consensus survey. J Orthop Res. 2018;36:2533-
- , et al. The COMET Handbook: version 1.0. Trials.
- G, et al. Agreement between patient-reported in the medical record. Am J Manag Care.

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> 48 Turner GM, Slade A, Retzer A, et al. An introduction to patient-reported outcome measures (PROMs) in trauma. J Trauma Acute Care Surg. 2019;86:314-320.

Figure 2 Legends

mths, months; NS, not stated; yrs, years.

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### Title: Supplementary File 1 MEDLINE (OVID) search strategy

Article title: Developing a core outcome set for Traumatic Brachial Plexus Injuries: a systematic review of outcomes Author: Miller et al (2020)

Search strategy 18/09/2018 COMBINE systematic review

### MEDLINE (OVID)

1.(brachial plexus adj3 injur\*).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]

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6 (brachial plexus adj3 avulsion\*).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]

7 Brachial Plexus/in, su, tr [Injuries, Surgery, Transplantation]

8 1 or 2 or 3 or 4 or 5 or 6 or 7

9 limit 8 to (humans and "all adult (19 plus years)")

10. limit 9 to yr= "2013- current"

### Supplementary file 2: COMET outcome taxonomy Article title: Developing a core outcome set for Traumatic Brachial Plexus Injuries: a systematic review of outcomes

Core Area	Outcome Domain
Death	1. Mortality/ survival
Physiological/clinical	2. Blood and lymphatic system outcomes
	3. Cardiac outcomes
	4. Congenital, familial and genetic outcomes
	5. Endocrine outcomes
	6. Ear and labyrinth outcomes
	7. Eye outcomes
	8. Gastrointestinal outcomes
	9. General outcomes
	10. Hepatobilary outcomes
	11. Immune system outcomes
	12. Infection and infestation outcomes
	13. Injury and poisoning outcomes
	14. Metabolism and nutrition outcomes
	15. Musculoskeletal and connective tissue outcomes
	16. Outcomes, relating to neoplasms: benign, malignant and
	unspecified (including cysts and polyps)
	17. Nervous system outcomes
	18. Pregnancy, puerperium and perinatal outcomes
	19. Renal and urinary outcomes
	20. Reproductive system and breast outcomes
	21. Psychiatric outcomes
	22. Respiratory, thoracic and mediastinal outcomes
	23. Skin and subcutaneous tissue outcomes
	24. Vascular outcomes
Life Impact	Functioning
	25. Physical functioning
	26. Social functioning
	27. Role functioning
	28. Emotional functioning/ well being
	29. Cognitive functioning
	30. Global quality of life
	31. Perceived health status
	32. Delivery of care
	33. Personal circumstances
Resource use	Resource Use
	34. Economic
	35. Hospital
	36. Need for further intervention
	37. Societal/ carer burden
Adverse Events	38. Adverse Events / effects

Dodd S, Clarke M, Becker L et al. A taxonomy has been developed for outcomes in medical research to help improve knowledge discovery. *J Clin Epidemiol*. 2018;96:84-92.

## Supplementary file 3. Included Studies

	Study title	First author	Year of publicatio
1	Effectiveness and safety of home-based muscle electrical stimulator in brachial plexus Injury patient(Limthongthang et al., 2014)	Limthongthang	2014
2	Elbow proprioception sense in total arm -type brachial plexus injured patients after neurotisation: a preliminary study(Homsreprasert et al., 2014)	Homreprasert	2014
3	Comparison between the anterior and posterior approach for transfer of the spinal accessory nerve to the suprascapular nerve in late traumatic brachial plexus injuries (Souza et al., 2014)	Souza	2014
4	Ultrasound-guided peripheral nerve stimulation for neuropathic pain after brachial plexus injury: two case reports(Kim et al., 2017)	Kim	2017
5	Contralateral lower trapezius transfer for restoration of shoulder external rotation in traumatic brachial plexus palsy: preliminary report and literature review(Satbhai et al., 2014)	Satbhai	2014
6	Restoration of shoulder abduction in brachial plexus avulsion injuries with double neurotization from the spinal accessory nerve: a report of 13 cases(Huan et al., 2017)	Huan	2017
7	Transfer of the musculocutaneous nerve branch to the brachialis muscle to the triceps for elbow extension: anatomical study and report of five cases(Bertelli et al., 2017)	Bertelli	2017
8	Posterior approach for accessory to suprascapular nerve transfer: an electrophysiological outcomes study(Rui et al., 2013)	Rui	2013
9	Reliability of functioning free muscle transfer and vascularized ulnar nerve grafting for elbow flexion in complete brachial plexus palsy (Potter and Ferris, 2017)	Potter	2017
10	Management of infraclavicular (Chuang Level IV) brachial plexus injuries: A single surgeon experience with 75 cases (Lam et al., 2015)	Lam	2015
11	Functioning free muscle transfer for the restoration of elbow flexion in brachial plexus injury patients (Estrella and Montales 2016)	Estrella	2016
12	Radial to axillary nerve transfers: A combined case series(Desai et al., 2016)	Desai	2016
13	Thalamic deep brain stimulation for neuropathic pain after amputation or brachial plexus avulsion(Pereira et al., 2013)	Pereira	2013
14	Nerve transfers for shoulder function for traumatic brachial plexus injuries(Estrella et al., 2014)	Estrella	2014
15	Results of operative treatment of brachial plexus injury resulting from shoulder dislocation: A study with a long-term follow-up(Gutkowska et al., 2017)	Gutkowska	2017
16	Surgical treatment of brachial plexus posterior cord lesion: A combination of nerve and tendon transfers, about nine patients(Oberlin., 2013)	Oberlin	2013
17	The medial cord to musculocutaneous (MCMc) nerve transfer: a new method to reanimate elbow flexion after C5-C6-C7-(C8) avulsive injuries of the brachial plexus—technique and results(Ferraresi et al., 2014)	Ferraresi	2014

18	Transfer of a terminal motor branch nerve to the flexor carpi ulnaris	Bertelli	2015
	for triceps reinnervation: anatomical study and clinical cases(Bertelli et al., 2015)		
19	Free functioning gracilis muscle transfer with and without	Maldonado	2017(a)
	simultaneous intercostal nerve transfer to musculocutaneous nerve for		
	restoration of elbow flexion after traumatic adult brachial pan-plexus		
	injury(Maldonado et al., 2017a)		
20	Isolated latissimus dorsi transfer to restore shoulder external rotation	Ghosh	2013
	in adults with brachial plexus injury(Ghosh et al., 2013)		
21	Functional outcome and quality of life after traumatic total brachial	Satbhai	2016
	plexus injury treated by nerve transfer or single/double free muscle		
	transfers(Satbhai et al., 2016)		
22	Successful graded mirror therapy in a patient with chronic	Mibu	2016
	deafferentation pain in whom traditional mirror therapy was		
	ineffective: A case report(Mibu et al., 2016)		
23	Bipolar Transfer of Latissimus Dorsi Myocutaneous Flap for Restoration	Azab	2017
	of Elbow Flexion in Late Traumatic Brachial Plexus Injury: Evaluation of		
	13 Cases(Azab et al., 2017)		
24	Comparison of objective muscle strength in C5-C6 and C5-C7 brachial	Tsai	2014
	plexus injury patients after double nerve transfer (Tsai et al. 2015)		
25	Phantom remodeling effect of dorsal root entry zone lesioning in	Son	2015
	phantom limb pain caused by brachial plexus avulsion(Son et al., 2015)		
26	Comparison of surgical strategies between proximal nerve graft and/or	Hu	2018
	nerve transfer and distal nerve transfer based on functional		
	restoration of elbow flexion: A retrospective review of 147 patients(Hu		
	et al., 2018)	_	
27	Reconstruction of shoulder abduction by multiple nerve fascicle	Ren	2013
20	transfer through posterior approach(Ren et al., 2013)	Viaa	2014
28	Intercostal nerve transfer to neurotize the musculocutaneous nerve	Xiao	2014
	after traumatic brachial plexus avulsion: A comparison of two, three,		
20	and four nerve transfers(Xiao et al., 2014)	Docnik	2017
29	Use of the DEKA Arm for amputees with brachial plexus injury: A case series (Posnik et al. 2017)	Resnik	2017
30	series(Resnik et al., 2017) Polyester tape scapulopexy for chronic upper extremity brachial plexus	Loochouanauar	2015
30		Leechavengvon	2015
21	injury(Leechavengvongs et al., 2015)	gs	2012
31	Contralateral C7 nerve transfer with direct coaptation to restore lower	Wang	2013
	trunk function after traumatic brachial plexus avulsion(Wang et al., 2013)		
32	Outcome of surgical reconstruction after traumatic total brachial	Dodakundi	2013
52	plexus palsy(Dodakundi et al., 2013)	Douakullul	2013
22	Bionic reconstruction to restore hand function after brachial	Δετμορ	2015
33	plexus injury: a case series of three patients(Aszmann et al., 2015)	Aszmann	2015
34	Surgical treatment of the plexus brachialis injury using long-lasting	Tsymbalyuk	2013
54	electrostimulation (Tsymbaliuk and Tretiak, 2013)	rsymualyuk	2012
35	Phrenic nerve transfer for reconstruction of elbow extension in severe	Flores	2016
55	brachial plexus injuries (Flores and Socolovsky, 2016)	110163	2010
	brachiai piekus hijuries(fibres and socolovsky, 2010)		

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# Supplementary file 3. Included Studies

36	Direct coaptation of the phrenic nerve with the posterior division of the lower trunk to restore finger and elbow extension function in patients with total brachial plexus injuries( Wang et al., 2016)	Wang	2016
37	A prospective study comparing single and double fascicular transfer to restore elbow flexion after brachial plexus injury(Martins et al., 2013)	Martins	2013
38	Chronic post-traumatic neuropathic pain of brachial plexus and upper limb: a new technique of peripheral nerve stimulation(Stevanato et al., 2014)	Stevanato	2014
39	Effectiveness of contralateral C7 nerve root and multiple nerve transfer for treatment of brachial plexus root avulsion(Wei et al., 2014)	Wei	2014
40	Combined proximal nerve graft and distal nerve transfer for a posterior cord brachial plexus injury(Plate et al., 2013)	Plate	2013
41	The role of elective amputation in patients with traumatic brachial plexus injury (Maldonado et al., 2016b)	Maldonado	2016
42	Early microsurgical management of clavicular fracture combined with brachial plexus injury( Liu et al., 2014)	Liu	2014(a)
43	Contralateral trapezius transfer to restore shoulder external rotation following adult brachial plexus injury (Elhassan et al., 2016)	Elhassan	2016
44	Comparative study of phrenic nerve transfers with and without nerve graft for elbow flexion after global brachial plexus injury(Liu et al., 2014)	Liu	2014
45	Shoulder and elbow recovery at 2 and 11 years following brachial plexus reconstruction( Wang et al., 2016)	Wang	2016
46	Functional outcomes after treatment of traumatic brachial plexus injuries: clinical study(Aras et al., 2013)	Aras	2013
47	Free gracilis transfer reinnervated by the nerve to the supinator for the reconstruction of finger and thumb extension in longstanding C7-T1 brachial plexus root avulsion(Soldado et al., 2013)	Soldado	2013
48	Restoration of hand function in C7–T1 brachial plexus palsies using a staged approach with nerve and tendon transfer(Zhang et al., 2014)	Zhang	2014
49	Neurotization to innervate the deltoid and biceps: 3 cases(Dy et al., 2013)	Dy	2013
50	Arthroscopic arthrodesis of the shoulder in brachial plexus palsy(Lenoir et al., 2017)	Lenoir	2017
51	Outcome of contralateral C7 nerve transferring to median nerve(Kai- ming Gao et al., 2013)	Gao	2013
52	Intercostal nerve transfer to the biceps motor branch in complete traumatic brachial plexus injuries (Cho et al., 2015)	Cho	2015
53	Tactile feedback for relief of deafferentation pain using virtual reality system: a pilot study(Sano et al., 2016)	Sano	2016
54	Functioning free gracilis transfer to reconstruct elbow flexion and quality of life in global brachial plexus injured patients(Yang et al., 2016)	Yang	2016

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### Supplementary file 3. Included Studies

55	Evaluation of infraspinatus reinnervation and function following spinal accessory nerve to suprascapular nerve transfer in adult traumatic brachial playus injuries (Paltzer et al., 2017)	Baltzer	2017
56	brachial plexus injuries(Baltzer et al., 2017) Anatomic study of the intercostal nerve transfer to the suprascapular	Hu	2014
	nerve and a case report(Hu et al., 2014)		
57	Shoulder abduction and external rotation restoration with nerve	Kostas-	2013
	transfer(Kostas-Agnantis et al., 2013)	Agnantis	
58	Contralateral C-7 transfer: is direct repair really superior to grafting?(Bhatia et al., 2017)	Bhatia	2017
59	Impact of phrenic nerve paralysis on the surgical outcome of intercostal nerve transfer(Kita et al., 2015)	Kita	2015
60	Flow-through anastomosis using a T-shaped vascular pedicle for	Hou	2015
	gracilis functioning free muscle transplantation in brachial plexus injury(Hou et al., 2015)		
61	Free functional muscle transfer tendon insertion secondary	Sechachalam	2017
	advancement procedure to improve elbow flexion(Sechachalam et al., 2017)		
62	Dual nerve transfers for restoration of shoulder function after brachial plexus avulsion injury(Chu et al., 2016)	Chu	2016
63	Cortical plasticity after brachial plexus injury and repair: a resting-state functional MRI study(Bhat et al., 2017)	Bhat	2017
64	Results of spinal accessory to suprascapular nerve transfer in 110	Bertelli	2016
	patients with complete palsy of the brachial plexus(Bertelli et al., 2016)		
65	Magnetic resonance neurographic and clinical long-term results after oberlins transfer for adult brachial plexus injuries(Frueh et al., 2017)	Frueh	2017
66	Free functioning gracilis muscle transfer versus intercostal nerve transfer to musculocutaneous nerve for restoration of elbow flexion after traumatic adult brachial pan-plexus injury(Maldonado et al., 2016a)	Maldonado	2016
67	Results of wrist extension reconstruction in C5–8 brachial plexus palsy by transferring the pronator quadratus motor branch to the extensor carpi radialis brevis muscle(Bertelli et al., 2016)	Bertelli	2016
68	Donor nerve sources in free functional gracilis muscle transfer for elbow flexion in adult brachial plexus injury(Nicoson et al., 2017)	Nicoson	2017
69	Use of contralateral spinal accessory nerve for ipsilateral suprascapular neurotization in global brachial plexus injury: a new technique(Bhandari and Deb, 2016)	Bhandari	2016
70	Objective evaluation of elbow flexion strength and fatigability after nerve transfer in adult traumatic brachial plexus injuries (Maricq et al., 2014)	Marciq	2014
71	Outcomes of muscle brachialis transfer to restore finger flexion in brachial plexus palsy(DeGeorge et al., 2017)	DeGeorge	2017
72	Functional outcome of nerve transfers for traumatic global brachial plexus avulsion(Liu et al., 2013)	Liu	2013

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# Supplementary file 3. Included Studies

73	Transfer of a flexor digitorum superficialis motor branch for wrist extension reconstruction in C5-C8 root injuries of the brachial plexus: a	Bertelli	2013
	case series(Bertelli and Ghizoni, 2013)		
74	Outcome after transfer of intercostal nerves to the nerve of triceps	Gao	2013
	long head in 25 adult patients with total plexus root avulsion		
	injury(KaiMing Gao et al., 2013)		
75	Good sensory recovery of the hand in brachial plexus surgery using the	Foroni	2017
	intercostobrachial nerve as the donor(Foroni et al., 2017)		
76	The phrenic nerve as a donor for brachial plexus injuries: is it safe and	Socolovsky	2015
	effective? Case series and literature analysis(Socolovsky et al., 2015)		
77	Complete avulsion of brachial plexus with associated vascular trauma:	Hattori	2013
	Feasibility of reconstruction using the double free muscle		
	technique(Hattori et al., 2013)		
78	Long-term outcome of brachial plexus re-implantation after complete	Kachramanoglo	2017
	brachial plexus avulsion injury(Kachramanoglou et al., 2017)	u	
79	Force recovery assessment of functioning free muscle transfers using	Kodama	2014
	ultrasonography(Kodama et al., 2014)		
80	Rhomboid nerve transfer to the suprascapular nerve for shoulder	Goubier	2016
	reanimation in brachial plexus palsy: A clinical report(Goubier and		
	Teboul, 2016)		
81	Outcome of contralateral C7 transfer to two recipient nerves in 22	Gao	2013
	patients with the total brachial plexus avulsion injury(Kaiming et al.,		
	2013)		
82	Comparative study of phrenic and intercostal nerve transfers for elbow	Liu	2015
	flexion after global brachial plexus injury(Yuzhou et al., 2015)		
83	Donor-side morbidity after contralateral C-7 nerve transfer: results at a	Li	2016
	minimum of 6 months after surgery( Li et al., 2016)		
84	Outcome after brachial plexus injury surgery and impact on quality of	Rasulić	2017
	life(Rasulic et al., 2017)		
85	Pronator teres branch transfer to the anterior interosseous nerve for	Yang	2014
	treating C8T1 brachial plexus avulsion: An anatomic study and case		
00	report(Yang et al., 2014)	<u>Culture</u>	2015
86	Operative treatment with nerve repair can restore function in patients	Stiasny	2015
07	with traction injuries in the brachial plexus(Stiasny et al., 2015)	Caldada	2010
87	Thoracodorsal nerve transfer for triceps reinnervation in partial	Soldado	2016
00	brachial plexus injuries(Soldado et al., 2016)	Thakkar	2014
88	Co-infusion of autologous adipose tissue derived neuronal differentiated mesenchymal stem cells and bone marrow derived	IIIdKKdI	2014
	hematopoietic stem cells, a viable therapy for post-traumatic brachial		
	plexus injury: a case report (Thakkar et al., 2014)		
89	Long-term clinical outcomes of spinal accessory nerve transfer to the	Emamhadi	2016
07	suprascapular nerve in patients with brachial plexus palsy(Emamhadi	LIIIaIIIIIaUI	2010
	et al., 2016)		
90	Surgical treatment for total root avulsion type brachial plexus injuries	Tu	2014
50	by neurotisation: a prospective comparison study between total and	TU	2014
	hemicontralateral C7 nerve root transfer(Tu et al., 2014)		

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### Supplementary file 3. Included Studies

91	Deactivation of distant pain-related regions induced by 20-day rTMS: a	Qiu	2014
	case study of one-week pain relief for long-term intractable		
	deafferentation pain (Qiu et al., 2014)		
92	End-to-side neurorrhaphy in brachial plexus reconstruction(Haninec et	Haninec	2013
	al., 2013)		
93	Reanimation of elbow extension with medial pectoral nerve transfer in	Flores	2013
	partial injuries to the brachial plexus (Flores., 2013)		
94	Early post-operative results after repair of traumatic brachial plexus	Mohammad-	2013
	palsy(Mohammad-Reda., 2013)	Reda	
95	Satisfied patients after shoulder arthrodesis for brachial plexus lesions	van der Lingen	2018
	even after 20 years of follow-up(van der Lingen et al., 2018)		
96	Posterior branch of the axillary nerve transfer to the lateral triceps	Kilka	2013
	branch for restoration of elbow extension: case report(Klika et al.,		
	2013)		
97	Clinical analysis of repairing the whole brachial plexus nerve root	Liu	2014
	avulsion by transferring C7 nerve root from the uninjured side(Liu et		
	al., 2014)		
98	Bipolar transfer of the pectoralis major muscle for restoration of elbow	Cambon-Binder	2018
	flexion in 29 cases(Cambon-Binder et al., 2018)		
99	Thoracodorsal nerve transfer for elbow flexion reconstruction in	Soldado	2014
-	infraclavicular brachial plexus injuries(Soldado et al., 2014)		
100	Median nerve fascicle transfer versus ulnar nerve fascicle transfer to	Cho	2014
	the biceps motor branch in C5-C6 and C5-C7 brachial plexus injuries:	-	
	nonrandomised prospective study of 23 consecutive patients (Cho et		
	al., 2014)		
101	Free functional muscle transplantation of an anomalous femoral	Kaizawa	2013
	adductor with a very large muscle belly: a case report(Kaizawa et al.,	Nu.24114	2010
	2013)		
102	Selective neurotisation of the radial nerve in the axilla using the	Tuohuti	2016
	intercostal nerve to treat complete brachial plexus palsy(Tuohuti et al.,	•••••	
	2016)		
103	Objective predictors of functional recovery associated with intercostal	Flores	2016
	nerves transfer for triceps reinnervation in global brachial plexus		2010
	palsy(Flores., 2016)		
104	Nerve transfer to relieve pain in upper brachial plexus injuries: does it	Emamhadi	2017
107	work? (Emamhadi., 2017)	Lindinida	2017
105	Phrenic nerve transfer versus intercostal nerve transfer for the repair	Abdixbir	2016
103	of brachial plexus root avulsion injuries(Abdixbir et al., 2016)	ADUIADII	2010
106	End-to-side neurorrhaphy to restore elbow flexion in brachial plexus	Limthongthang	2016
100	injury(Limthongthang et al., 2016)	Lintitongthang	2010
107	Chordata method combined with electrotherapy in functional recovery	De Oliveira	2016
107		De Oliveira	2010
	after brachial plexus injury:report of three clinical cases(De Oliveira et		
400	al., 2016)		2045
108	Clinical outcome following transfer of the supinator motor branch to	Xu	2015
	the posterior interosseous nerve in patients with C7-T1 brachial plexus		
	palsy(Xu et al., 2015)		

## Supplementary file 3. Included Studies

	109	Transposition of branches of radial nerve innervating supinator to	Wu	2017
		posterior interosseous nerve for functional reconstruction of finger		
		and thumb extension in 4 patients with middle and lower trunk root		
_		avulsion injuries of brachial plexus(Wu et al., 2017)		
	110	Electromyographic findings in gracilis muscle grafts used to augment	Kazamel	2016
		elbow flexion in traumatic brachial plexopathy(Kazamel and Sorenson,		
_		2016)		
	111	Double distal intraneural fascicular nerve transfers for lower brachial	Li	2016
_		plexus injuries(Li et al., 2016)		
	112	Restoration of elbow and hand function in total brachial plexus palsy	Amal	2016
		with intercostal nerves and C5 root neurotisation. Results in 21		
		patients(Arnal et al., 2016)		
_	113	The phrenic nerve transfer in the treatment of a septuagenarian with	Jiang	2018
		brachial plexus avulsion injury: a case study(Jiang and Lao, 2018)		
	114	Outcomes of transferring a healthy motor fascicle from the radial	Flores	2017
		nerve to a branch for the triceps to recover elbow extension in partial		
		brachial plexus palsy(Flores., 2017)		
_	115	Successful nerve transfers for traumatic brachial plexus palsy in a	Johnsen	2016
		septuagenarian(Johnsen and Wolfe, 2016)		
_	116	Free functioning gracilis muscle transfer for elbow flexion	Maldonado	2017(b)
		reconstruction after traumatic brachial pan-plexus injury: Where is the		
		optimal distal tendon attachment for elbow flexion?(Maldonado et al.,		
		2017b)		
_	117	Results of distal nerve transfers in restoration of shoulder function in	Bhandari	2017
		C5 and C6 root avulsion injury to the brachial plexus (Bhandari., 2017)		
_	118	Bipolar dual-lead spinal cord stimulation between two electrodes on	Watanabe	2018
		the ventral and dorsal sides of the spinal cord: consideration of		
		putative mechanisms(Watanabe et al., 2018)		
_	119	Triceps nerve to deltoid nerve transfer after an unsatisfactory intra-	Al-Qattan	2017
		plexus neurotisation of the posterior division of the upper trunk(Al-		
		Qattan et al., 2017)		
_	120	Trapezius muscle transfer for restoration of elbow extension in a	Alrabai	2018
		traumatic brachial plexus injury(Alrabai et al., 2018)		
_	121	Transfer of the radial nerve branch to the extensor carpi radialis brevis	Bertelli	2015
		to the anterior interosseous nerve to reconstruct thumb and finger		
		flexion(Bertelli., 2015)		
_	122	Ultrasound-guided pulse-dose radiofrequency: treatment of	Magistroni	2014
		neuropathic pain after brachial plexus lesion and arm	-	
		vascularisation(Magistroni et al., 2014)		
-	123	Phrenic nerve transfer to the musculocutaneous nerve for the repair	Liu	2015
	-	of brachial plexus injury: electrophysiological characteristics(Liu et al.,		-
		2015)		
_	124	Postoperative motor deficits following elbow flexion reanimation by	Hanneur	2018
		nerve transfer( Hanneur et al., 2018)		
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#### Supplementary file 3. Included Studies

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3 4	125	Comparative study of phrenic and partial ulnar nerve transfers for	Liu	2018
5		elbow flexion after upper brachial plexus avulsion-a retrospective		
6		clinical analysis(Liu et al., 2018)		
7	126	Contralateral medial pectoral nerve transfer with free gracilis muscle	Yavari	2018
8 9		transfer in old brachial plexus injury(Yavari et al., 2018)		
9 10	127	MEG-BMI to control phantom limb pain(Yanagisawa et al., 2018)	Yanagisawa	2018
11	128	Complete brachial plexus injury- an amputation dilemma, A case	Choong	2015
12		report(Choong and Shalimar, 2015)		
13	129	Reversal of phantom pain and hand-to-face remapping after brachial	Tsao	2016
14 15		plexus avulsion(Tsao and Finn, 2016)		
16	130	A newly developed upper limb single-joint HAL in a patient with elbow	Kubota	2017
17		flexion reconstruction after traumatic brachial plexus injury: A case		
18		report(Kubota et al., 2017)		
19 20	131	Free reverse gracilis muscle combined with steindler flexorplasty for	Bertelli	2018
20		elbow flexion reconstruction after failed primary repair of extended		
22		upper-type paralysis of the brachial plexus(Bertelli., 2018)		
23	132	Multiple nerve and tendon transfers – a new strategy for restoring	Xu	2017
24		hand function in a patient with C7-T1 brachial plexus avulsions(Xu et al		
25 26		., 2017)		
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### Supplementary file 3. Included Studies

#### References

- Limthongthang R, Muennoi P, Phoojaroenchanachai R, Vathana T, Wongtrakul S.
   Effectiveness and safety of home-based muscle electrical stimulator in brachial plexus injury patients. J Med Assoc Thail. 2014, 97: S56–61.
- [2] Homsreprasert T, Limthongthang R, Vathana T, Wongtrakul S. Elbow joint proprioceptive sense in total arm-type brachial plexus injured patients after neurotization: a preliminary study. J Med Assoc Thail. 2014, 97: S103–7.
- [3] Souza F, Bernardino S, Filho H, Gobbato PL, Martins HAL, Martins RS, et al. Comparison between the anterior and posterior approach for transfer of the spinal accessory nerve to the suprascapular nerve in late traumatic brachial plexus injuries. Acta Neurochir (Wien) 2014, 156: 2345–9.
- [4] Kim JH, Shin SH, Lee YR, Lee HS, Chon JY, Sung CH, et al. Ultrasound-guided peripheral nerve stimulation for neuropathic pain after brachial plexus injury: two case reports. J Anesth. 2017, 31: 453–7.
- [5] Satbhai NG, Doi K, Hattori Y, Sakamoto S. Contralateral lower trapezius transfer for restoration of shoulder external rotation in traumatic brachial plexus palsy: a preliminary report and literature review. J Hand Surg Eur. 2014, 39: 861–7.
- [6] Huan KWSJ, Tan JSW, Tan SH, Teoh LC, Yong FC. Restoration of shoulder abduction in brachial plexus avulsion injuries with double neurotization from the spinal accessory nerve: a report of 13 cases. J Hand Surg Eur. 2017, 42: 700–5.
- [7] Bertelli JA, Soldado F, Ghizoni MF, Rodriguez-Baeza A, J.A. B, F. S, et al. Transfer of the musculocutaneous nerve branch to the brachialis muscle to the triceps for elbow extension: anatomical study and report of five cases. J Hand Surg Eur. 2017, 42: 710–4.
- [8] Rui J, Zhao X, Zhu Y, Gu Y, Lao J, J. R, et al. Posterior approach for accessory-suprascapular nerve transfer: an electrophysiological outcomes study. J Hand Surg Eur, 2013, 38: 242–7.
- Potter SM, Ferris SI. Reliability of functioning free muscle transfer and vascularized ulnar nerve grafting for elbow flexion in complete brachial plexus palsy. J Hand Surg Eur Vol 2017, 42: 693–9.
- [10] Lam WL, Fufa D, Chang N-J, Chuang DC-C. Management of infraclavicular (Chuang Level IV) brachial plexus injuries: A single surgeon experience with 75 cases. J Hand Surg Eur. 2015, 40: 573–82.
- [11] Estrella EP, Montales TD. Functioning free muscle transfer for the restoration of elbow flexion in brachial plexus injury patients. Injury. 2016, 47: 2525–33.
- [12] Desai MJ, Daly CA, Seiler JG 3rd, Wray WH 3rd, Ruch DS, Leversedge FJ, et al. Radial to Axillary Nerve Transfers: A Combined Case Series. J Hand Surg Am. 2016, 41: 1128–34.
- [13] Pereira EAC, Boccard SG, Linhares P, Chamadoira C, Rosas MJ, Abreu P, et al. Thalamic deep brain stimulation for neuropathic pain after amputation or brachial plexus avulsion. Neurosurg Focus. 2013, 35:E7.
- [14] Estrella EP, Favila AS Jr. Nerve transfers for shoulder function for traumatic brachial plexus injuries. J Reconstr Microsurg. 2014, 30: 59-64.

Supplementary file 3. Included Studies

- [15] Gutkowska O, Martynkiewicz J, Mizia S, Bak M, Gosk J. Results of Operative Treatment of Brachial Plexus Injury Resulting from Shoulder Dislocation: A Study with A Long-Term Follow-Up. World Neurosurg. 2017,105:623–31.
- [16] Oberlin C, Chino J, Belkheyar Z. Surgical treatment of brachial plexus posterior cord lesion: A combination of nerve and tendon transfers, about nine patients. Chir Main. 2013, 32:141–6.
- [17] Ferraresi S, Garozzo D, Basso E, Maistrello L, Lucchin F, Di Pasquale P. The medial cord to musculocutaneous (MCMc) nerve transfer: A new method to reanimate elbow flexion after C5-C6-C7-(C8) avulsive injuries of the brachial plexus - Technique and results. Neurosurg Rev. 2014, 37:321–9.
- [18] Bertelli J, Soldado F, Ghizoni MF, Rodriguez-Baeza A, J. B, F. S, et al. Transfer of a terminal motor branch nerve to the flexor carpi ulnaris for triceps reinnervation: Anatomical study and clinical cases. J Hand Surg Am. 2015, 40:2229-2235.
- [19] Maldonado AA, Kircher MF, Spinner RJ, Bishop AT, Shin AY. Free Functioning Gracilis Muscle Transfer With and Without Simultaneous Intercostal Nerve Transfer to Musculocutaneous Nerve for Restoration of Elbow Flexion After Traumatic Adult Brachial Pan-Plexus Injury. J Hand Surg Am 2017, 42: 293.
- [20] Ghosh S, Singh VK, Jeyaseelan L, Sinisi M, Fox M, S. G, et al. Isolated latissimus dorsi transfer to restore shoulder external rotation in adults with brachial plexus injury. Bone Jt J. 2013, 95: 660–3.
- [21] Satbhai NG, Doi K, Hattori Y, Sakamoto S, N.G. S, K. D, et al. Functional outcome and quality of life after traumatic total brachial plexus injury treated by nerve transfer or single/double free muscle transfers: A comparative study. Bone Jt J. 2016, 98: 209–17.
- [22] Mibu A, Nishigami T, Tanaka K, Osumi M, Tanabe A. Successful Graded Mirror Therapy in a Patient with Chronic Deafferentation Pain in Whom Traditional Mirror Therapy was Ineffective: A Case Report. Pain Pract. 2016, 16: E62–9.
- [23] Azab AA-H, Alsabbahi MS, A.A.-H. A, Azab AA-H, Alsabbahi MS. Bipolar Transfer of Latissimus Dorsi Myocutaneous Flap for Restoration of Elbow Flexion in Late Traumatic Brachial Plexus Injury: Evaluation of 13 Cases. Ann Plast Surg. 2017, 78: 198–201.
- [24] Tsai Y-J, Su F-C, Hsiao C-K, Tu Y-K. Comparison of objective muscle strength in C5-C6 and C5-C7 brachial plexus injury patients after double nerve transfer. Microsurgery. 2015, 35: 107–14.
- [25] Son BC, Ha SW. Phantom Remodeling Effect of Dorsal Root Entry Zone Lesioning in Phantom Limb Pain Caused by Brachial Plexus Avulsion. Stereotact Funct Neurosurg 2015, 93: 240–4.
- [26] Hu CH, Chang TN, Lu JC, Laurence VG, Chuang DC. Comparison of Surgical Strategies between Proximal Nerve Graft and/or Nerve Transfer and Distal Nerve Transfer Based on Functional Restoration of Elbow Flexion: A Retrospective Review of 147 Patients. Plast Reconstr Surg. 2018, 141: 68e-79e.
- [27] Ren G, Li R, Xiang D, Yu B. Reconstruction of shoulder abduction by multiple nerve fascicle transfer through posterior approach. Injury. 2013, 44: 492–7.
- [28] Xiao C, Lao J, Wang T, Zhao X, Liu J, Gu Y. Intercostal nerve transfer to neurotize the musculocutaneous nerve after traumatic brachial plexus avulsion: a comparison of two, three, and four nerve transfers. J Reconstr Microsurg 2014, 30: 297–304.
- [29] Resnik L, Fantini C, Latlief G, Phillips S, Sasson N, Sepulveda E, et al. Use of the DEKA Arm for

# Article title: Developing a core outcome set for Traumatic Brachial Plexus Injuries: a systematic review of outcomes For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

amputees with brachial plexus injury: A case series. PLoS One. 2017, 12: e0178642.

- [30] Leechavengvongs S, Jiamton C, Uerpairojkit C, Malungpaishorpe K, Witoonchart K, Poonotoke P, et al. Polyester tape scapulopexy for chronic upper extremity brachial plexus injury. J Hand Surg Am. 2015, 40:1184
- [31] Wang S, Li P, Xue Y, Yiu H, Li YC, Wang H. Contralateral C7 nerve transfer with direct coaptation to restore lower trunk function after traumatic brachial plexus avulsion. J Bone Joint Surg Am. 2013, 95: 821–2.
- [32] Dodakundi C, Doi K, Hattori Y, Sakamoto S, Fujihara Y, Takagi T, et al. Outcome of surgical reconstruction after traumatic total brachial plexus palsy. J Bone Joint Surg Am. 2013, 95:1505–12.
- [33] Aszmann OC, Roche AD, Salminger S, Paternostro-Sluga T, Herceg M, Sturma A, et al. Bionic reconstruction to restore hand function after brachial plexus injury: a case series of three patients. Lancet. 2015, 385: 2183–9.
- [34] Tsymbaliuk VI, Tretiak IB. [Surgical treatment of the plexus brachialis injury using long-lasting electrostimulation]. Klin Khirurhiia. 2013, 59–61.
- [35] Flores LP, Socolovsky M. Phrenic Nerve Transfer for Reconstruction of Elbow Extension in Severe Brachial Plexus Injuries. J Reconstr Microsurg. 2016, 32: 546–50.
- [36] Wang S, Li P, Xue Y, Zou J, Li W, Li Y. Direct Coaptation of the Phrenic Nerve With the Posterior Division of the Lower Trunk to Restore Finger and Elbow Extension Function in Patients With Total Brachial Plexus Injuries. Neurosurgery. 2016, 78: 208–14.
- [37] Martins RS, Siqueira MG, Heise CO, Foroni L, Teixeira MJ. A prospective study comparing single and double fascicular transfer to restore elbow flexion after brachial plexus injury. Neurosurgery. 2013, 72: 709–15.
- [38] Stevanato G, Devigili G, Eleopra R, Fontana P, Lettieri C, Baracco C, et al. Chronic posttraumatic neuropathic pain of brachial plexus and upper limb: a new technique of peripheral nerve stimulation. Neurosurg Rev. 2014, 37: 473–9.
- [39] Wei W, Alimujiang-Abulaiti, Tuerxunjiang-Dadihan, Meihua S, Yafei L, Chunxiao Y, et al. [EFFECTIVENESS OF CONTRALATERAL C7 NERVE ROOT AND MULTIPLE NERVES TRANSFER FOR TREATMENT OF BRACHIAL PLEXUS ROOT AVULSION]. Zhongguo Xiu Fu Chong Jian Wai Ke Za Zhi. 2014, 28: 737–40.
- [40] Plate JF, Ely LK, Pulley BR, Smith BP, Li Z. Combined proximal nerve graft and distal nerve transfer for a posterior cord brachial plexus injury. J Neurosurg. 2013, 118: 155–9.
- [41] Maldonado AA, Kircher MF, Spinner RJ, Bishop AT, Shin AY. The role of elective amputation in patients with traumatic brachial plexus injury. J Plast Reconstr Aesthetic Surg. 2016, 69:311–7.
- [42] Liu Y, Wang W, Regmi AM, Ahemaitijiang-Yusufu. Early microsurgical management of clavicular fracture combined with brachial plexus injury. Zhongguo Xiu Fu Chong Jian Wai Ke Za Zhi. 2014a,28: 1329–32.
- [43] Elhassan BT, Wagner ER, Spinner RJ, Bishop AT, Shin AY. Contralateral Trapezius Transfer to Restore Shoulder External Rotation Following Adult Brachial Plexus Injury. J Hand Surg Am. 2016, 41: e45-51.
- [44] Liu Y, Lao J, Gao K, Gu Y, Zhao X. Comparative study of phrenic nerve transfers with and

### Supplementary file 3. Included Studies

 without nerve graft for elbow flexion after global brachial plexus injury. Injury. 2014b, 45: 227–31.

- [45] Wang J-P, Rancy SK, Lee SK, Feinberg JH, Wolfe SW. Shoulder and Elbow Recovery at 2 and 11 Years Following Brachial Plexus Reconstruction. J Hand Surg Am. 2016, 41:173–9.
- [46] Aras Y, Aydoseli A, Sabanci PA, Akcakaya MO, Alkir G, Imer M. Functional outcomes after treatment of traumatic brachial plexus injuries: clinical study. Ulus Travma Acil Cerrahi Derg. 2013, 19: 521–8.
- [47] Soldado F, Bertelli J, F. S. Free gracilis transfer reinnervated by the nerve to the supinator for the reconstruction of finger and thumb extension in longstanding C7-T1 brachial plexus root avulsion. J Hand Surg Am. 2013, 38: 941–6.
- [48] Zhang C-G, Dong Z, Gu Y-D. Restoration of hand function in C7-T1 brachial plexus palsies using a staged approach with nerve and tendon transfer. J Neurosurg. 2014, 121: 1264–70.
- [49] Dy CJ, Kitay A, Garg R, Kang L, Feinberg JH, Wolfe SW, et al. Neurotization to innervate the deltoid and biceps: 3 Cases. J Hand Surg Am. 2013, 38:237–40.
- [50] Lenoir H, Williams T, Griffart A, Lazerges C, Chammas M, Coulet B, et al. Arthroscopic arthrodesis of the shoulder in brachial plexus palsy. J Shoulder Elb Surg. 2017, 26: e115–21.
- [51] Gao K, Lao J, Zhao X, Gu Y. Outcome of contralateral C7 nerve transferring to median nerve. Chin Med J (Engl). 2013, 126: 3865–8.
- [52] Cho AB, Iamaguchi RB, Silva GB, Paulos RG, Kiyohara LY, Sorrenti L, et al. Intercostal nerve transfer to the biceps motor branch in complete traumatic brachial plexus injuries. Microsurgery. 2015, 35: 428–31.
- [53] Sano Y, Wake N, Ichinose A, Osumi M, Oya R, Sumitani M, et al. Tactile feedback for relief of deafferentation pain using virtual reality system: a pilot study. J Neuroeng Rehabil. 2016, 13:61.
- [54] Yang Y, Yang J-T, Fu G, Li X-M, Qin B-G, Hou Y, et al. Functioning free gracilis transfer to reconstruct elbow flexion and quality of life in global brachial plexus injured patients. Sci Rep. 2016, 6: 22479.
- [55] Baltzer HL, Wagner ER, Kircher MF, Spinner RJ, Bishop AT, Shin AY, et al. Evaluation of infraspinatus reinnervation and function following spinal accessory nerve to suprascapular nerve transfer in adult traumatic brachial plexus injuries. Microsurgery. 2017, 37: 365–70.
- [56] Hu S, Chu B, Song J, Chen L. Anatomic study of the intercostal nerve transfer to the suprascapular nerve and a case report. J Hand Surg Eur. 2014, 39: 194–8.
- [57] Kostas-Agnantis I, Korompilias A, Vekris M, Lykissas M, Gkiatas I, Mitsionis G, et al. Shoulder abduction and external rotation restoration with nerve transfer. Injury. 2013, 44: 299–304.
- [58] Bhatia A, Doshi P, Koul A, Shah V, Brown JM, Salama M, et al. Contralateral C-7 transfer: is direct repair really superior to grafting? Neurosurg Focus. 2017, 43: E3.
- [59] Kita Y, Tajiri Y, Hoshikawa S, Hara Y, Iijima J. Impact of phrenic nerve paralysis on the surgical outcome of intercostal nerve transfer. Hand Surg. 2015, 20: 47–52.
- [60] Hou Y, Yang J, Yang Y, Qin B, Fu G, Li X, et al. Flow-through anastomosis using a T-shaped vascular pedicle for gracilis functioning free muscle transplantation in brachial plexus injury. Clinics (Sao Paulo). 2015, 70: 544–9.

#### Supplementary file 3. Included Studies

- [61] Sechachalam S, O'Byrne A, MacQuillan A. Free Functional Muscle Transfer Tendon Insertion Secondary Advancement Procedure to Improve Elbow Flexion. Tech Hand Up Extrem Surg. 2017, 21: 8–12.
- [62] Chu B, Wang H, Chen L, Gu Y, Hu S. Dual Nerve Transfers for Restoration of Shoulder Function After Brachial Plexus Avulsion Injury. Ann Plast Surg. 2016, 76: 668–73.
- [63] Bhat DI, Indira Devi B, Bharti K, Panda R. Cortical plasticity after brachial plexus injury and repair: a resting-state functional MRI study. Neurosurg Focus. 2017, 42: E14.
- [64] Bertelli JA, Ghizoni MF, J.A. B. Results of spinal accessory to suprascapular nerve transfer in 110 patients with complete palsy of the brachial plexus. J Neurosurg Spine. 2016, 24: 990–5.
- [65] Frueh FS, Ho M, Schiller A, Ducommun P, Manoliu A, Andreisek G, et al. Magnetic Resonance Neurographic and Clinical Long-Term Results After Oberlin's Transfer for Adult Brachial Plexus Injuries. Ann Plast Surg. 2017, 78: 67–72.
- [66] Maldonado AA, Kircher MF, Spinner RJ, Bishop AT, Shin AY. Free Functioning Gracilis Muscle Transfer versus Intercostal Nerve Transfer to Musculocutaneous Nerve for Restoration of Elbow Flexion after Traumatic Adult Brachial Pan-Plexus Injury. Plast Reconstr Surg. 2016, 138: 483e-488e.
- [67] Bertelli JA, Ghizoni MF, Tacca CP. Results of wrist extension reconstruction in C5-8 brachial plexus palsy by transferring the pronator quadratus motor branch to the extensor carpi radialis brevis muscle. J Neurosurg. 2016, 124: 1442–9.
- [68] Nicoson MC, Franco MJ, Tung TH. Donor nerve sources in free functional gracilis muscle transfer for elbow flexion in adult brachial plexus injury. Microsurgery. 2017, 37: 377–82.
- [69] Bhandari PS, Deb P. Use of contralateral spinal accessory nerve for ipsilateral suprascapular neurotization in global brachial plexus injury: A new technique. J Neurosurg Spine. 2016, 24: 186–8.
- [70] Maricq C, Jeunehomme M, Mouraux D, Remy P, Brassinne E, Bahm J, et al. Objective evaluation of elbow flexion strength and fatigability after nerve transfer in adult traumatic upper brachial plexus injuries. Hand Surg. 2014, 19: 335–41.
- [71] DeGeorge B, Becker H, Faryna J, Spinner R, Bishop A. Outcomes of brachialis muscle transfer to restore finger flexion in traumatic lower trunk brachial plexus palsy. J Hand Surg Am. 2017, 42: S33–4.
- [72] Liu Y, Lao J, Gao K, Gu Y, Zhao X. Functional outcome of nerve transfers for traumatic global brachial plexus avulsion. Injury. 2013, 44:655–60.
- [73] Bertelli JA, Ghizoni MF. Transfer of a flexor digitorum superficialis motor branch for wrist extension reconstruction in C5-C8 root injuries of the brachial plexus: a case series. Microsurgery. 2013, 33:39–42.
- [74] Gao K, Lao J, Zhao X, Gu Y. Outcome after transfer of intercostal nerves to the nerve of triceps long head in 25 adult patients with total brachial plexus root avulsion injury. J Neurosurg 2013, 118: 606–10.
- [75] Foroni L, Siqueira MG, Martins RS, Heise CO, Sterman HN, Imamura AY. Good sensory recovery of the hand in brachial plexus surgery using the intercostobrachial nerve as the donor. Arq Neuropsiquiatr. 2017, 75: 796–800.
- [76] Socolovsky M, di Masi G, Bonilla G, Dominguez Paez M, Robla J, Calvache Cabrera C, et al. The

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phrenic nerve as a donor for brachial plexus injuries: is it safe and effective? Case series and literature analysis. Acta Neurochir (Wien). 2015, 157: 1077–86.

- [77] Hattori Y, Doi K, Sakamoto S, Satbhai NG. Complete avulsion of brachial plexus with associated vascular trauma: feasibility of reconstruction using the double free muscle technique. Plast Reconstr Surg. 2013, 132: 1504–12.
- [78] Kachramanoglou C, Carlstedt T, Koltzenburg M, Choi D, C. K, T. C, et al. Long-Term Outcome of Brachial Plexus Reimplantation After Complete Brachial Plexus Avulsion Injury. World Neurosurg. 2017, 103: 28–36.
- [79] Kodama N, Doi K, Hattori Y. Force recovery assessment of functioning free muscle transfers using ultrasonography. J Hand Surg Am. 2014, 39: 2269–76.
- [80] Goubier J, Teboul F. Rhomboid nerve transfer to the suprascapular nerve for shoulder reanimation in brachial plexus palsy: A clinical report. Hand Surg Rehabil. 2016, 35: 363–6.
- [81] Gao K, Lao J, Zhao X, Gu Y. Outcome of contralateral C7 transfer to two recipient nerves in 22 patients with the total brachial plexus avulsion injury. Microsurgery. 2013, 33: 605–11.
- [82] Liu Y, Lao J, Zhao X. Comparative study of phrenic and intercostal nerve transfers for elbow flexion after global brachial plexus injury. Injury. 2015, 46: 671–5.
- [83] Li XM, Yang JT, Hou Y, Yang Y, Qin BG, Fu G, et al. Donor-side morbidity after contralateral C-7 nerve transfer: results at a minimum of 6 months after surgery. J Neurosurg. 2016, 124: 1434–41
- [84] Rasulic L, Savic A, Zivkovic B, Vitosevic F, Micovic M, Bascarevic V, et al. Outcome after brachial plexus injury surgery and impact on quality of life. Acta Neurochir (Wien) 2017, 159: 1257–64
- [85] Yang J, Jia X, Yu C, Gu Y. Pronator teres branch transfer to the anterior interosseous nerve for treating C8T1 brachial plexus avulsion: An anatomic study and case report. Neurosurgery. 2014, 75: 375–9.
- [86] Stiasny J, Birkeland P, J. S. Operative treatment with nerve repair can restore function in patients with traction injuries in the brachial plexus. Dan Med J. 2015, 62.
- [87] Soldado F, Ghizoni MF, Bertelli J, F. S, M.F. G. Thoracodorsal nerve transfer for triceps reinnervation in partial brachial plexus injuries. Microsurgery. 2016, 36: 191–7.
- [88] Thakkar UG, Vanikar A V, Trivedi HL. Co-infusion of autologous adipose tissue derived neuronal differentiated mesenchymal stem cells and bone marrow derived hematopoietic stem cells, a viable therapy for post-traumatic brachial plexus injury: a case report. Biomed J. 2014, 37: 237–40.
- [89] Emamhadi M, Alijani B, Andalib S, M. E, B. A. Long-term clinical outcomes of spinal accessory nerve transfer to the suprascapular nerve in patients with brachial plexus palsy. Acta Neurochir (Wien). 2016, 158: 1801–6.
- [90] Tu YK, Tsai YJ, Chang CH, Su FC, Hsiao CK, Tan JS. Surgical treatment for total root avulsion type brachial plexus injuries by neurotization: a prospective comparison study between total and hemicontralateral C7 nerve root transfer. Microsurgery. 2014, 34: 91–101.
- [91] Qiu YQ, Hua XY, Zuo CT, Li T, Zheng MX, Shen YD, et al. Deactivation of distant pain-related regions induced by 20-day rTMS: a case study of one-week pain relief for long-term intractable deafferentation pain. Pain Physician. 2014, 17: E99–105.

- [92] Haninec P, Mencl L, Kaiser R. End-to-side neurorrhaphy in brachial plexus reconstruction. J Neurosurg. 2013, 119: 689–94.
- [93] Flores LP. Reanimation of elbow extension with medial pectoral nerve transfer in partial injuries to the brachial plexus. J Neurosurg. 2013, 118: 588–93.
- [94] Mohammad-Reda A. Early post-operative results after repair of traumatic brachial plexus palsy. Turk Neurosurg. 2013, 23: 1–9.
- [95] van der Lingen MAJ, de Joode SGCJ, Schotanus MGM, Grimm B, van Nie FA, Speth LAWM, et al. Satisfied patients after shoulder arthrodesis for brachial plexus lesions even after 20 years of follow-up. Eur J Orthop Surg Traumatol. 2018, 28: 1089–94
- [96] Klika BJ, Spinner RJ, Bishop AT, Kircher MF, Shin AY. Posterior branch of the axillary nerve transfer to the lateral triceps branch for restoration of elbow extension: case report. J Hand Surg Am. 2013, 38: 1145–9.
- [97] Liu J, Wang X, Zhang S, Wang L, Xia D, Gao Q, et al. A clinical analysis of repairing the whole brachial plexus nerve root avulsion by transferring C7 nerve root from the uninjured side. J Neurol Sci. 2014, 31: 521–31.
- [98] Cambon-Binder A, Walch A, Marchei P, Belkheyar Z. Bipolar transfer of the pectoralis major muscle for restoration of elbow flexion in 29 cases. J Shoulder Elb Surg. 2018, 27: e330-e336
- [99] Soldado F, Ghizoni MF, Bertelli J. Thoracodorsal nerve transfer for elbow flexion reconstruction in infraclavicular brachial plexus injuries. J Hand Surg Am. 2014, 39: 1766–70.
- [100] Cho A, Paulos R, De Resende M, Kiyohara L, Sorrenti L, Wei TH, et al. Median nerve fascicle transfer versus ulnar nerve fascicle transfer to the biceps motor branch in C5-C6 and C5-C7 brachial plexus injuries: Nonrandomized prospective study of 23 consecutive patients. Microsurgery. 2014, 34: 511–5.
- [101] Kaizawa Y, Kakinoki R, Ohta S, Noguchi T. Free functional muscle transplantation of an anomalous femoral adductor with a very large muscle belly: A case report. J Brachial Plex Peripher Nerve Inj. 2013, 8: 11.
- [102] Tuohuti T, Yu Q, Yang J, Wang T. Selective neurotization of the radial nerve in the axilla using intercostal nerve to treat complete brachial plexus palsy. Int J Clin Exp Med. 2016, 9: 22880– 5.
- [103] Flores LP. Objective Predictors of Functional Recovery Associated with Intercostal Nerves Transfer for Triceps Reinnervation in Global Brachial Plexus Palsy. Brazilian Neurosurg 2016, 35: 271–8.
- [104] Emamhadi M. Nerve transfer to relieve pain in upper brachial plexus injuries: Does it work? Clin Neurol Neurosurg. 2017,163: 67–70.
- [105] Abdixbir A, Li P, Ilhamjan U, Exmetjan Y. Phrenic nerve transfer versus intercostal nerve transfer for the repair of brachial plexus root avulsion injuries. Chinese J Tissue Eng Res. 2016, 20: 7660–5.
- [106] Limthongthang R, Vathana T, Wongtrakul S, Songcharoen P. End-to-Side Neurorrhaphy to Restore Elbow Flexion in Brachial Plexus Injury. J Med Assoc Thai. 2016, 99: 1203–8.
- [107] De Oliveira C, Da Silva Melo D, Mestriner R, De Menezes M, Da Silva Filho I, Da Silva J.
   Chordata method combined with electrotherapy in functional recovery after brachial plexus injury: Report of three clinical cases. Sci Med (Porto Alegre). 2016, 26: 22425.

Supplementary file 3. Included Studies

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- [108] Xu B, Dong Z, Zhang C-G, Gu Y-D. Clinical outcome following transfer of the supinator motor branch to the posterior interosseous nerve in patients with C7-T1 brachial plexus palsy. J Reconstr Microsurg. 2015, 31: 102–6.
- [109] Wu X, Cong XB, Huang QS, Ai FX, Liu YT, Lu XC, et al. Transposition of branches of radial nerve innervating supinator to posterior interosseous nerve for functional reconstruction of finger and thumb extension in 4 patients with middle and lower trunk root avulsion injuries of brachial plexus. J Huazhong Univ Sci Technolog Med Sci. 2017, 37: 933–7.
- [110] Kazamel M, Sorenson EJ. Electromyographic Findings in Gracilis Muscle Grafts Used to Augment Elbow Flexion in Traumatic Brachial Plexopathy. J Clin Neurophysiol. 2016. 33:549– 53.
- [111] Li Z, Reynolds M, Satteson E, Nazir O, Petit J, Smith BP. Double Distal Intraneural Fascicular Nerve Transfers for Lower Brachial Plexus Injuries. J Hand Surg Am. 2016, 41: e15-9.
- [112] Arnal M, Cambon A, Marcheix P. Restoration of elbow and hand function in total brachial plexus palsy with intercostal nerves and C5 root neurotization. Results in 21 patients. Hand Surg Rehabil. 2016, 35: 283–7.
- [113] Jiang Y, Lao J. The phrenic nerve transfer in the treatment of a septuagenarian with brachial plexus avulsion injury: a case report. Int J Neurosci. 2018, 128: 467–71.
- [114] Flores LP. Outcomes of Transferring a Healthy Motor Fascicle From the Radial Nerve to a Branch for the Triceps to Recover Elbow Extension in Partial Brachial Plexus Palsy. Neurosurgery. 2017, 80: 448–53.
- [115] Johnsen PH, Wolfe SW. Successful Nerve Transfers for Traumatic Brachial Plexus Palsy in a Septuagenarian: A Case Report. Hand (N Y). 2016, 11: NP30–3.
- [116] Maldonado AA, Romero-Brufau S, Kircher MF, Spinner RJ, Bishop AT, Shin AY. Free Functioning Gracilis Muscle Transfer for Elbow Flexion Reconstruction after Traumatic Adult Brachial Pan-Plexus Injury: Where Is the Optimal Distal Tendon Attachment for Elbow Flexion?. Plast Reconstr Surg. 2017, 139: 128–36.
- [117] Bhandari PS. Results of Distal Nerve Transfers in Restoration of Shoulder Function in C5 and C6 Root Avulsion Injury to the Brachial Plexus. Indian J Neurotrauma 2017, 14: 21–5.
- [118] Watanabe M, Yamamoto T, Fukaya C, Obuchi T, Kano T, Kobayashi K, et al. Bipolar dual-lead spinal cord stimulation between two electrodes on the ventral and dorsal sides of the spinal cord: consideration of putative mechanisms. Acta Neurochir (Wien). 2018, 160: 639–43.
- [119] Al-Qattan M, Kattan A, Al-Qahtany B, Al-Qattan O. Triceps nerve to deltoid nerve transfer after an unsatisfactory intra-plexus neurotization of the posterior division of the upper trunk. Int J Surg Case Rep. 2017, 37: 124–6.
- [120] Alrabai H, Gesheff G, Hammouda A, Conway J. Trapezius Muscle Transfer for Restoration of Elbow Extension in a Traumatic Brachial Plexus Injury. J Hand Surg Am. 2018, 43: 872.
- [121] Bertelli JA. Transfer of the radial nerve branch to the extensor carpi radialis brevis to the anterior interosseous nerve to reconstruct thumb and finger flexion. J Hand Surg Am. 2015, 40: 323-328.
- [122] Magistroni E, Ciclamini D, Panero B. Ultrasound-guided pulse-dose radiofrequency: Treatment of neuropathic pain after brachial plexus lesion and arm revascularization. Case Rep Med. 2014, 201:429618.

#### Supplementary file 3. Included Studies

- [123] Liu Y, Xu X, Zou Y, Li S, Zhang B. Phrenic nerve transfer to the musculocutaneous nerve for the repair of brachial plexus injury: Electrophysiological characteristics. Neural Regen Res. 2015, 10: 328–33.
- [124] Le Hanneur M, Walch A, Gerosa T, Grandjean A, Masmejean E. Postoperative motor deficits following elbow flexion reanimation by nerve transfer. Hand Surg Rehabil 2018, 37: 289-294
- [125] Liu Y, Zhuang Y, Yu H, Xiong H. Comparative study of phrenic and partial ulnar nerve transfers for elbow flexion after upper brachial plexus avulsion: A retrospective clinical analysis. J Plast Reconstr Aesthetic Surg. 2018, 71: 1245–51.
- [126] Yavari M, Mahmoudvand H, Nadri S. Contralateral medial pectoral nerve transfer with free gracilis muscle transfer in old brachial plexus palsy. J Surg Res. 2018, 231: 94–8.
- [127] Yanagisawa T, Fukuma R, Seymour B, Hosomi K, Kishima H, Shimizu T, et al. MEG-BMI to control phantom limb pain. Neurol Med Chir (Tokyo). 2018, 58: 327–33.
- [128] Choong C, Shalimar A. Complete brachial plexus injury An amputation dilemma. A case report. Malaysian Orthop J. 2015, 9: 52–4.
- [129] Tsao J, Finn S. Reversal of phantom pain and hand-to-face remapping after brachial plexus avulsion. Ann Clin Transl Neurol. 2016, 3: 463–4..
- [130] Kubota S, Hara Y, Shimizu Y, Kadone H, Kubo T, Marushima A, et al. A newly developed upper limb single-joint HAL in a patient with elbow flexion reconstruction after traumatic brachial plexus injury: A case report. Interdiscip Neurosurg Adv Tech Case Manag. 2017, 10: 66–8.
- [131] Bertelli JA. Free Reverse Gracilis Muscle Combined With Steindler Flexorplasty for Elbow Flexion Reconstruction After Failed Primary Repair of Extended Upper-Type Paralysis of the Brachial Plexus. J Hand Surg Am. 2019, 44: 112-120
- [132] Xu B, Dong Z, Zhang C. Multiple nerve and tendon transfers: A new strategy for restoring hand function in a patient with C7-T1 brachial plexus avulsions. J Neurosurg. 2017, 127: 837– 42.

# Supplementary file 4: Unique outcomes mapped to potential domains and core areas according to COMET

# Online Supplementary file 4. Table: Unique outcomes mapped to potential domains and core areas according to COMET(Dodd et al., 2018)

Outcomes ( n=157)	Subdomains	Domains	Core Areas
Isometric muscle	Muscle strength/	Musculoskeletal and	Physiological/Clinical
strength	function	connective tissue	
Concentric strength		domain	
Eccentric strength			
Muscle			
flicker/contraction			
Anti-gravity muscle			
activity			
Muscle endurance			
Muscle fatigue			
Muscle torque			
Active range of	Active movement	-	
movement			
Perception of			
movement			
Antigravity			
movement			
Independent			
movement without			
donor			
Passive range of	Passive movement		
movement			
Movement	Control of		
control/stability	movement/stability		
Muscle mass	Muscle mass		
<u> </u>		-	
Bony union	Bone		
Joint position	structure/position		
Joint stability	-		-
General sensory	General sensory	Nervous system	
recovery	recovery		
Feeling of numbness	_		
Proprioception	-		
	Discriminative	-	
Light touch	touch		
2 PD			

Vibration	-		
Object recognition			
Pain	Protective touch		
Temperature	_		
Deep pressure		-	
Brachial plexus	Peripheral nervous		
structure	system structure		
Level of	Reinnervation		
reinnervation			
Time to			
reinnervation			
Progression of	Progression of		
regeneration	regeneration		
Speed of motor	Speed of motor		
sensory conduction	and sensory		
	conduction		
Pain intensity	Pain intensity/relief	General	
Pain relief /		outcomes/symptoms	
reduction			
Pain duration	Pain		
Pain frequency	duration/frequency		
Pain quality	Pain quality and	6.	
Pain interference	interference with		
with walking	life		
Pain interference in		4	
mood			
Pain interference	-		
with work		U,	
Pain interference in	-		
activities of daily		2	
living			
Pain interference	-		
with relationships			
Pain interference	-		
with enjoyment of			
life			
Pain interference	-		
with sleep			
Sensitivity to cold	Pain when arm		
Scholing to colu	exposed to cold		
Paraesthesia	Paraesthesia and		
Itchiness	itchiness		
1101111033			

# Supplementary file 4: Unique outcomes mapped to potential domains and core areas according to COMET

Sensitivity to	Sensitivity to touch,		
pressure	pressure etc		
Sensitivity to touch			
Pain location	Location of pain		
Pain relief from	Pain medication		
medication	use		
Stiffness	Stiffness		
Impact on general sleep	Impact on sleep		
Impact on sleep on affected side			
Frequency sleep disturbed by injury			
General physical	Physical function	Physical functioning	Life Impact
function	non-specific		
Patient led functional			
outcome			
Walking short	Lower limb and		
distance	non -upper limb		
Balance	function		
Running			
Climbing stairs			
Bending			
Kneeling			
Reaching	Reaching, pulling,		
Pulling	pushing, carrying		
Pushing	etc		
Carrying			
Throwing			
Lifting			
General function of arm		)	•
Turning and twisting arm	Turning twisting, gripping and	1	
Grip and release	releasing with the arm		
Pinching	Fine hand		
Fine hand movement	movement		
(writing/buttons)	including writing		
Returning to work	Impact on paid or unpaid work or role	Role functioning	
Ability to do work	in education		
Usual time at work			
Type of work	1		

Usual school activities			
	Role function -		
General rating to			
perform a patient	patient specific		
specific activity			
Impact on ADL	Carrying out daily		
(general)	routine, (including		
Return to ADL	food preparation,		
(general)	housework,		
	garden, plants)		
Impact on food			
preparation and			
feeding			
Housework (washing,			
cleaning, ironing,			
folding, vacuuming)			
Gardening (Includes			
indoor plants)			
Using a phone			
Maintaining personal			
hygiene			
Maintaining personal	Maintaining		
appearance	personal hygiene		
(grooming hair)			
Dressing	Maintaining	6.	
5	personal		
	appearance		
Transport needs (e.g	Dressing		
driving)			
Impact on normal	Transport needs		
hobbies	luces at a r		
Time doing normal	Impact on	2	
hobbies	recreational		
Playing instrument in	activities and sport		
usual way			
Ability to play			
instrument			
Impact on time spent			
playing instrument			
Impact on time spent			
doing sport			
Impact on	•		
participation in sport			
Social activities with	Effect on	Social functioning	
friends			
menus	relationship with		1

# Supplementary file 4: Unique outcomes mapped to potential domains and core areas according to COMET

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# Supplementary file 4: Unique outcomes mapped to potential domains and core areas according to COMET

Social activities with	family, friends,		
neighbours	neighbours and		
Social activities with	groups		
family	-		
Social activities with			
groups	-		
Dependence on			
family and friends	-		
Appearance			
interferes with social			
activities			
Intimate	Effect on intimate		
relationships	relationships		
Emotional impact on	Emotional	Emotional	
work	distress/mood	functioning	
Energy levels			
Emotional impact on			
ADL			
Happiness			
Impact on life			
enjoyment /			
satisfaction			
Emotional impact on		0	
relationships			
Anxiety		<b>C</b> .	
Depression			
Acceptance/	Thoughts and		
Adjustment	beliefs	4	
Coping with trauma	(acceptance,		
	coping)		
Confidence	Self esteem and		
Self esteem	confidence		
Body image	Body image		•
Quality of life	Quality of Life	Global Quality of Life	Quality of Life
Rating of health	Perceived Health	Health status	Health status
	status		
General patient	Patient satisfaction	Delivery of Care	Delivery of Care
satisfaction			
Satisfaction with			
appearance of arm			
Satisfaction with			
function			
Satisfaction with			
movement			
Satisfaction with			
strength			

Satisfaction with pain			
Satisfaction with			
colour			
Satisfaction with			
shape			
Satisfaction with			
feeling			
Satisfaction with			
procedure		_	
Patient preference	Patient preference	_	
Quality of	Accessibility,		
intervention	quality and		
	adequacy of		
	intervention	_	
Time to surgery	Time to surgery		
Operation time	Operation time	Resource Use	Resource Use
Motor morbidity	Donor site	Adverse Events	Adverse Event
Sensory morbidity	morbidity		
Pain		_	
General	General		
complications	complications		
Pneumothorax	Respiratory		
Respiratory function	complications		
Respiratory			
symptoms			
Pneumonia		_	
Arterial thrombosis	Vascular		
Venous thrombosis	complications		
Haematoma			
Venous spasm		3	
latrogenic vascular injury			
Vascularity of flap	-		
Swelling		_	
Fracture	Musculoskeletal complications		
Passive range of			
motion loss			
Co-contraction			
Bowstringing			
Failure of tendon			
attachment			
Joint Instability			
Scapula crepitus			

Supplementary file 4: Unique outcomes mapped to potential domains and core areas according to

Article title: Developing a core outcome set for Traumatic Brachial Plexus Injuries: a systematic review of outcomes For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

Erasmushogeschool . Protected by copyright, including for uses related to text and data mining, Al training, and similar technologies.

# Supplementary file 4: Unique outcomes mapped to potential domains and core areas according to COMET

Infection	Infection	
complications	complications	

Dodd, S. et al. A taxonomy has been developed for outcomes in medical research to help improve knowledge discovery. Journal of clinical epidemiology. 2018, 96: 84–92.

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 Supplementary file 5. Measurement of outcomes and measurement tools used
 Supplementary file 5. Measurement of outcomes and measurement tools used

 Supplementary file 5. Measurement of outcomes and measurement tools used
 Supplementary file 5. Measurement of outcomes and measurement tools used

 56 outcome subdomains in 4 core areas (Physiological/clinical, Life Impact, Resource Use and Adverse events) and within the following COMET domains

Musculoskeletal/connective tissue, Nervous system outcome domain, General outcome and symptom domain, Pfgysical functioning, Role functioning, Emotional functioning, Global quality of life, Perceived health status, Delivery of care, Hospital resources and Adverse Events uly 202 Eras relatec

	Outcome subdomains	Measurem	ent type used	(N)		ద్ది స్త్రామం Measuremeథ్జి క్రాణకtruments used ( number of studies )
Core Area			ent type used	,		and date
		Patient reported Outcome	Clinician reported Outcome	Perfomanc e Outcome	Not Clear	d from htt ol . ta mining
	Musculoskeletal/connective tissue					<b>P:</b>
	Muscle strength	30	129	19	3	DASH (n= 23, U을FI (n=2), MHQ (n=1), 플 중
S						Manual Muscle esting
ž					1/,	Manual muscle sesting undefined (n=5)
/CLINICAL						MRC muscleggrading (n=61 , including UCLA)
						MRC musclegrading modified (n= 22),
2						MRC modified, Charlear how (n= 5)
8						MRC modifigd, Fade 3 active must equal passive (n=2)
PHYSIOLOGICAL						MRC modified, grade 2 active must equal passive movement ( n=2)
Ρ						MRC modified, 123+ contraction with resistance against a finger
						for less than 30 geconds, M4 contraction of resistance against a
						finger against a ginger for more than 30 seconds (n=1)
						MRC modified: 🛱0, M1+, M1, M1+, M2-, M2, M2+,M3-, M3,
						M3+, M4-, M4, 🙀 4+, M5-, M5 ( n=6)
						MRC modified, Hanger flexion tested with wrist extended 20-30
						degrees (n=1) 😭

BMJ	Open	136/bmjc d by copy	Page 66 o
BMJ	sed	MRC modified, Addition of M4.5 (n=1) MRC modified, Addition of M4.5 (n=1) MRC modified, Addition of M4.5 (n=1) MRC modified, Added two muscles together (n=1) MRC modified, Added two muscles together (n=1) MRC modified, Added two muscles core (n=1) MRC modified, Added muscle score (n=1) MRC modified, Added the stabilising LF and IF to take testing MF Added the stabilising LF and IF to take testing MF Added the stabilising the stabilising LF and IF to take testing MF Added the stabilising the stabilising LF and IF to take testing MF Added the stabilising the	able and I Centre • equal to ed M3 ( d (n =1)
	en l	Grip strength JAMAR, undefined method (n=4); Hook isokinetic machine, undefined method (n=4); Hook isokinetic machine, undefined method (n=1); Grip strength JAMAR, mean of 3 trials n=2); Grip strength, PABLO s undefined (a=1) Pinch grip, JAMAR, undefined (n= 3), grip JAMAR, mean 3 trials (n= 1); Peak isometric, hand dynamometer (a=2); Isometric strength, hand held dynamometer, best of 3 trials (n=1); Isometric strengt & Kendall pesitions, 3 trials mean value (n=1); Measur digital scale, after 5 seconds (n=1) Concentric strength through range, Isokinetics (n=1) Eccentric strength through range, isokinetics (n=1) Combined action of using elbow and hand on digital h scale (n=1)	grip – ength system, , Pinch d held ch , Kendall rement on

e 67 of 74	BMJ Open 5. Measurement of outcomes and measurement tools used
Supplementary file 5	5. Measurement of outcomes and measurement tools used
	jht, n- 20
	Narakas score nepolified (one study)
	Thoaraco brach al grasp (n=1)
	Elbow flexion weight (n=1)
	Elbow extergior with weight (n=1)
	Wrist flexion with weight (n=1)
	Wrist exten and with weight (n=1)
	Fist power 遊遊 Seight (n=1)
	Fist power with Sweight (n=1) Pinch power (n=1) Pinch power (n=1) ULM (one study) ULM (one study) ULM (one study) Shoulder flexion above shoulder height with 500g (n=1) Shoulder flexion above shoulder with 1kg (n=1) Move weight on table (100g) (n=1) Move weight on table (500g) (n=1) Move weight on table (1KG) (n=1) SHAP (one study) SHAP (one study)
	ULM (one sချီးဗိုးကွန်
	Shoulder flessigrifto shoulder height with 500g (n=1)
	Shoulder fleရှိပိုက်ခိုခbove shoulder height with 500g (n=1)
	Shoulder flegiorgabove shoulder with 1kg (n=1) Move weight on table (100g) (n=1) Move weight on table (500g) (n=1) Move weight on table (1KG) (n=1) SHAP (one study)
	Move weight on table (100g) (n=1)
	Move weight on table (500g) (n=1)
	Move weight on table (1KG) (n=1)
	SHAP (one study)
	Grip strengta (n=1)
	Pinch strength ()
	Pinch grip (lateral) (n=1)
	Pinch grip (the second
	Grip strengta (pawer) (n=1)
	Heavy extergion (n=1)
	ogia 20
	مَنْ يَحْتَقُونُ مَنْ يَحْتَقُونُ مَنْ يَحْتَقُونُ مَنْ يَحْتَقُونُ مَنْ يَحْتَقُونُ مَنْ يَحْتَقُونُ مُنْ يَحْ Ability to lift weight, undefined (n=1)
	Ability to lift weight, undefined (n=1) Number of repertions movement can be performed in 10
	seconds (n=1) 중 Maximum weig뮼 sustained when flexing elbow (n=1)
	Unclear (n= 3)
	M M

#### Supplementary file 5. Measurement of outcomes and measurement tools used

		E	3MJ Open		
Supplementary file 5. Measurement of outco	omes and mea	surement tool	s used		136/bmjopen-,
					ight,
					Force recovery: Gross sectional area of the muscle under
					isometric contraction divided by cross sectional area at rest
					(n=1) of o
Active movement	5	103	3	63	୍ର୍ର୍ର୍୍ର୍ର୍ର୍ର୍ର୍ର୍ର୍ର୍ର୍ର୍ର୍ର୍ର୍ର୍ର୍
					MPI(n=2), CONSTANT- MURLEY(n=2) (2xPRO, 8x ClinRO), AR
					(PerfO, n=1န္ကြည့္ကြည္က်၊ (PerfO, n=2), Goniometry(n=48), Visual
					assessment ភ្នំឌ្វី 🕺 ), First web space in cm (n=3), Total active
					movement(සු-මූ) pPulp to palm distance (n=2)
	Jr				Months to fall stive movement (n=1)
	1 h				Months to an weight wei
					Months to igiga movement (n= 1)
					Months to independent movement without donor (n=1)
Descive range of movement		6		7	Not clear ( $n = 63$ )
Passive range of movement Movement control and stability		6	1		Not defined n=Z, Goniometry(n=6)
, ,		1		2	MPI (ClinRozn=1, ULM (PerfO, n=1), Not clear (n=2)
Bone structure/position/healing				4	Not clear (nfa4) = ; ; ;
Muscle mass				4	Not clear(n 4)
Nervous system outcome subdomains					and n
General sensory recovery including		9		8	Sensory BMgC ( $\dot{\beta}$ =5), Modified Sensory BMRC (n= 2), Highet
proprioception					classificatio (n=2), Not clear (n=8)
Discriminative touch (light touch, two point	1	14			MHQ (n=1), Cotton wool (n=3), Semmes Weinstein
discrimination, vibration, object recognition)					Monofilamမ္မိဳts ခ်ာ=4), Two point discrimination( n=2), Tunin
					fork (n=4), Not gefined (ClinRo, n=1)
Protective touch (pain, temperature, deep pressure)		3		7	Blunt pin (nម្ម័3), Not clear (n=7)
Structure of peripheral nervous system		1			MRI (n=1) 🚆
Reinnervation (level of reinnervation, time		54			Two point scale on EMG(n=1) Four point scale on EMG (n=4
to innervation)					Not clear EMG (🎽 = 49)
Progression of regeneration		5			Tinel sign (n=5)
Speed of motor and sensory conduction		9			EMG (n=9)
General outcomes / symptoms					n n

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### Supplementary file 5. Measurement of outcomes and measurement tools used

	Supplementary file 5. Measurement of outco	mes and meas	surement too	ls used		136/bmjopen-20 1 by copyright, i
	Pain intensity/ relief	73			3	DASH (n=27 A S (n=1), TAPES (n=1), VAS(n=18), NRS(n=12), HOC (n=1) WBFRS(n=1), BPI (n= 1), UNWNS (n=1), McGill Pain Questionnaire SF (n=2), McGill pain questionnaire (n= 1), MPI (n=13), CONSTANT-MURLEY (n=2), 4 point scale (n=3)
	Pain duration or frequency	12	0	0	0	SST (n=1), SB36 ==5), MHQ (n=1), TAPES(n=1), NPSI (n=1), BPI (n=1), UCLASS and Ider rating score (n=1), Not described PRO (n=1)
	Pain quality	7				TAPES (n= 1, B) (n=1), UWNS(n= 1), McGill SF(n=2), McGill (n=1), Non (c) (n=1)
	Pain when arm exposed to cold	1				NPSI (n=1) 2 8 8
	Paraesthesia	27				DASH (n=278 g g
	Sensitivity to touch, pressure, vibration etc	3				NPSI (n=1) យ៉ឺ្ម៍ហ៊ីស៊ីឆ្នី (n= 1), NRS (n=1)
	Location of pain	1	てて			BPI (n=1) <u>n</u> .
	Pain medication use	1		4		BPI(n=1) 🦉 🚆
	Stiffness	27				DASH (n=27≱ 🚆
	Physical functioning			<b>C</b> .		trai <u>a</u>
	Physical function non-specific	2				PSFS (n=1), AP (n=1)
	Lower limb and non-upper limb function (walking, running, climbing stairs etc)	7			1	SF36 (n=5), 뚧AP통S (n= 1), BPI (n=1) Non describad ເ편O (n=1)
ст	Reaching, pulling, pushing, carrying, throwing , lifting	37		3		DASH (n=27砦 U聲I (n=2), MHQ(n=1), ASES(n=1), SST (n=1), SF36(n=5), 孫和女(n=1), AMULA ( n=1) UNBtP ( n=1)
IMPAC	Turning twisting, gripping and releasing with the arm	30		5	1	DASH (n=27, UEI (n=2), MHQ (n=1),ARAT(n=1),SHAP(n=1), JHFT (n=1), AMULA (n=1), UNBtP (n=1), Not clear (n=1)
LIFE	Fine hand movement include writing	30		6		DASH (n=27, UETI (n=2), MHQ (n=1), ARAT(n=1), SHAP(n=1), JHFT (n=1) Burder Peg test (n=1), AMULA (n=1), UNBtP (n=1)
	Role Functioning					· · · · · · · · · · · · · · · · · · ·
	Impact on return to work	41				DASH (n =27), UEFI (n=2),MHQ (n=1), ASES (n=1), SST (n=1), SF36 (n=5), TAPES (n=1), MPI (n=1) No description ERO (n=1), Questionnaire no data ( n=1)
	Role function patient specific	1				PSFS(n=1)

			BMJ Open	1 1 1 3 By copyrig Page 1 Page 1
Supplementary file 5. Measurement of outo	comes and mea	asurement too	ls used	by copyright Page 7
				, in 20
Carrying out daily routine, (including food	36	1	5	DASH (n=27 UGI (n=2), MHQ (n=1), TAPES(n=1), BPI (n=1),
preparation, housework, garden, plants)				UCLA $(n=1)$ , $HAP$ $(n=1)$ , Jebsen $(n=1)$ , ULM $(n=1)$
				Questionnative not defined (n=2), No description PRO (n=1)
				Unclear CLinັັROອີ=1), AMULA (n=1), UNBtP (n=1) ຜູ້ຜູ້ຮັ
Maintaining personal hygiene	35		2	DASH (n=27 A S (n=1), SST(n=1), SF36(n=5), MHQ(n=1)
	·			AMULA (n=)
Maintaining personal appearance	3		1	UEFI (n=2), 45 (n= 1), AMULA (n=1)
Dressing	32		2	DASH (n =27, ) By FI (n=2), MHQ (n=1), ASES (n= 1), SST (n=1),
	Up			AMULA (n=) &
Transport needs	29			DASH (n =2 4 4 5 FI (n=2),
Impact on recreational activities and sport	34			DASH (n =2ឱ្យភ្លើឆ្នំFI (n=2), ASES (n= 1), TAPES(n=1), CONSTANT-
		No		MURLEY (n=), The t described PRO (n=1)
Social functioning				
Effect on relationship with family, friends,	34			DASH (n =2,), See 6 (n=5), TAPES (n=1), MHQ (n=1)
neighbours and groups				
Effect on intimate relationships	27			DASH (n = $2\frac{3}{2}$
Emotional Functioning				
Emotional distress/ mood	11			SF36 (n=5), APES (n= 1), BPI(n=1), UWNS(n=1), Self-rated
				anxiety scale ( $n_{1}^{2}$ ), Self-rated depression scale ( $n=1$ ), MHQ
Thoughts and beliefs (acceptance and adjustment)	1			TAPES (n=1)点 S
Self-esteem and self confidence	28			DASH (n=27 GES(n= 1)
Body image	3			MHQ (n=2) 2NOc described (n=1)
Sleep and overall health		+		
Impact on sleep	37	+	+	DASH (n=27), UHI (n=3), ASES(n= 1), MHQ (n=1), SST (n=1),
				$BPI(n=1)$ , CONS $\mathbf{E}$ NT- MURLEY(n=2), Not described PRO (n=1)
General Quality of life	1			Not described PBO (n=1)
Perceived Health Status	6			SF36 (n=5), TAPES (n=1)
Delivery of Care				
Patient satisfaction	10			TAPES (n=1), UC A (n=1), MHQ (n=1),10-point scale (n=1)

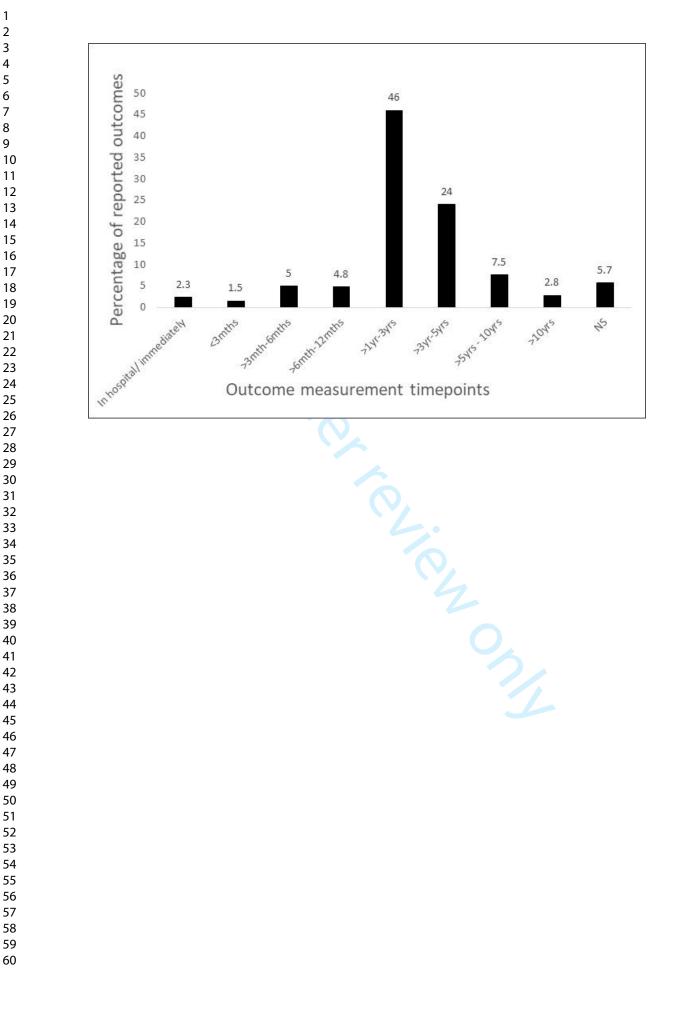
	Supplementary file 5. Measurement of or	utcomes and me	asurement too	ls used		136/bmjopen-20; 1 by copyright, ir
						4 point scale (n=2), 3 point likert scale (n=1), Questionnaire r
						described (ඳි1)නුot defined PRO(n=2)
	Patient preference for treatment	1				Not describမd (#1)
	Accessibility, quality and adequacy of intervention		00		1	4 point scaluses related to text and data min
	Hospital					
	Operation time			8	1	L
RESOURCE					2	ng, Al tad (@ining, and similar technologies.
	Adverse Events					gies.
ш	Donor site motor morbidity to include weakness		18		19	BMRC (n=7), BMRC modified(n=2), Dynanometry (n=8), EMG(n=1)
ADVERSE	Donor site sensory morbidity	1	3		4	10-point scale P O (n=1) Not defined (n=4),2PD (n=2), Monofilaments (n=1)
A	Donor site morbidity -pain	3				Not defined PRO((n=3)

## Supplementary file 5. Measurement of outcomes and measurement tools used

					, in 202
General complications				2	Unclear (n=윌 옹
Respiratory complications	1	5		4	4 point scal 🛱 PR 🕃 (n=1), x-ray (n=2), FEV (n=1), TLC(n=1), MVV
					(n-1), Not dန္ဂ်ိုးဂမိံဖိ (n=4),
Vascular complications		2		13	Not defined $\overline{\underline{I}}$ n= $\underline{\underline{3}}$ 3), Visual assessment (n=1), USS (n=1)
Musculoskeletal complications		2		19	Not defined ClineRO(n=2), Unclear (n=19)
Infection complications		1		2	Not defined Clip Ro(n=1), Unclear (n=2)
	669	366	46	168	ated

DASH Disabilities of the arm shoulder and hand, UEFI Upper Extremity Functional Index, MHQ Michigan Hand Questionnaire, BMRC British Medical Research Council, ULM Upper Limb Module, SHAP Southampton Hand Assessment Procedure, SST Simple Shoulder Test, MPI Mayo clinic Performance Index for the elbow, A a to the elbow, A to the elbow a second test and the elbow and the el Reported Outcome, PerfO Performance Outcome, PRO Patient Reported Outcome, ASES American Shoulder and Elbow Surgeons Index, T 20 2 the Trinity Amputation and Prosthesis Experience Scales, VAS Visual Analogue Scale, NRS Numerical Rating Scale, WBFRS Wong Baker Faces Rating Scale, UNWNS University of W 3 in to neuropathic pain Score, SF36 Short Form Experience Scales, VAX Visual Analogue Scale, MRS Numerical Rating Scale, WB/FRS WWRS Baker Faces Rating Scale, UWWRS University of Weights Neuropathic Pain Specific Functional Scale, AMWNS University of Weights Neuropathic Pain Specific Functional Scale, AMWNS University of Weights Neuropathic Pain Specific Functional Scale, AMWNS University of Weights Neuropathic Pain Specific Functional Scale, AMWNS University of Weights Neuropathic Pain Specific Functional Scale, AMWNS University of Weights Neuropathic Pain Specific Functional Scale, AMWINS University of Weights Neuropathic Pain Specific Functional Scale, AMWINS University of Weights Neuropathic Pain Specific Functional Scale, AMWINS University of Weights Neuropathic Pain Specific Function Test, FEV Forced Expiratory Volume, TLC Tidal Lung Component Option Pain Specific Function Test, FEV Forced Expiratory Volume, TLC Tidal Lung Component Option Pain Specific Function Test, FEV Forced Expiratory Volume, TLC Tidal Lung Component Option Pain Specific Function Test, FEV Forced Expiratory Volume, TLC Tidal Lung Component Option Pain Specific Function Test, FEV Forced Expiratory Volume, TLC Tidal Lung Component Option Pain Specific Function Component Option Pain Specific Function Component Option Pain Specific Function Component Option Pain Specific Paint Component Option Pain Specific Paint Component Option 36 health survey, NPSI Neuropathic Pain Symptom Inventory, BPI Brief Pain Inventory, PSFS Pain Specific Functional Scale, AMULA Americar 🛱 🖧 sures for Upper Limb Amputees, UNBPT

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## PRISMA 2009 Checklist

		BMJ Open BMJ Open	Page 74 of
PRISMA 2	009	У б/Ь	
Section/topic	#	Checklist item	Reported on page #
TITLE		97 c	
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT	<u> </u>		
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data so	2
INTRODUCTION		xt an article and a state of the state of th	
Rationale	3	Describe the rationale for the review in the context of what is already known.	3
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants migrventions, comparisons, outcomes, and study design (PICOS).	4
METHODS		ing, ttp	
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), And if available, provide registration information including registration number.	5
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristic (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	7
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with stridy authors to identify additional studies) in the search and date last searched.	5
Search	8	Present full electronic search strategy for at least one database, including any limits use , such that it could be repeated.	S1
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	6
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in deploted te) and any processes for obtaining and confirming data from investigators.	8
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	8
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	8
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	n/a
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I <sup>2</sup> ) for each meta-analysis. (e.g., I <sup>2</sup> ) for each meta-analysis. For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml	n/a

cted by copyright, in 0.1136/bmjopen-2020 Page 75 of 74 **BMJ Open** PRISMA 2009 Checklist Page 1 of 2 lud Reported Section/topic # Checklist item on page # Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective Risk of bias across studies 15 n/a reporting within studies). ဗ Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regiression), if done, indicating 16 Additional analyses n/a which were pre-specified. RESULTS Give numbers of studies screened, assessed for eligibility, and included in the review, with review, screened, assessed for eligibility, and included in the review, with revi Study selection 7 17 each stage, ideally with a flow diagram. For each study, present characteristics for which data were extracted (e.g., study size, PCC), follow-up period) and Study characteristics 18 Table S2 provide the citations. Risk of bias within studies Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12). 19 n/a For all outcomes considered (benefits or harms), present, for each study: (a) simple sunt data for each Results of individual studies 20 n/a intervention group (b) effect estimates and confidence intervals, ideally with a forest plot 22 Synthesis of results 21 Present results of each meta-analysis done, including confidence intervals and measures of zonsistency. n/a Risk of bias across studies 22 Present results of any assessment of risk of bias across studies (see Item 15). n/a Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-egression [see Item 16]). Additional analysis 23 n/a DISCUSSION Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to Summary of evidence 24 25-26 key groups (e.g., healthcare providers, users, and policy makers). Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of 25 27 31 Limitations identified research, reporting bias). 33 Provide a general interpretation of the results in the context of other evidence, and implications for future research. Conclusions 26 30 **FUNDING** Funding 27 Describe sources of funding for the systematic review and other support (e.g., supply of data; role of funders for the Title systematic review. 39 page From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The RISMA Statement. PLoS Med 6(7): e1000097. 42 doi:10.1371/iournal.pmed1000097 A For more information, visit: www.prisma-statement.org. 43 44 For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml 45 46

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## Developing a core outcome set for traumatic brachial plexus injuries: a systematic review of outcomes.

Journal:	BMJ Open
Manuscript ID	bmjopen-2020-044797.R1
Article Type:	Original research
Date Submitted by the Author:	07-Dec-2020
Complete List of Authors:	Miller, Caroline; University of East Anglia, School of Health Sciences, The Queens Building; Queen Elizabeth Hospital Birmingham, Physiotherapy Department cross, jane; University of East anglia, school AHP O'Sullivan, Joel; Queen Elizabeth Hospital Birmingham, Physiotherapy Power, Dominic; Queen Elizabeth Hospital Birmingham, The Birmingham Peripheral Nerve Injury Service Kyte, Derek; University of Birmingham, Institute of Applied Health Research Jerosch-Herold, Christina; University of East Anglia, Health Sciences
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Secondary Subject Heading:	Emergency medicine, Rehabilitation medicine, Surgery
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11 12	4	Developing a core outcome set for traumatic brachial plexus injuries: a
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ABSTRACT
Background Clinical decisions on treatment for traumatic brachial plexus injuries (TBPI)

should be based in best evidence from systematic reviews. However a lack of consistency in
outcome reporting has hampered combining study findings. As a first step to developing a
Core Outcome Set for TBPI, a systematic review is needed to identify what outcomes have
been outcome assessed in traumatic brachial plexus injury research.

9 Method Medline (OVID), EMBASE, CINAHL, and AMED were systematically searched for 10 studies evaluating the clinical effectiveness of interventions in adult traumatic brachial plexus injuries from January 2013 to September 2018. Two authors independently screened 11 12 papers. All outcomes were extracted verbatim from studies. If a patient reported or performance outcome measure was used then outcomes were extracted directly from the 13 14 instrument. Variation in outcome reporting was determined by assessing the number of 15 unique outcomes reported across all included studies. Outcomes were categorized into 16 domains using a prespecified taxonomy.

Results Verbatim outcomes (n= 1460) were extracted from 132 studies including 30
questionnaires. Unique outcomes (n= 157) were structured into four core areas and 11
domains. Outcomes within the musculoskeletal domain were measured in 87% of studies,
physical functioning in 23%, emotional functioning in 22% and adverse events in 33%. One
study measured quality of life. We identified 62 different methods for measuring muscle
strength, 16 for range of movement and 63 studies did not define how they measured
movement.

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3 4	1	Conclusion This review of outcome reporting in traumatic brachial plexus injury research
5 6 7	2	demonstrated an impairment focus and heterogeneity. A core outcome set would ensure
8 9	3	standardized and relevant outcomes are reported to facilitate future systematic review and
10 11 12	4	meta-analysis.
13 14	5	
15 16 17	6	Prospero registration number: CRD42018109843
18 19 20	7	
21 22 23	8	Strengths and limitations of this study
24 25	9	This study is a comprehensive and systematic review of all reported clinical
26 27 28	10	outcomes reported in traumatic brachial plexus studies from 2013- 2018 inclusive.
29 30	11	Unique outcomes were systematically categorized into a clear taxonomy to inform
31 32 33	12	the development of a core outcome set.
34 35	13	<ul> <li>Definition of unique outcomes and categorisation was conducted by researchers and</li> </ul>
36 37 38	14	clinicians to account for multidisciplinary perspectives.
39 40	15	Quality assessment was not undertaken as the aim of the study was to review
41 42 43	16	outcome reporting and not to synthesize data about effectiveness of interventions.
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2	INTRODUCTION
3	A traumatic brachial plexus injury (TBPI) is a major injury to the brachial plexus. It can result
4	in significant functional, social, psychological and economic effects, [1,2] with most
5	occurring in young men as a result of motorbike accidents,[3]. Survival from major trauma is
6	increasing,[4] and with this an increase in the incidence of TBPI,[5] which accounts for 1.2%
7	of polytrauma,[6].The complex and chronic nature of the injury is associated with significant
8	healthcare costs,[7] in addition to indirect costs estimated at up to \$2.34 million (in 2017
9	dollars) over the lifetime of an manual labourer in the USA with a TBPI,[8]. There are
10	multiple strategies for managing a patient with a TBPI with recent advancements in nerve
11	microsurgery,[9] and robotics,[10] resulting in increased treatment options. The choice of
12	treatment should be made using up-to-date, high quality scientific evidence,[11,12].
13	
14	Ideally, a meta-analysis would identify the most effective treatment for an individual with a
15	TBPI, however, such analysis requires homogenous outcome measurement and reporting
16	across studies to enable optimum synthesis. Indeed, despite increasing numbers of TBPI
17	studies, outcome heterogeneity and poorly defined outcomes has been highlighted as a
18	significant challenge to evidence synthesis in two recent systematic reviews, [13,14]. There is
19	now international agreement that the definition of a core outcome set (COS) for TBPI is a
20	priority,[15,16]. A COS is a minimum agreed set of outcomes to be reported and measured
21	in all studies,[17,18]. Development of a COS has been shown to reduce heterogeneity of

outcome reporting in other health conditions, with 81% of trialists in rheumatoid arthritis(RA) now measuring the COS for RA,[19].

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To date a minimum set of outcomes, important to patients and professionals for reporting in TBPI studies, has not been agreed. The choice of what are important outcomes to measure in TBPI is complex due to patient heterogeneity with different mechanisms, locations and severity of injury. COS methodology is continuously being refined and promoted by the Core Outcome Measures in Effectiveness Trials (COMET) initiative [20]. Development of a COS usually begins with identification of a long list of outcomes which is then prioritised through a consensus process. This systematic review sits within the larger global COMBINE project to identify a COS for TBPI. A Delphi study and consensus meeting, informed by data from this systematic review and interviews with people with the injury, will prioritise the final COS for TBPI. As a first step in the development of an international COS for TBPI we conducted a systematic review to identify outcomes reported and measurement instruments used and their timing in the literature. The final step of the global project will match the COS to existing validated measurement instruments and make recommendations on when they should be collected, therefore it was necessary to identify currently used instruments and their timepoints also. 

2		
3	1	The aim of this review was to:
4		
5 6 7	2	1. Identify what outcome domains are assessed in studies evaluating surgical and non-
, 8 9	3	surgical treatment for TBPI.
10 11	4	2. Compare the definitions of outcomes and time points of outcomes assessed.
12 13 14	5	3. Identify how the outcomes were measured, that is what validated or non-validated
15 16	6	instruments are used.
17 18	7	
19	8	
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21	9	
22	10	
23	11	
24 25	12	METHODS
25		
27	13	We followed the methods described in the Cochrane Handbook for Systematic Reviews of
28		
29	14	Interventions, [21] and report in accordance with the Preferred Reporting Items for
30		
31	15	Systematic Reviews and Meta-Analysis (PRISMA) guidelines,[22]. The systematic review
32	15	Systematic Neviews and Weta-Analysis (Phistica) guidennes,[22]. The systematic review
33 34	16	protocol was proceestively registered with DBOSDERO (DDOSDERO registration number)
35	16	protocol was prospectively registered with PROSPERO (PROSPERO registration number:
36	47	
37	17	CRD42018109843). Deviations from the protocol are reported in supplementary file 1.
38		
39	18	
40 41		
42	19	Identification of studies
43	-	
44	20	We conducted an electronic search of Medline (OVID), EMBASE (OVID), CINAHL and AMED
45	20	
46	21	on the 18 <sup>th</sup> September 2018. Studies published between 01 Jan 2013 and 18 September
47	21	on the 16° September 2018. Studies published between 01 Jan 2015 and 18 September
48 49	22	2010 and the data of the terms of the state of the state of TRR second state of the
50	22	2018 were included to reflect outcomes employed in current TBPI care. An example of the
51		
52	23	search strategy for Ovid MEDLINE is presented in supplementary file 2. The thesaurus
53		
54	24	vocabulary of each database was used to adapt search terms. Boolean operators (AND, OR)
55		
56 57	25	were used to narrow or widen the search and no language restrictions were applied.
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1	Study eligibility
2	Studies were included if they met the following criteria:
3	Study type: Any controlled and uncontrolled experimental and observational studies
4	evaluating interventions in traumatic brachial plexus injury including case reports, case
5	series, case studies, prospective and retrospective cohort studies, randomized and non-
6	randomized clinical trials. We excluded conference proceedings, abstract only publications
7	and those not involving human subjects.
8	Participants: Studies reporting outcomes in individuals with traumatic brachial plexus injury
9	aged 16 years or over. Studies of patients with obstetric brachial plexus injuries were
10	excluded.
11	Interventions: Any surgical or non-surgical intervention for TBPI.
12	Outcomes: All outcomes reported in the published abstract, methods or results. These
13	included physiological and functional outcomes, adverse events and patient reported
14	outcomes (PROs) either reported in the study or subsequently extrapolated from the PRO
15	instruments.
16	Language: Non-English language publications were included
17	
18	Study selection process
19	The reference management software Mendeley was used to compile the literature, with
20	duplicates removed. Authors (X and X) independently screened the titles and then the
21	abstracts against the eligibility criteria. Disagreements were discussed and a third reviewer
22	(x) was involved where required. Studies appearing to meet the inclusion criteria based on
23	title and abstract were retrieved as full text articles, and were read to assess for eligibility
24	with decisions on inclusion and exclusion recorded (Figure 1. PRISMA flow diagram).
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2		
3 4	1	Disagreements in study selection were resolved by discussion within the research team (x, x,
5 6	2	x).
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8 9	3	
10 11 12	4	
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15 16	6	
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18	8	
19 20	9	Quality assessment
21 22 23	10	Quality assessment of studies was not relevant as the objective was to systematically
24 25 26	11	document all outcomes reported in TBPI studies rather than synthesize the data about
20 27 28	12	intervention effectiveness.
29 30	13	
31 32 33	14	Data Extraction
34 35	15	Data were extracted into a piloted data extraction sheet (Microsoft Excel). General data
36 37 38	16	extracted from each study included author, study design, recruiting country, publication
39 40	17	year, number of participants, gender, mean age, level of TBPI and intervention tested. The
41 42 43	18	following information was extracted regarding outcomes: each outcome reported
44 45	19	(verbatim), area of body assessed if relevant (shoulder, elbow, wrist or hand), method of
46 47 48	20	administration, name of measure, timepoints of measure and reported complications. The
49 50	21	number of outcomes per study was also documented.
51 52	22	
53 54 55	23	Data extraction was performed independently by X and X for the first 20% of included
56 57	24	studies. These were compared, and disagreements discussed and resolved through debate
58 59 60	25	or discussion with a third reviewer (X). Following this a further ten percent of studies had

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2						
3 4	1	data extracted by both X and X. Due to the high level of agreement between reviewers (				
4 5						
6	2	91% agreement) on outcomes extracted, at this stage, the remaining studies underwent				
7 8	n	outraction by a single reviewer (V)				
9	3	extraction by a single reviewer (X).				
10	4					
11 12	•					
13	5	Where a validated PRO or performance outcome measurement was used and composed				
14 15						
16	6	of multiple items, the following data was extracted by the first author: verbatim name of				
17	_					
18 19	7	the instrument, verbatim wording for each individual item. A performance outcome				
20	8	measurement was defined as "A measurement based on a standardized task performed by				
21	0	incasurement was defined as "A measurement based on a standardized task performed by				
22 23	9	a patient that is administered and evaluated by an appropriately trained individual or is				
24						
25 26	10	independently completed" [23]. The frequency of use of instruments was noted and				
20						
28	11	compared between studies. The instruments were categorized as: (i) General Health				
29 30	12	(generic - for use with any patient); (ii) Upper limb physical function (region-specific); (iii)				
31	12	(generic - for use with any patient), (ii) opper limb physical function (region-specific), (iii)				
32 33	13	Symptom or domain specific (to assess a single symptom e.g. pain) and (iv) Condition				
33 34						
35	14	Specific. Timepoints of measurement of all outcomes were noted. If the outcome was				
36 37						
38	15	assessed at different timepoints then all timings were recorded.				
39	10					
40 41	16					
42	17	Classification of outcomes into domains and defining unique outcomes				
43 44	17	classification of outcomes into domains and demaing unique outcomes				
45	18	Identically worded and spelled verbatim outcomes were removed at this stage. Identical				
46						
47 48	19	outcomes measured over different time points were noted as one outcome. Where				
49						
50 51	20	outcomes were assessed using an instrument containing several items, each individual item				
52	21	was assigned an outcome name using the International Classification of Eurotioning, and				
53	21	was assigned an outcome name using the International Classification of Functioning and				
54 55	22	following standard linking rules,[24].				
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1	X categorized all outcomes into an outcome taxonomy developed by COMET for
2	categorizing outcomes for core outcome set development, [25]. These included 5 core areas
3	and 38 outcome domains. This is presented in supplementary file 3. A long list of all
4	categorized outcomes was presented to researchers (X and X) at a face to face meeting
5	where the categorization of all outcomes was reviewed using the recommended taxonomy.
6	Subdomains were created within the larger taxonomy to manage the large variation in TBPI
7	clinical outcomes extracted. Disagreements not resolved at this stage were discussed
8	further with subject experts (for example, the Adverse Event domain was discussed with a
9	surgeon).
10	Due to the diversity in terminology used to report outcomes, we grouped similar outcomes
11	within each subdomain. It is recommended that outcomes with different words, phrasing,
12	or spelling addressing the same concept should be categorized as a unique outcome,[26].
13	For example, active range of motion of shoulder abduction and active goniometry of
14	shoulder abduction were named as active shoulder abduction range and grasp strength and
15	grip strength were named as grip strength. Independent meetings were held with four
16	subject experts to ratify and define unique outcome names within each domain.
17	
18	Patient and Public Involvement
19	The need for a COS in TBPI care was conceived following discussions with patients and
20	health professionals. Patients highlighted the diverse effect the injury has on their life and
21	that often these outcomes were overlooked by professionals, such as body image. There is a
22	patient advisory group for the COS and the systematic review was discussed at these
23	meetings. Patients were not actively involved in data collection or analysis of this review.

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2						
3 4	1	Dissemination will occur at the annual traumatic brachial plexus charity UK meeting where				
5	_					
6 7	2	updates from the project are presented yearly and through a six monthly newsletter.				
8	3					
9 10	4	Results				
11 12 13	5					
14 15 16	6	Included studies				
17 18	7	The search identified 1159 studies, after removing duplicates 1105 studies remained. Titles				
19 20 21	8	and abstract review identified 169 potentially relevant articles. Of these, 37 studies did not				
22 23	9	meet the inclusion criteria and were excluded (PRISMA flow diagram; figure 1) thus, 132				
24 25 26	10	studies formed the basis of this review. All included studies are presented in supplementary				
27 28	11	file 4.				
29 30	12					
31 32 33	13	Place figure 1 here				
34 35	14	Figure 1. Preferred Reporting Items for Systematic Reviews and meta-analysis flow diagram.				
36 37 38	15					
39 40	16	Study characteristics				
41 42 43	17	Thirty-two countries from six continents recruited 3201 participants into the 132 studies				
44 45	18	(Table 1). Of the 132 studies, 87 (66%) were retrospective case series with most studies				
46 47 48	19	published from Asia (n=61, 46%). The most frequently studied surgical intervention was				
49 50	20	nerve transfers (n=66, 57%).				
51 52 53	21					
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 Table 1. Characteristics and demographics of included studies

	Study number (%)
Number of retrospective studies	87/132(66)
Number of prospective studies	21/132 (16)
Number of case studies	23/132(17)
Randomized controlled trial	1/132 (0.8)
World region recruitment	
Asia	61/132(46)
North America	20/132(15)
South America	20/132(15)
Europe	27/132(20)
Africa	3/132(2.2)
Australasia	1/132(0.8)
Year published	
2013	25/132 (19)
2014	24/132(18)
2015	15/132(11)
2016	30/132(23)
2017	27/132(20)
2018	11/132(8.3)
Gender (total 3201)	
Male	2622/3201(82)
Female	323/3201(10)
Not stated	256/3201(7.9)
Site of plexus injury per study (n=13	2)
	26/132(20)

1 2			
3 4		Pan plexus (all avulsed)	50/132(38)
5 6		Infraclavicular	7/132(5.3)
7 8		Mixture	32/132(24)
9		Unclear	7/132(5.3)
10 11			
12 13		Interventions (n=132)	
14 15		Surgical	115/132(87)
16 17		Electrotherapy	2/132(1.5)
18 19		Pain treatments	11/132 (8.3)
20		Rehabilitation	2/132(1.5)
21 22		Orthotic	1/132(0.7)
23 24		Stem cell	1/132(0.7)
25 26		Types of surgical intervention (n=115)	
27 28		Neurotisation	66/115(57)
29 30		Tendon transfer	7/115(6.1)
31 32		Free flap	16/115(14)
33		Multiple surgeries	12/115(10)
34 35		Contralateral C7	8/115(6.9)
36 37		Other	6/115(5.2)
38 39	1		
40 41	2 3		
42 43	4		
44 45	5 6		
46 47	7		
48	8 9		
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#### **Outcomes**

> Extraction of each verbatim outcome domain from each study (e.g range of movement and muscle strength) and those extracted from measures composed of several items identified a total of 1460 verbatim outcomes. After removing duplicates 157 different unique outcomes remained. No single outcome was reported across all 132 studies. Outcome definition variation. Many outcomes were not clearly defined and different terms were frequently found for the same concept. For example, shoulder abduction strength was

described in eleven different ways including 'deltoid strength', 'motor function of axillary

nerve', 'motor recovery of shoulder abductors', 'muscle power supraspinatus', 'motor 

function of Deltoid', 'motor function of Supraspinatus'.

Outcome timing variation: Of the 1460 verbatim outcomes, 46% (672) were measured 

between one and three years following intervention. For 83 outcomes the timing of the E.

measurement was not stated. See Figure 2.

Place Figure 2 here

Figure 2. Timepoints of reported outcomes 

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8 9	3	Outcome domains: The 157 different types of outcomes were categorized into four core
10		
11 12	4	areas (Physiological and Clinical, Life Impact, Resource Use, Adverse Events/Complications)
13 14	5	and 11 domains according to the COMET recommendations, [24]. See supplementary file 5.
15 16	6	The core area Physiological/Clinical included three domains: musculoskeletal and connective
17 18	7	tissue outcomes, nervous system outcomes and general/symptom outcomes. The core area
19		
20 21	8	Life Impact included seven domains: physical functioning, social functioning, role
22 23	9	functioning, emotional functioning, global quality of life, perceived health status and
24 25		
25 26	10	delivery of care. The core area Resource Use included one domain: hospital resources. The
27 28 29	11	core area Adverse Events included one domain: adverse events. No outcome could be
30 31	12	placed into the core area Death.
32 33 34	13	
35 36 37	14	Tables 2 to 4 summarise the number of unique outcomes within each domain and the
38 39	15	number of studies reporting these outcomes in each core area. The most frequently
40 41	16	reported domains were all in the Physiological/ Clinical core area and included
42 43 44	17	musculoskeletal and connective tissue (87%), nervous system (35%) and symptoms (36%).
45 46	18	Forty-four studies (33%) reported complications/ adverse events.
47 48	19	
49 50	20	
51 52		
53 54	21	
55 56 57	22	
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59 60	23	

# 23 Table 2. Physiological /Clinical Core Area

Outcome Domains	Number of unique outcomes reported within domain	Examples of unique outcomes	Number of studies reporting outcomes in domain (%)
Musculoskeletal and connective tissue	18	Active range of movement, muscle strength, muscle fatigue	115/132 (87%)
Nervous system	15	Progression of nerve regeneration, ability to feel light touch, ability to feel pain	46/132 (35%)
General/ symptoms	23	Pain intensity/relief, pain duration, pain quality, pain when arm exposed to cold, stiffness, sleep, paresthesia	47/132 (36%)
	C		

	Table 3. Life Impact Cor			
	Outcome Domains	Number of unique outcomes reported within domain	Examples of unique outcomes	Number of studies reporting outcomes within domain (%)
	Physical functioning	19	Reaching, fine hand movement	30/132 (23%)
	Role functioning	23	Return to work, Impact on normal hobbies	33/132 (25%)
	Social functioning	7	Social activities with family	30/132 (23%)
	Emotional functioning	13	Body image, acceptance	29/132 (22%)
	Global quality of life	1	Quality of life	1/132 (0.8%)
	Perceived health Status	1	Health status rating	6/132 (4.5%)
	Delivery of care	13	Patient satisfaction, quality of care, patient preference, time to surgery	11/132(8.3%)
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**Examples of unique** 

Motor weakness,

Co -contraction,

Pneumothorax

Hematoma

Infection

General

complications

**Operation time** 

**Passive movement** 

sensory loss

outcomes

Number of studies

reporting outcomes

within domain

24/132(18%)

12/132 (9%)

6/132 (4.5%)

7/132 (5.3%)

3/132 (2.3%)

2/132 (1.5%)

1/132 (.75%)

**Resource Use Core Areas** 

2 3 4 5 6	1 2					
7	3	Table 4. Adverse Events	Fable 4. Adverse Events and Resource Use Cor			
8 9 10 11 12		Outcome Domains	Number of unique outcomes reported within domain			
13 14		Adverse Events Core	Area			
15 16 17		Donor site morbidity	3			
18 19 20		Musculoskeletal	7			
21 22		Respiratory	4			
23 24		Vascular	7			
25 26		Infection	1			
27 28 29 30		General non specified complications	1			
31 32		Resource Use Core Ar	ea 🤇			
33 34 35 36		Hospital resource use	1			
37 38	4					
39 40	5					
41 42	6 7					
43 44	8					
45 46	9 10					
47 48	10					
49	12					
50 51	13 14					
52	15					
53 54	16					
55 56	17 18					
57	19					
58 59						
60						

2	In addition to extraction of standalone clinician reported and patient reported outcomes
3	such as muscle power, range or movement or return to work, outcomes were also extracted
4	from individual items contained in a total of 30 different instruments; PRO measures (n=
5	20), combined clinician-reported and patient-reported measures (n= 3) and performance
6	measures (n= 7). See table 5. These measures were reported 83 times in the included
7	publications. Most outcome measures were used once (n= 25, 30%). The most frequently
8	reported measures were the Disabilities of the Arm Shoulder and Hand (DASH,[27])
9	questionnaire (n=27 studies, 32%) and the Visual Analogue Scale (n=18, 22%). The median
10	number of items per instrument was 15 ranging from one (Visual Analogue Scale, Numerical
11	Rating Scale and Wong Baker Faces rating scale),[28] to 54,[29]. These items mapped to 34
12	different outcome domains.
13	
14	There was wide variation in the methods used to measure outcomes. This is presented in
15	supplementary file 6 (Measurement instruments mapped to domains). For example; 62
15 16	supplementary file 6 (Measurement instruments mapped to domains). For example; 62 different measurements were used to evaluate muscle function, including the British
16	different measurements were used to evaluate muscle function, including the British
16 17	different measurements were used to evaluate muscle function, including the British Medical Research Council,[30] eleven different modifications of the British Medical Council,
16 17 18	different measurements were used to evaluate muscle function, including the British Medical Research Council,[30] eleven different modifications of the British Medical Council, Isokinetics, Dynanometry and Constant - Murley score,[31]. In addition, it was often not
16 17 18 19	different measurements were used to evaluate muscle function, including the British Medical Research Council,[30] eleven different modifications of the British Medical Council, Isokinetics, Dynanometry and Constant - Murley score,[31]. In addition, it was often not clear which instrument was used for measurement of the outcomes. For example, the
16 17 18 19 20	different measurements were used to evaluate muscle function, including the British Medical Research Council,[30] eleven different modifications of the British Medical Council, Isokinetics, Dynanometry and Constant - Murley score,[31]. In addition, it was often not clear which instrument was used for measurement of the outcomes. For example, the instrument used to measure active range of movement was not reported in 36% of total

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## Table 5: Outcome measures used in included studies

		Numbe r of items	Numbe r of scales	Frequenc y (n=83)
PRO	Upper limb physical function measures (n= 16)			
Measures	Disabilities of Arm Shoulder and Hand	38	3	27
	Upper Extremity Functional Index	20	0	2
	American Shoulder and Elbow Score	15	0	1
	Modified American Shoulder and Elbow Score	13	0	1
	Simple Shoulder test	12	0	1
	Michigan Hand Questionnaire	37	0	1
PRO & ClinRO	University of California Los Angelus shoulder score	5	0	1
Measure	Constant- Murley	5	0	1
	MAYO Performance Index	4	0	1
Performan	Jebsen Taylor	7	0	1
ce Measures	University of New Brunswick Test of Prosthetic Function for Unilateral Amputees (UNB)	30	3	1
	Upper Limb Module Questionnaire	22	3	1
	Action Reach Arm Test	19	4	1
	Southampton Hand Assessment Procedure	26	0	1
	Purdue Peg test	3	0	1
	Activities Measure for Upper Limb Amputees	24	0	1
PRO	Generic questionnaires (n=2)			
Measures	36 item short form survey (SF36)	36	8	5
	Patient Specific Functional Score	4	0	1
	Condition specific questionnaires (n=1)			

1						
2 3						
4		Trinity Amputation and Prosthesis scale	54	5	1	
5 6		Symptom specific questionnaires (n=10)				
7			1	0	10	
8		Visual Analogue Scale	1	0	18	
9 10		Numerical Rating Scale	1	0	6	
11		Wong Baker Faces rating scale	1	0	1	
12 13		Brief pain inventory	15	6	1	
14 15		Neuropathic pain symptom inventory	10	5	1	
16 17		University of Washington Neuropathic score	10	3	1	
18					1	
19 20		McGill Pain Questionnaire	28	3	1	
21		McGill Pain Questionnaire SF	17	3	1	
22 23		McGill Pain Questionnaire (Japanese version)	17	3	1	
24 25		Self- rating anxiety scale	20	0	1	
26		Zung Self rating Depression scale	20	0	1	
27 28						
20						
30	1					
31	2					
32	3					
33	4					
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2 3	_	
4	1	DISCUSSION
5 6	2	
7 8 9	3	This systematic review aimed to identify what outcome domains have been reported in
) 10 11	4	studies evaluating interventions for TBPI, examine outcome definitions and timepoints and
12 13	5	identify the instruments used to assess outcomes. We found a wide variation in reported
14 15 16	6	outcomes, timing of outcomes and outcome instruments used. Furthermore, a lack of
17 18	7	standardized definition for commonly reported outcomes was observed. This heterogeneity
19 20 21	8	in outcome reporting across studies hinders evidence synthesis and results in research
22 23	9	waste,[32].
24 25 26	10	
27 28	11	The most commonly reported core area was Physiological/ Clinical including
29 30 31	12	musculoskeletal, nervous system and symptom domains. Eighty-seven percent of studies
32 33	13	reported musculoskeletal outcomes. However, there were 21 different outcomes reported
34 35	14	in this category making comparison between studies difficult. Furthermore, the diversity of
36 37 38	15	measures used to assess the outcomes increases the difficulty with synthesis. For example,
39 40	16	muscle function/ strength was assessed using 59 different measures, whilst 10 studies did
41 42 43	17	not report what measure they used. To compound this muscle strength was assessed by
44 45	18	both physical examination by a clinician (86%) and also by asking the patient(10%).
46 47 48	19	
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Only 42% of studies (55/132) evaluated PROs and within these studies there was significant heterogeneity in the measurement instrument used. Twenty-three different instruments were used with 18 only ever used once. The DASH was the most common instrument employed, in just over half the studies evaluating a PRO. The PRO instruments also varied greatly in terms of content with some as simple as a single item whilst others included up to 54 items. Over 273 individual questionnaire items were evident from the 23 PRO instruments mapping to 34 different outcomes domains. This highlighted a lack of consistency with no domain being measured by all PRO instruments. None of the included PRO assessments were designed specifically for individuals with a TBPI. Although this may be beneficial in terms of comparison with other conditions, such instruments may not be sensitive to issues of importance to patients with TBPI. These issues combined pose major questions regarding the clinical interpretation of results from TBPI studies. It is clear that that individuals with a TBPI suffer significant emotional and psychoscocial issues,[1,33]. However such issues were infrequently and inconsistently measured within this review. Only one study considered Quality of Life (QoL) as an outcome, [34] using a single item PRO. Similarly, physical, role and social functioning outcomes were reported in 23%, 25% and 23% of studies respectively. This relates strongly to the use of the DASH within the studies. Indeed, emotional functioning was reported in 29 studies, 27 of these studies used the DASH which has one item on confidence and capability mapping to this domain. If the DASH was excluded, only seven studies would assess outcomes within the emotional functioning domain. This is surprising considering the existing literature which 

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evidences the complex emotional and psychological factors, individuals face when adjusting
 to their injury,[1,35].

4 Complications/adverse events were reported in 33% of studies. Documentation of 5 complications is crucial to improve patient care and gather data for benchmarking. In 1992, 6 the Clavien-Dindo classification, [36] was introduced to assist with classification of 7 complications to enable comparison between studies, [36]. However, within the adverse 8 events outcomes identified in this review there was heterogeneity. Of the 37 verbatim 9 outcomes reported within the donor morbidity (motor) outcome 19 did not define how this 10 was assessed. 11 There are some limitations. We excluded outcomes from older studies to ensure we 12 13 identified outcomes relevant to contemporary TBPI care. Formal quality assessment of 14 studies was not undertaken, however the review was designed to identify the breadth of 15 reporting in the literature and not to examine the effectiveness of interventions. The strengths of this review are that the protocol and the data extraction form were 16 17 prespecified, prospectively registered and the literature search systematic. To account for 18 multidisciplinary perspectives, researchers and clinicians where involved in categorizing

outcomes into domains. It is the first review to detail the scale of outcome heterogeneity in
 TBPI research using a systematic method. International and non-English publications were

included to reduce the risk of selection bias.

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Variation in definitions and measurement of outcomes has been found within other areas of healthcare. Outcome heterogeneity is found in the reporting of outcomes relating to burn care, [37] breast reconstruction, [38] and spinal cord injury, [39] amongst others. A recent review of outcome reporting within burns illustrated wound healing was defined in 166 different ways across 147 studies, [37]. A solution to the variation in outcome reporting across studies in TBPI is the development of a COS, [20]. This has been shown to improve consistency of outcome reporting, [19,40]. Development of a COS in TBPI would not restrict the range of outcomes that can be measured. Researchers and clinicians would still be free to select additional outcomes but the inclusion of such a COS would facilitate synthesis of evidence, [41,42]. Whilst work has begun in obstetric brachial plexus injuries to develop a minimum data set[43], there is no COS for TBPI. 

Considerable work has been done by the Core Outcome Measures in Effectiveness Trials (COMET) initiative through dissemination of resources for COS development and support for methodological development. COMET recommends a five step process to develop a COS: define the scope, assess the need, develop the protocol, determine what to measure and determine how to measure, [44]. This systematic review addresses these first two steps for the development of the COS in TBPI care. This review has shown the majority of TBPI studies use only clinician reported outcomes to evaluate interventions. However they do not adequately capture patients' health related quality of life, [45] and may underestimate the impact of a condition, [46]. Concurrent qualitative work to identify outcomes which are important to individuals with a TBPI has been completed by this group. The next stage involves integration of all potential outcomes from this review and the qualitative work into a long list of domains. Healthcare professionals and patients will be invited to prioritize

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these outcomes during a three round international online Delphi process and consensus meeting. This will strengthen the case for uptake of a COS for TBPI as it represents patients' and clinicians' perspectives on what outcomes are important. The final stage will map existing validated measures to the outcome domains in the final COS. A future study will evaluate the psychometric properties of those mapped measurement instruments and identify if new measures need to be developed.

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3	1	CONCLUSION
4 5		
6 7	2	This systematic review has shown that outcome reporting in TBPI care is heterogenous and
8 9	3	impairment focused with a lack of standardized definitions for commonly reported
10 11 12	4	outcomes. This makes it difficult to compare and combine data from studies to inform
12 13 14	5	decision making in clinical practice. The measurement instruments used in the studies were
15 16 17	6	also often not clear, particularly when range of movement was assessed. In future studies,
17 18 19	7	authors need to be clearer with descriptions of outcomes assessed and how they were
20 21	8	measured. Less than half the studies in this review evaluated outcomes using PRO
22 23 24	9	measures. Given that TBPI has a significant impact on health-related quality of life, it is
25 26	10	recommended that authors of future studies include PROs in future studies. We have
27 28 29	11	identified a list of potentially relevant outcomes and categorized these into a clear
30 31	12	taxonomy. This will inform the next stage of developing a COS for TBPI where patients,
32 33 34	13	surgeons and therapists will be involved in a consensus process to decide the final outcomes
35 36	14	included in a COS for TBPI.
37 38 39	15	
40 41	16	
42 43 44	17	
45 46	18	Acknowledgements
47 48 49	19	We would like to thank Colin Shirley for his assistance and guidance categorising
50 51	20	neurophysiological outcomes
52 53 54	21	
55 56 57	22	
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5		
6	2	Competing Interests
7 8		
9	•	
10	3	Conflicting interests: CM, CJH, JC, DMP and JOS declare no potential conflicts of interest
11		
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22 23	0	grants from Machinan Cancel Support, grants from Kidney research ok, outside the
24	9	submitted work; .
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41 42	15	Data availability
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45	16	All data relevant to the study are included in the article or uploaded as supplementary
46 47	17	information.
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51 52		
53	19	Ethical approval
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55 56	20	Ethical approval was not sought for the present study because it was a systematic review
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58	21	and did not involve human participation
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6	2	Informed consent
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18	c	Contributorship
19	6	Contributorship
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21	7	CM, CJH and JC conceived and designed the review. CM and JOS reviewed the titles,
22	/	civi, ciri and je conceived and designed the review. Civi and jos reviewed the titles,
23	-	
24	8	abstracts and full text papers for eligibility. Authors resolved disagreements by discussion or
25		
26	9	where necessary CJH and DMP offered their view. CM and JOS were responsible for
27		
28	10	extracting data and data extraction was verified by CJH. CM, CJH and JC categorised
29	10	extracting data and data extraction was verned by early early early early and se categorised
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31 32	11	outcomes. Categorisation was reviewed and edited by DMP and DK. CM prepared the
32 33		
34	12	manuscript. CJH,JC, DMP, DK and JOS reviewed and edited the manuscript.
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1 2 3 4	1		
5 6 7	2		References
8 9	3		
10 11 12	4	[1]	Brito S, White J, Thomacos N, et al. The lived experience following free functioning
13 14	5		muscle transfer for management of pan-brachial plexus injury: reflections from a
15 16 17	6		long-term follow-up study. <i>Disabil Rehabil</i> 2019;1:1–9.
18 19	7	[2]	Morris M, Daluiski A, Dy C. A thematic analysis of online discussion boards for
20 21	8		brachial plexus injury. J Hand Surg AM 2016;41(8):813-8.
22 23 24	9	[3]	Kaiser R, Waldauf P, Ullas G, et al. Epidemiology, etiology, and types of severe adult
25 26	10		brachial plexus injuries requiring surgical repair: systematic review and meta-analysis.
27 28 29	11		Neurosurg Rev 2020;43(2):443-452.
30 31	12	[4]	Moran CG, Lecky F, Bouamra O, et al. Changing the system - major trauma patients
32 33 34	13		and their outcomes in the NHS (England) 2008-17. EClinicalMedicine 2018;13–21.
35 36	14	[5]	Dy CJ, Peacock K, Olsen MA, et al. Incidence of surgically treated brachial plexus injury
37 38 39	15		in privately insured adults under 65 years of age in the USA. Hosp Spec Surg J
40 41	16		2020;online.
42 43	17	[6]	Midha R. Epidemiology of brachial plexus injuries in a multitrauma population.
44 45 46	18		Neurosurgery 1997;40:1182–8
47 48	19	[7]	Felici N, Zaami S, Ciancolini G, et al. Cost analysis of brachial plexus injuries: Variability
49 50 51	20		of compensation by insurance companies before and after surgery. Handchir
52 53	21		Mikrochir Plast Chir 2014;46:85–9.
54 55 56	22	[8]	Hong TS, Tian A, Sachar R, et al. Indirect cost of traumatic brachial plexus injuries in
57 58	23		the United States. J Bone Joint Surg Am 2019;101:e80.
59 60	24	[9]	Bhandari PS, Maurya S. Recent advances in the management of brachial plexus

BMJ Open

1 2			
2 3 4	1		injuries. Indian J Plast Surg 2014;47:191–8.
5 6 7	2	[10]	Kubota S, Hara Y, Shimizu Y, et al. A newly developed upper limb single-joint HAL in a
7 8 9	3		patient with elbow flexion reconstruction after traumatic brachial plexus injury: A
10 11	4		case report. Interdiscip Neurosurg Adv Tech Case Manag 2017;10:66–8.
12 13 14	5	[11]	Dickinson HD. Evidence-based decision-making: an argumentative approach. Int J
15 16	6		Med Inform 1998;51:71–81.
17 18 19	7	[12]	Sackett DL, Rosenberg WM, Gray JA, et al . Evidence based medicine: what it is and
20 21	8		what it isn't. <i>BMJ</i> 1996;312:71–2.
22 23 24	9	[13]	Ayhan E, Soldado F, Fontecha CG, et al. Elbow flexion reconstruction with nerve
25 26	10		transfer or grafting in patients with brachial plexus injuries: A systematic review and
27 28 29	11		comparison study. <i>Microsurgery</i> 2020;40:79–86.
30 31	12	[14]	Donnelly MR, Rezzadeh KT, Vieira D et al. Is one nerve transfer enough? A systematic
32 33	13		review and pooled analysis comparing ulnar fascicular nerve transfer and double
34 35 36	14		ulnar and median fascicular nerve transfer for restoration of elbow flexion after
37 38	15		traumatic brachial plexus injury. <i>Microsurgery</i> 2020;40:361–9.
39 40 41	16	[15]	Dy CJ, Garg R, Lee SK, et al. A systematic review of outcomes reporting for brachial
42 43	17		plexus reconstruction. J Hand Surg Am 2015;40:308–13.
44 45 46	18	[16]	Hill B, Williams G, Olver J, et al. Letter regarding outcome reporting for brachial
47 48	19		plexus reconstruction. J Hand Surg Am 2015;40:1504.
49 50 51	20	[17]	Gargon E, Gurung B, Medley N, et al. Choosing important health outcomes for
52 53	21		comparative effectiveness research: a systematic review. PLoS One 2014;17(7):A435
54 55 56	22	[18]	Williamson P, Altman D, Blazeby J et al. Driving up the quality and relevance of
57 58	23		research through the use of agreed core outcomes. J Health Serv Res Policy
59 60	24		2012;17:1–2.

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1

1 2			
3 4	1	[19]	Kirkham JJ, Bracken M, Hind L, et al. Industry funding was associated with increased
5 6 7	2		use of core outcome sets. <i>J Clin Epidemiol</i> 2019;115:90–7.
7 8 9	3	[20]	Williamson PR, Altman DG, Blazeby JM et al. The COMET (Core Outcome Measures in
10 11	4		Effectiveness Trials) Initiative. Trials 2011;12:A70.
12 13 14	5	[21]	Higgins J, Green S. Cochrane Handbook for Systematic Reviews of Interventions
15 16	6		Version (updated March 2011). version 5. 2011.
17 18 19	7	[22]	Shamseer L, Moher D, Clarke M, et al. Preferred reporting items for systematic review
20 21	8		and meta-analysis protocols (PRISMA-P) 2015: elaboration and explanation. BMJ
22 23 24	9		2015;349:g7647.
24 25 26	10	[23]	Richardson E, Burnell J, Adams HR, et al. Developing and Implementing Performance
27 28	11		Outcome Assessments: Evidentiary, Methodologic, and Operational Considerations.
29 30 31	12		Ther Innov Regul Sci.2019;53(1):146-153.
32 33	13	[24]	Cieza A, Geyh S, Chatterji S, et al. ICF linking rules: an update based on lessons
34 35 36	14		learned. J Rehabil Med 2005;37:212–8.
37 38	15	[25]	Dodd S, Clarke M, Becker L, et al. A taxonomy has been developed for outcomes in
39 40 41	16		medical research to help improve knowledge discovery. J Clin Epidemiol 2018;96:84–
42 43	17		92.
44 45 46	18	[26]	Young AE, Brookes ST, Avery KNL, et al. A systematic review of core outcome set
40 47 48	19		development studies demonstrates difficulties in defining unique outcomes. J Clin
49 50	20		<i>Epidemiol</i> 2019;115:14–24.
51 52 53	21	[27]	Hudak PL, Amadio PC, Bombardier C, et al. Development of an upper extremity
54 55	22		outcome measure: The DASH (disabilities of the arm, shoulder, and head). Am J Ind
56 57 58	23		Med 1996;29:602–8.
59 60	24	[28]	Baker C, Wong D. Q.U.E.S.T: a process of pain assessment in children (continuing

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2			
3 4	1		eductation credit). Orthop Nurs 1987;6:11–21.
5 6 7	2	[29]	Gallagher P, MacLachlan M. Development and psychometric evaluation of the trinity
8 9	3		amputation and prosthesis experience scales (TAPES). Rehabil Psychol 2000;45:130–
10 11	4		54.
12 13 14	5	[30]	Medical Research Council. Aids to the investigation of the peripheral nervous system.
15 16	6		London: Her Majesty's stationary office; 1943.
17 18 19	7	[31]	Constant CR, Murley AH (1987) A clinical method of functional assessment of the
20 21	8		shoulder. Clinical Orthopaedics & Related Research 1987;214:160-164
22 23 24	9	[32]	Chalmers I, Glasziou P. Avoidable waste in the production and reporting of research
24 25 26	10		evidence. <i>Lancet</i> 2009;374:86–9.
27 28	11	[33]	McDonald J, Pettigrew J. Traumatic brachial plexus injury: the lived experience. British
29 30 31	12		Journal of Occupational Therapy 2014;77(3):147-154.
32 33	13	[34]	Kim JH, Shin SH, Lee YR, et al. Ultrasound-guided peripheral nerve stimulation for
34 35 36	14		neuropathic pain after brachial plexus injury: two case reports. J Anesth 2017;31:453–
37 38	15		7. 2
39 40 41	16	[35]	Miller C, Peek AL, Power D, et al. Psychological consequences of traumatic upper limb
42 43	17		peripheral nerve injury: A systematic review. <i>Hand Ther</i> 2017;22:35–45.
44 45 46	18	[36]	Clavien P, Sanabria J, Strasberg S. Proposed classification of complications of surgery
47 48	19		with examples of utility in cholecystectomy. Surgery 1992;111(5):518-26
49 50 51	20	[37]	Young AE, Davies A, Bland S et al. Systematic review of clinical outcome reporting in
52 53	21		randomised controlled trials of burn care. BMJ Open 2019;15;9(2):e025135
54 55	22	[38]	Potter S, Brigic A, Whiting PF, et al. Reporting clinical outcomes of breast
56 57 58	23		reconstruction: a systematic review. J Natl Cancer Inst 2011;103:31–46.
59 60	24	[39]	Watzlawick R, Antonic A, Sena ES, et al. Outcome heterogeneity and bias in acute

Page 36 of 72

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2 3 4	1		experimental spinal cord injury A meta-analysis. Neurology 2019;2;93(1):e40-e51
5 6 7	2	[40]	Bautista-Molano W, Navarro-Compán V, Landewé RBM, et al. How well are the
7 8 9	3		ASAS/OMERACT core outcome sets for ankylosing spondylitis implemented in
10 11	4		randomized clinical trials? A systematic literature review. Clin Rheumatol
12 13 14	5		2014;33:1313–22.
15 16	6	[41]	Clarke M, Williamson PR. Core outcome sets and systematic reviews. Syst Rev
17 18 19	7		2016;5:11.
20 21	8	[42]	Clarke M. Standardising outcomes for clinical trials and systematic reviews. Trials
22 23 24	9		2007;8:39.
24 25 26	10	[43]	Pondaag W, Malessy MJA. Outcome assessment for Brachial Plexus birth injury.
27 28 29	11		Results from the iPluto world-wide consensus survey. J Orthop Res 2018;36:2533–41.
29 30 31	12	[44]	Williamson PR, Altman DG, Bagley H, et al. The COMET Handbook: version 1.0. Trials
32 33	13		2017;18:280.
34 35 36	14	[45]	Pakhomov S, Jacobsen SJ, Chute CG, et al. Agreement between patient-reported
37 38	15		symptoms and their documentation in the medical record. Am J Manag Care
39 40 41	16		2008;14:530–9.
42 43	17	[46]	Turner GM, Slade A, Retzer A, et al. An Introduction to Patient Reported Outcome
44 45 46	18		Measures (PROMs) in Trauma. J Trauma Acute Care Surg 2019;86(2):314-320
47 48	19		
49 50 51	20 21	Figur	e 2 Legends
52 53	22	mths	, months; NS, not stated; yrs, years.
54 55 56 57 58 59 60	23 24 25 26 27		

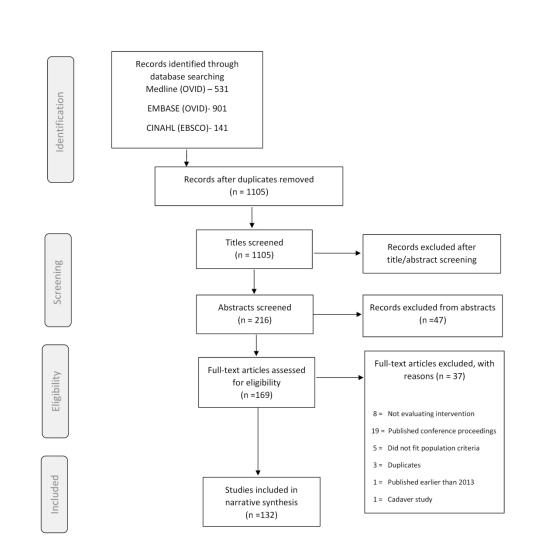
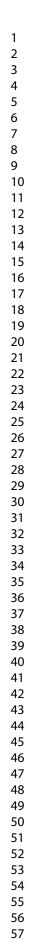


Figure 1. Preferred Reporting Items for Systematic Reviews and meta-analysis flow diagram.

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58 59

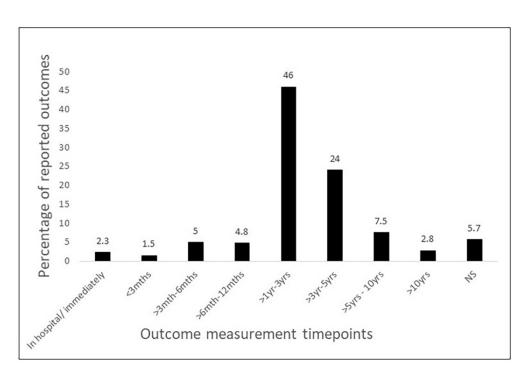


Figure 2. Timepoints of reported outcomes

# Developing a core outcome set for traumatic brachial plexus injuries: a systematic review of outcomes

Appendix S1. Deviations from study protocol

Protocol method	Deviation from protocol method with justification
We planned to hand search Journal of Hand Surgery (Eur) and The Journal of Hand Surgery (American).	We did not hand search these Journals as they were all indexed for MEDLINE.
We planned to include studies with participants aged 18 and over within the review.	We reduced the age of include participants to 16 or over as many studies included older teenagers with adults in their studies. On discussion with the research team we concluded that there was no difference between treatment of those age 16 and over versus aged 18. If we excluded these studies many outcomes used across these age ranges would have been lost.

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#### Title: Supplementary File 2 MEDLINE (OVID) search strategy

Article title: Developing a core outcome set for Traumatic Brachial Plexus Injuries: a systematic review of outcomes Author: Miller et al (2020)

Search strategy 18/09/2018 COMBINE systematic review

#### MEDLINE (OVID)

1.(brachial plexus adj3 injur\*).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]

2 (brachial plexus adj3 pals\*).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]

3 (brachial plexus adj3 lesion\*).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]

4 brachial plexopath\*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]

5 (brachial plexus adj3 traction\*).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]

6 (brachial plexus adj3 avulsion\*).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]

7 Brachial Plexus/in, su, tr [Injuries, Surgery, Transplantation]

8 1 or 2 or 3 or 4 or 5 or 6 or 7

9 limit 8 to (humans and "all adult (19 plus years)")

10. limit 9 to yr= "2013- current"

#### BMJ Open

- Supplementary file 3: COMET outcome taxonomy Article title: Developing a core outcome set for Traumatic Brachial Plexus Injuries: a
- systematic review of outcomes

Title: Supplementary file 3: COMET outcome taxonomy - adapted from Dodd et al (2018)

Core Area	Outcome Domain
Death	1. Mortality/ survival
Physiological/clinical	2. Blood and lymphatic system outcomes
	3. Cardiac outcomes
	4. Congenital, familial and genetic outcomes
	5. Endocrine outcomes
	6. Ear and labyrinth outcomes
	7. Eye outcomes
	8. Gastrointestinal outcomes
	9. General outcomes
	10. Hepatobilary outcomes
	11. Immune system outcomes
	12. Infection and infestation outcomes
	13. Injury and poisoning outcomes
	14. Metabolism and nutrition outcomes
	15. Musculoskeletal and connective tissue outcomes
	16. Outcomes, relating to neoplasms: benign, malignant and
	unspecified (including cysts and polyps)
	17. Nervous system outcomes
	18. Pregnancy, puerperium and perinatal outcomes
	19. Renal and urinary outcomes
	20. Reproductive system and breast outcomes
	21. Psychiatric outcomes
	22. Respiratory, thoracic and mediastinal outcomes
	23. Skin and subcutaneous tissue outcomes
	24. Vascular outcomes
Life Impact	Functioning
	25. Physical functioning
	26. Social functioning
	27. Role functioning
	28. Emotional functioning/ well being
	29. Cognitive functioning
	30. Global quality of life
	31. Perceived health status
	32. Delivery of care
	33. Personal circumstances
Resource use	Resource Use
	34. Economic
	35. Hospital
	36. Need for further intervention
	37. Societal/ carer burden
Adverse Events	38. Adverse Events / effects

Dodd S, Clarke M, Becker L et al. A taxonomy has been developed for outcomes in medical research to help improve knowledge discovery. *J Clin Epidemiol*. 2018;96:84-92.

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	Study title	First author	Year of publicatior
1	Effectiveness and safety of home-based muscle electrical stimulator in brachial plexus Injury patient(Limthongthang et al., 2014)	Limthongthang	2014
2	Elbow proprioception sense in total arm -type brachial plexus injured	Homroprocort	2014
2		Homreprasert	2014
	patients after neurotisation: a preliminary study(Homsreprasert et al., 2014)		
3	Comparison between the anterior and posterior approach for transfer	Souza	2014
	of the spinal accessory nerve to the suprascapular nerve in late		
	traumatic brachial plexus injuries (Souza et al., 2014)		
4	Ultrasound-guided peripheral nerve stimulation for neuropathic pain	Kim	2017
	after brachial plexus injury: two case reports(Kim et al., 2017)		
5	Contralateral lower trapezius transfer for restoration of shoulder	Satbhai	2014
-	external rotation in traumatic brachial plexus palsy: preliminary report		-
	and literature review(Satbhai et al., 2014)		
6	Restoration of shoulder abduction in brachial plexus avulsion injuries	Huan	2017
-	with double neurotization from the spinal accessory nerve: a report of		
	13 cases(Huan et al., 2017)		
7	Transfer of the musculocutaneous nerve branch to the brachialis	Bertelli	2017
	muscle to the triceps for elbow extension: anatomical study and report	Dertein	2017
	of five cases(Bertelli et al., 2017)		
8	Posterior approach for accessory to suprascapular nerve transfer: an	Rui	2013
5	electrophysiological outcomes study(Rui et al., 2013)	Nui	2015
9	Reliability of functioning free muscle transfer and vascularized ulnar	Potter	2017
9	nerve grafting for elbow flexion in complete brachial plexus palsy	Poller	2017
	(Potter and Ferris, 2017)		
10		Lam	2015
10	Management of infractavicular (Chuang Level IV) brachial plexus	LdIII	2015
11	injuries: A single surgeon experience with 75 cases (Lam et al., 2015)	Fatualla	2010
11	Functioning free muscle transfer for the restoration of elbow flexion in	Estrella	2016
	brachial plexus injury patients (Estrella and Montales 2016)	<u> </u>	2016
12	Radial to axillary nerve transfers: A combined case series (Desai et al.,	Desai	2016
4.2	2016)	Develop	2012
13	Thalamic deep brain stimulation for neuropathic pain after amputation	Pereira	2013
	or brachial plexus avulsion(Pereira et al., 2013)		
14	Nerve transfers for shoulder function for traumatic brachial plexus	Estrella	2014
	injuries(Estrella et al., 2014)		
15	Results of operative treatment of brachial plexus injury resulting from	Gutkowska	2017
	shoulder dislocation: A study with a long-term follow-up(Gutkowska et		
	al., 2017)		
16	Surgical treatment of brachial plexus posterior cord lesion: A	Oberlin	2013
	combination of nerve and tendon transfers, about nine		
	patients(Oberlin., 2013)		
17	The medial cord to musculocutaneous (MCMc) nerve transfer: a new	Ferraresi	2014
	method to reanimate elbow flexion after C5-C6-C7-(C8) avulsive		
	injuries of the brachial plexus—technique and results(Ferraresi et al.,		
	2014)		
			1

Supplementary file 4. Included Studies

	Transfer of a terminal motor branch nerve to the flexor carpi ulnaris	Bertelli	2015
	for triceps reinnervation: anatomical study and clinical cases (Bertelli et al., 2015)		
19	Free functioning gracilis muscle transfer with and without	Maldonado	2017(a)
	simultaneous intercostal nerve transfer to musculocutaneous nerve for		
	restoration of elbow flexion after traumatic adult brachial pan-plexus		
	injury(Maldonado et al., 2017a)		
20	Isolated latissimus dorsi transfer to restore shoulder external rotation	Ghosh	2013
	in adults with brachial plexus injury(Ghosh et al., 2013)		
21	Functional outcome and quality of life after traumatic total brachial	Satbhai	2016
	plexus injury treated by nerve transfer or single/double free muscle		
	transfers(Satbhai et al., 2016)		
22	Successful graded mirror therapy in a patient with chronic	Mibu	2016
	deafferentation pain in whom traditional mirror therapy was		
	ineffective: A case report(Mibu et al., 2016)		
23	Bipolar Transfer of Latissimus Dorsi Myocutaneous Flap for Restoration	Azab	2017
	of Elbow Flexion in Late Traumatic Brachial Plexus Injury: Evaluation of		
	13 Cases(Azab et al., 2017)		
24	Comparison of objective muscle strength in C5-C6 and C5-C7 brachial	Tsai	2014
27	plexus injury patients after double nerve transfer (Tsai et al. 2015)	1501	2014
25	Phantom remodeling effect of dorsal root entry zone lesioning in	Son	2015
23	phantom limb pain caused by brachial plexus avulsion(Son et al., 2015)	5011	2015
26		11	2010
26	Comparison of surgical strategies between proximal nerve graft and/or nerve transfer and distal nerve transfer based on functional	Hu	2018
	restoration of elbow flexion: A retrospective review of 147 patients (Hu		
27	et al., 2018)	Dan	2012
27	Reconstruction of shoulder abduction by multiple nerve fascicle transfer through posterior approach(Ren et al., 2013)	Ren	2013
20		Via a	2014
28	Intercostal nerve transfer to neurotize the musculocutaneous nerve	Xiao	2014
	after traumatic brachial plexus avulsion: A comparison of two, three,		
	and four nerve transfers(Xiao et al., 2014)		
		<b>D</b> 11	2047
29	Use of the DEKA Arm for amputees with brachial plexus injury: A case	Resnik	2017
	series(Resnik et al., 2017)		
29 30	series(Resnik et al., 2017) Polyester tape scapulopexy for chronic upper extremity brachial plexus	Resnik Leechavengvon	2017 2015
30	series(Resnik et al., 2017) Polyester tape scapulopexy for chronic upper extremity brachial plexus injury(Leechavengvongs et al., 2015)	Leechavengvon gs	2015
	series(Resnik et al., 2017) Polyester tape scapulopexy for chronic upper extremity brachial plexus injury(Leechavengvongs et al., 2015) Contralateral C7 nerve transfer with direct coaptation to restore lower	Leechavengvon	
30	series(Resnik et al., 2017) Polyester tape scapulopexy for chronic upper extremity brachial plexus injury(Leechavengvongs et al., 2015)	Leechavengvon gs	2015
30	series(Resnik et al., 2017) Polyester tape scapulopexy for chronic upper extremity brachial plexus injury(Leechavengvongs et al., 2015) Contralateral C7 nerve transfer with direct coaptation to restore lower	Leechavengvon gs	2015
30	series(Resnik et al., 2017) Polyester tape scapulopexy for chronic upper extremity brachial plexus injury(Leechavengvongs et al., 2015) Contralateral C7 nerve transfer with direct coaptation to restore lower trunk function after traumatic brachial plexus avulsion(Wang et al.,	Leechavengvon gs	2015
30 31	series(Resnik et al., 2017) Polyester tape scapulopexy for chronic upper extremity brachial plexus injury(Leechavengvongs et al., 2015) Contralateral C7 nerve transfer with direct coaptation to restore lower trunk function after traumatic brachial plexus avulsion(Wang et al., 2013)	Leechavengvon gs Wang	2015 2013
30 31	series(Resnik et al., 2017) Polyester tape scapulopexy for chronic upper extremity brachial plexus injury(Leechavengvongs et al., 2015) Contralateral C7 nerve transfer with direct coaptation to restore lower trunk function after traumatic brachial plexus avulsion(Wang et al., 2013) Outcome of surgical reconstruction after traumatic total brachial	Leechavengvon gs Wang	2015 2013
30 31 32	series(Resnik et al., 2017) Polyester tape scapulopexy for chronic upper extremity brachial plexus injury(Leechavengvongs et al., 2015) Contralateral C7 nerve transfer with direct coaptation to restore lower trunk function after traumatic brachial plexus avulsion(Wang et al., 2013) Outcome of surgical reconstruction after traumatic total brachial plexus palsy(Dodakundi et al., 2013)	Leechavengvon gs Wang Dodakundi	2015 2013 2013
30 31 32	series(Resnik et al., 2017) Polyester tape scapulopexy for chronic upper extremity brachial plexus injury(Leechavengvongs et al., 2015) Contralateral C7 nerve transfer with direct coaptation to restore lower trunk function after traumatic brachial plexus avulsion(Wang et al., 2013) Outcome of surgical reconstruction after traumatic total brachial plexus palsy(Dodakundi et al., 2013) Bionic reconstruction to restore hand function after brachial	Leechavengvon gs Wang Dodakundi	2015 2013 2013
30 31 32 33	series(Resnik et al., 2017) Polyester tape scapulopexy for chronic upper extremity brachial plexus injury(Leechavengvongs et al., 2015) Contralateral C7 nerve transfer with direct coaptation to restore lower trunk function after traumatic brachial plexus avulsion(Wang et al., 2013) Outcome of surgical reconstruction after traumatic total brachial plexus palsy(Dodakundi et al., 2013) Bionic reconstruction to restore hand function after brachial plexus injury: a case series of three patients(Aszmann et al., 2015)	Leechavengvon gs Wang Dodakundi Aszmann	2015 2013 2013 2013 2015
30 31 32 33	series(Resnik et al., 2017) Polyester tape scapulopexy for chronic upper extremity brachial plexus injury(Leechavengvongs et al., 2015) Contralateral C7 nerve transfer with direct coaptation to restore lower trunk function after traumatic brachial plexus avulsion(Wang et al., 2013) Outcome of surgical reconstruction after traumatic total brachial plexus palsy(Dodakundi et al., 2013) Bionic reconstruction to restore hand function after brachial plexus injury: a case series of three patients(Aszmann et al., 2015) Surgical treatment of the plexus brachialis injury using long-lasting	Leechavengvon gs Wang Dodakundi Aszmann	2015 2013 2013 2013 2015
30 31 32 33 34	series(Resnik et al., 2017) Polyester tape scapulopexy for chronic upper extremity brachial plexus injury(Leechavengvongs et al., 2015) Contralateral C7 nerve transfer with direct coaptation to restore lower trunk function after traumatic brachial plexus avulsion(Wang et al., 2013) Outcome of surgical reconstruction after traumatic total brachial plexus palsy(Dodakundi et al., 2013) Bionic reconstruction to restore hand function after brachial plexus injury: a case series of three patients(Aszmann et al., 2015) Surgical treatment of the plexus brachialis injury using long-lasting electrostimulation (Tsymbaliuk and Tretiak, 2013)	Leechavengvon gs Wang Dodakundi Aszmann Tsymbalyuk	2015 2013 2013 2013 2015 2013

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#### Supplementary file 4. Included Studies

1 2

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36	Direct coaptation of the phrenic nerve with the posterior division of the lower trunk to restore finger and elbow extension function in patients with total brachial plexus injuries( Wang et al., 2016)	Wang	2016
37	A prospective study comparing single and double fascicular transfer to	Martins	2013
	restore elbow flexion after brachial plexus injury(Martins et al., 2013)		
38	Chronic post-traumatic neuropathic pain of brachial plexus and upper	Stevanato	2014
	limb: a new technique of peripheral nerve stimulation(Stevanato et al.,		
	2014)		
39	Effectiveness of contralateral C7 nerve root and multiple nerve	Wei	2014
	transfer for treatment of brachial plexus root avulsion(Wei et al., 2014)		
40	Combined proximal nerve graft and distal nerve transfer for a posterior	Plate	2013
	cord brachial plexus injury(Plate et al., 2013)		
41	The role of elective amputation in patients with traumatic brachial	Maldonado	2016
	plexus injury(Maldonado et al., 2016b)		
42	Early microsurgical management of clavicular fracture combined with	Liu	2014(a)
	brachial plexus injury( Liu et al., 2014)		
43	Contralateral trapezius transfer to restore shoulder external rotation	Elhassan	2016
	following adult brachial plexus injury (Elhassan et al., 2016)		
44	Comparative study of phrenic nerve transfers with and without nerve	Liu	2014
	graft for elbow flexion after global brachial plexus injury(Liu et al.,		
	2014)		
45	Shoulder and elbow recovery at 2 and 11 years following brachial	Wang	
	plexus reconstruction( Wang et al., 2016)		2016
46	Functional outcomes after treatment of traumatic brachial plexus	Aras	2013
40	injuries: clinical study(Aras et al., 2013)	/1105	2015
47	Free gracilis transfer reinnervated by the nerve to the supinator for the	Soldado	2013
-17	reconstruction of finger and thumb extension in longstanding C7-T1	5010000	2013
	brachial plexus root avulsion(Soldado et al., 2013)		
48	Restoration of hand function in C7–T1 brachial plexus palsies using a	Zhang	2014
-0	staged approach with nerve and tendon transfer(Zhang et al., 2014)	Zhang	2014
49	Neurotization to innervate the deltoid and biceps: 3 cases(Dy et al.,	Dy	2013
45	2013)	Dy	2015
50	Arthroscopic arthrodesis of the shoulder in brachial plexus palsy(Lenoir	Lenoir	2017
50	et al., 2017)	Lenon	2017
51	Outcome of contralateral C7 nerve transferring to median nerve(Kai-	Gao	2013
51	ming Gao et al., 2013)	Gau	2013
52	Intercostal nerve transfer to the biceps motor branch in complete	Cho	2015
52	traumatic brachial plexus injuries (Cho et al., 2015)	Chu	2013
53	Tactile feedback for relief of deafferentation pain using virtual reality	Sano	2016
22	system: a pilot study(Sano et al., 2016)	Sano	2010
E/		Vang	2016
54	Functioning free gracilis transfer to reconstruct elbow flexion and	Yang	2016
	quality of life in global brachial plexus injured patients(Yang et al.,		
	2016)		

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#### Supplementary file 4. Included Studies

55	Evaluation of infraspinatus reinnervation and function following spinal accessory nerve to suprascapular nerve transfer in adult traumatic brachial plexus injuries(Baltzer et al., 2017)	Baltzer	2017
56	Anatomic study of the intercostal nerve transfer to the suprascapular nerve and a case report(Hu et al., 2014)	Hu	2014
57	Shoulder abduction and external rotation restoration with nerve transfer(Kostas-Agnantis et al., 2013)	Kostas- Agnantis	2013
58	Contralateral C-7 transfer: is direct repair really superior to grafting?(Bhatia et al., 2017)	Bhatia	2017
59	Impact of phrenic nerve paralysis on the surgical outcome of intercostal nerve transfer(Kita et al., 2015)	Kita	2015
60	Flow-through anastomosis using a T-shaped vascular pedicle for gracilis functioning free muscle transplantation in brachial plexus injury(Hou et al., 2015)	Hou	2015
61	Free functional muscle transfer tendon insertion secondary advancement procedure to improve elbow flexion(Sechachalam et al., 2017)	Sechachalam	2017
62	Dual nerve transfers for restoration of shoulder function after brachial plexus avulsion injury(Chu et al., 2016)	Chu	2016
63	Cortical plasticity after brachial plexus injury and repair: a resting-state functional MRI study(Bhat et al., 2017)	Bhat	2017
64	Results of spinal accessory to suprascapular nerve transfer in 110 patients with complete palsy of the brachial plexus(Bertelli et al., 2016)	Bertelli	2016
65	Magnetic resonance neurographic and clinical long-term results after oberlins transfer for adult brachial plexus injuries(Frueh et al., 2017)	Frueh	2017
66	Free functioning gracilis muscle transfer versus intercostal nerve transfer to musculocutaneous nerve for restoration of elbow flexion after traumatic adult brachial pan-plexus injury(Maldonado et al., 2016a)	Maldonado	2016
67	Results of wrist extension reconstruction in C5–8 brachial plexus palsy by transferring the pronator quadratus motor branch to the extensor carpi radialis brevis muscle(Bertelli et al., 2016)	Bertelli	2016
68	Donor nerve sources in free functional gracilis muscle transfer for elbow flexion in adult brachial plexus injury(Nicoson et al., 2017)	Nicoson	2017
69	Use of contralateral spinal accessory nerve for ipsilateral suprascapular neurotization in global brachial plexus injury: a new technique(Bhandari and Deb, 2016)	Bhandari	2016
70	Objective evaluation of elbow flexion strength and fatigability after nerve transfer in adult traumatic brachial plexus injuries (Maricq et al., 2014)	Marciq	2014
71	Outcomes of muscle brachialis transfer to restore finger flexion in brachial plexus palsy(DeGeorge et al., 2017)	DeGeorge	2017
72	Functional outcome of nerve transfers for traumatic global brachial plexus avulsion(Liu et al., 2013)	Liu	2013

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#### Supplementary file 4. Included Studies

73	Transfer of a flexor digitorum superficialis motor branch for wrist	Bertelli	2013
	extension reconstruction in C5-C8 root injuries of the brachial plexus: a case series(Bertelli and Ghizoni, 2013)		
74	Outcome after transfer of intercostal nerves to the nerve of triceps	Gao	2013
	long head in 25 adult patients with total plexus root avulsion	040	2015
	injury(KaiMing Gao et al., 2013)		
75	Good sensory recovery of the hand in brachial plexus surgery using the	Foroni	2017
	intercostobrachial nerve as the donor(Foroni et al., 2017)		
76	The phrenic nerve as a donor for brachial plexus injuries: is it safe and	Socolovsky	2015
	effective? Case series and literature analysis(Socolovsky et al., 2015)		
77	Complete avulsion of brachial plexus with associated vascular trauma:	Hattori	2013
	Feasibility of reconstruction using the double free muscle		
	technique(Hattori et al., 2013)		
78	Long-term outcome of brachial plexus re-implantation after complete	Kachramanoglo	2017
	brachial plexus avulsion injury(Kachramanoglou et al., 2017)	u	
79	Force recovery assessment of functioning free muscle transfers using	Kodama	2014
	ultrasonography(Kodama et al., 2014)		
30	Rhomboid nerve transfer to the suprascapular nerve for shoulder	Goubier	2016
	reanimation in brachial plexus palsy: A clinical report(Goubier and		
	Teboul, 2016)		
31	Outcome of contralateral C7 transfer to two recipient nerves in 22	Gao	2013
	patients with the total brachial plexus avulsion injury(Kaiming et al.,		
	2013)		
32	Comparative study of phrenic and intercostal nerve transfers for elbow	Liu	2015
	flexion after global brachial plexus injury(Yuzhou et al., 2015)		
33	Donor-side morbidity after contralateral C-7 nerve transfer: results at a	Li	2016
	minimum of 6 months after surgery( Li et al., 2016)		
34	Outcome after brachial plexus injury surgery and impact on quality of	Rasulić	2017
_	life(Rasulic et al., 2017)		
85	Pronator teres branch transfer to the anterior interosseous nerve for	Yang	2014
	treating C8T1 brachial plexus avulsion: An anatomic study and case		
	report(Yang et al., 2014)	<u></u>	2045
86	Operative treatment with nerve repair can restore function in patients	Stiasny	2015
~~	with traction injuries in the brachial plexus (Stiasny et al., 2015)	Califada	204.0
37	Thoracodorsal nerve transfer for triceps reinnervation in partial brachial plexus injuries(Soldado et al., 2016)	Soldado	2016
00		Thaldvar	2014
38	Co-infusion of autologous adipose tissue derived neuronal differentiated mesenchymal stem cells and bone marrow derived	Thakkar	2014
	hematopoietic stem cells, a viable therapy for post-traumatic brachial		
	plexus injury: a case report (Thakkar et al., 2014)		
20		Emambadi	2016
39	Long-term clinical outcomes of spinal accessory nerve transfer to the suprascapular nerve in patients with brachial plexus palsy(Emamhadi	Emamhadi	2016
	et al., 2016)		
90	Surgical treatment for total root avulsion type brachial plexus injuries	Tu	2014
	by neurotisation: a prospective comparison study between total and	i u	2014
	hemicontralateral C7 nerve root transfer(Tu et al., 2014)		

Supplementary file 4. Included Studies

91	Deactivation of distant pain-related regions induced by 20-day rTMS: a	Qiu	2014
	case study of one-week pain relief for long-term intractable		
	deafferentation pain (Qiu et al., 2014)		
92	End-to-side neurorrhaphy in brachial plexus reconstruction (Haninec et	Haninec	2013
	al., 2013)		
93	Reanimation of elbow extension with medial pectoral nerve transfer in	Flores	2013
	partial injuries to the brachial plexus (Flores., 2013)		
94	Early post-operative results after repair of traumatic brachial plexus	Mohammad-	2013
	palsy(Mohammad-Reda., 2013)	Reda	
95	Satisfied patients after shoulder arthrodesis for brachial plexus lesions	van der Lingen	2018
	even after 20 years of follow-up(van der Lingen et al., 2018)		
96	Posterior branch of the axillary nerve transfer to the lateral triceps	Kilka	2013
	branch for restoration of elbow extension: case report(Klika et al.,		
	2013)		
97	Clinical analysis of repairing the whole brachial plexus nerve root	Liu	2014
	avulsion by transferring C7 nerve root from the uninjured side(Liu et		
00	al., 2014)	Camban Dindar	2010
98	Bipolar transfer of the pectoralis major muscle for restoration of elbow	Cambon-Binder	2018
00	flexion in 29 cases(Cambon-Binder et al., 2018) Thoracodorsal nerve transfer for elbow flexion reconstruction in	Soldado	2014
99		5010400	2014
100	infraclavicular brachial plexus injuries(Soldado et al., 2014) Median nerve fascicle transfer versus ulnar nerve fascicle transfer to	Cho	2014
100	the biceps motor branch in C5-C6 and C5-C7 brachial plexus injuries:	Cho	2014
	nonrandomised prospective study of 23 consecutive patients (Cho et		
	al., 2014)		
101	Free functional muscle transplantation of an anomalous femoral	Kaizawa	2013
101	adductor with a very large muscle belly: a case report (Kaizawa et al.,	Raizawa	2015
	2013)		
102	Selective neurotisation of the radial nerve in the axilla using the	Tuohuti	2016
	intercostal nerve to treat complete brachial plexus palsy(Tuohuti et al.,		2010
	2016)		
103	Objective predictors of functional recovery associated with intercostal	Flores	2016
	nerves transfer for triceps reinnervation in global brachial plexus		
	palsy(Flores., 2016)		
104	Nerve transfer to relieve pain in upper brachial plexus injuries: does it	Emamhadi	2017
	work? (Emamhadi., 2017)		
105	Phrenic nerve transfer versus intercostal nerve transfer for the repair	Abdixbir	2016
	of brachial plexus root avulsion injuries(Abdixbir et al., 2016)		
106	End-to-side neurorrhaphy to restore elbow flexion in brachial plexus	Limthongthang	2016
	injury(Limthongthang et al., 2016)		
107	Chordata method combined with electrotherapy in functional recovery	De Oliveira	2016
	after brachial plexus injury:report of three clinical cases (De Oliveira et		
	al., 2016)		
108	Clinical outcome following transfer of the supinator motor branch to	Xu	2015
	the posterior interosseous nerve in patients with C7-T1 brachial plexus		
	palsy(Xu et al., 2015)		
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110 F 110 F 111 F 112 F 113 F 113 F 114 C 115 S S	Transposition of branches of radial nerve innervating supinator to posterior interosseous nerve for functional reconstruction of finger and thumb extension in 4 patients with middle and lower trunk root avulsion injuries of brachial plexus(Wu et al., 2017) Electromyographic findings in gracilis muscle grafts used to augment elbow flexion in traumatic brachial plexopathy(Kazamel and Sorenson, 2016) Double distal intraneural fascicular nerve transfers for lower brachial plexus injuries(Li et al., 2016) Restoration of elbow and hand function in total brachial plexus palsy with intercostal nerves and C5 root neurotisation. Results in 21 patients(Arnal et al., 2016) The phrenic nerve transfer in the treatment of a septuagenarian with brachial plexus avulsion injury: a case study(Jiang and Lao, 2018) Outcomes of transferring a healthy motor fascicle from the radial nerve to a branch for the triceps to recover elbow extension in partial brachial plexus palsy(Flores., 2017) Successful nerve transfers for traumatic brachial plexus palsy in a septuagenarian(Johnsen and Wolfe, 2016) Free functioning gracilis muscle transfer for elbow flexion reconstruction after traumatic brachial pan-plexus injury: Where is the	Wu Kazamel Li Amal Jiang Flores Johnsen	2017 2016 2016 2016 2018 2017 2016
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	Free functioning gracilis muscle transfer for elbow flexion		
<b>116</b>			
	reconstruction after traumatic brachial pap ployus injury: Whore is the	Maldonado	2017(b)
	· · · · ·		
	optimal distal tendon attachment for elbow flexion?(Maldonado et al.,		
	2017b)		
<b>117</b>	Results of distal nerve transfers in restoration of shoulder function in	Bhandari	2017
(	C5 and C6 root avulsion injury to the brachial plexus (Bhandari., 2017)		
	Bipolar dual-lead spinal cord stimulation between two electrodes on	Watanabe	2018
	the ventral and dorsal sides of the spinal cord: consideration of		
F	putative mechanisms(Watanabe et al., 2018)		
119	Triceps nerve to deltoid nerve transfer after an unsatisfactory intra-	Al-Qattan	2017
F	plexus neurotisation of the posterior division of the upper trunk(Al-		
(	Qattan et al., 2017)		
120	Trapezius muscle transfer for restoration of elbow extension in a 🕥 🏸	Alrabai	2018
t	traumatic brachial plexus injury(Alrabai et al., 2018)		
121	Transfer of the radial nerve branch to the extensor carpi radialis brevis	Bertelli	2015
t	to the anterior interosseous nerve to reconstruct thumb and finger		
f	flexion(Bertelli., 2015)		
<b>122</b> (	Ultrasound-guided pulse-dose radiofrequency: treatment of	Magistroni	2014
r	neuropathic pain after brachial plexus lesion and arm		
۱	vascularisation(Magistroni et al., 2014)		
	Phrenic nerve transfer to the musculocutaneous nerve for the repair	Liu	2015
(	of brachial plexus injury: electrophysiological characteristics(Liu et al.,		
	2015)		
124	Postoperative motor deficits following elbow flexion reanimation by	Hanneur	2018
	nerve transfer( Hanneur et al., 2018)		

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125	Comparative study of phrenic and partial ulnar nerve transfers for	Liu	2018
	elbow flexion after upper brachial plexus avulsion-a retrospective		
	clinical analysis(Liu et al., 2018)		
126	Contralateral medial pectoral nerve transfer with free gracilis muscle	Yavari	2018
	transfer in old brachial plexus injury(Yavari et al., 2018)		
127	MEG-BMI to control phantom limb pain(Yanagisawa et al., 2018)	Yanagisawa	2018
128	Complete brachial plexus injury- an amputation dilemma, A case	Choong	2015
	report(Choong and Shalimar, 2015)		
129	Reversal of phantom pain and hand-to-face remapping after brachial	Tsao	2016
	plexus avulsion(Tsao and Finn, 2016)		
130	A newly developed upper limb single-joint HAL in a patient with elbow	Kubota	2017
	flexion reconstruction after traumatic brachial plexus injury: A case		
	report(Kubota et al., 2017)		
131	Free reverse gracilis muscle combined with steindler flexorplasty for	Bertelli	2018
	elbow flexion reconstruction after failed primary repair of extended		
	upper-type paralysis of the brachial plexus(Bertelli., 2018)		
132	Multiple nerve and tendon transfers – a new strategy for restoring	Xu	2017
	hand function in a patient with C7-T1 brachial plexus avulsions(Xu et al		
	., 2017)		

#### Supplementary file 4. Included Studies

#### References

- Limthongthang R, Muennoi P, Phoojaroenchanachai R, Vathana T, Wongtrakul S.
   Effectiveness and safety of home-based muscle electrical stimulator in brachial plexus injury patients. J Med Assoc Thail. 2014, 97: S56–61.
- [2] Homsreprasert T, Limthongthang R, Vathana T, Wongtrakul S. Elbow joint proprioceptive sense in total arm-type brachial plexus injured patients after neurotization: a preliminary study. J Med Assoc Thail. 2014, 97: S103–7.
- [3] Souza F, Bernardino S, Filho H, Gobbato PL, Martins HAL, Martins RS, et al. Comparison between the anterior and posterior approach for transfer of the spinal accessory nerve to the suprascapular nerve in late traumatic brachial plexus injuries. Acta Neurochir (Wien) 2014, 156: 2345–9.
- [4] Kim JH, Shin SH, Lee YR, Lee HS, Chon JY, Sung CH, et al. Ultrasound-guided peripheral nerve stimulation for neuropathic pain after brachial plexus injury: two case reports. J Anesth. 2017, 31: 453–7.
- [5] Satbhai NG, Doi K, Hattori Y, Sakamoto S. Contralateral lower trapezius transfer for restoration of shoulder external rotation in traumatic brachial plexus palsy: a preliminary report and literature review. J Hand Surg Eur. 2014, 39: 861–7.
- [6] Huan KWSJ, Tan JSW, Tan SH, Teoh LC, Yong FC. Restoration of shoulder abduction in brachial plexus avulsion injuries with double neurotization from the spinal accessory nerve: a report of 13 cases. J Hand Surg Eur. 2017, 42: 700–5.
- [7] Bertelli JA, Soldado F, Ghizoni MF, Rodriguez-Baeza A, J.A. B, F. S, et al. Transfer of the musculocutaneous nerve branch to the brachialis muscle to the triceps for elbow extension: anatomical study and report of five cases. J Hand Surg Eur. 2017, 42: 710–4.
- [8] Rui J, Zhao X, Zhu Y, Gu Y, Lao J, J. R, et al. Posterior approach for accessory-suprascapular nerve transfer: an electrophysiological outcomes study. J Hand Surg Eur, 2013, 38: 242–7.
- [9] Potter SM, Ferris SI. Reliability of functioning free muscle transfer and vascularized ulnar nerve grafting for elbow flexion in complete brachial plexus palsy. J Hand Surg Eur Vol 2017, 42: 693–9.
- [10] Lam WL, Fufa D, Chang N-J, Chuang DC-C. Management of infractavicular (Chuang Level IV) brachial plexus injuries: A single surgeon experience with 75 cases. J Hand Surg Eur. 2015, 40: 573–82.
- [11] Estrella EP, Montales TD. Functioning free muscle transfer for the restoration of elbow flexion in brachial plexus injury patients. Injury. 2016, 47: 2525–33.
- [12] Desai MJ, Daly CA, Seiler JG 3rd, Wray WH 3rd, Ruch DS, Leversedge FJ, et al. Radial to Axillary Nerve Transfers: A Combined Case Series. J Hand Surg Am. 2016, 41: 1128–34.
- [13] Pereira EAC, Boccard SG, Linhares P, Chamadoira C, Rosas MJ, Abreu P, et al. Thalamic deep brain stimulation for neuropathic pain after amputation or brachial plexus avulsion. Neurosurg Focus. 2013, 35:E7.
- [14] Estrella EP, Favila AS Jr. Nerve transfers for shoulder function for traumatic brachial plexus injuries. J Reconstr Microsurg. 2014, 30: 59-64.

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- Supplementary file 4. Included Studies
- [15] Gutkowska O, Martynkiewicz J, Mizia S, Bak M, Gosk J. Results of Operative Treatment of Brachial Plexus Injury Resulting from Shoulder Dislocation: A Study with A Long-Term Follow-Up. World Neurosurg. 2017,105:623–31.
- [16] Oberlin C, Chino J, Belkheyar Z. Surgical treatment of brachial plexus posterior cord lesion: A combination of nerve and tendon transfers, about nine patients. Chir Main. 2013, 32:141–6.
- [17] Ferraresi S, Garozzo D, Basso E, Maistrello L, Lucchin F, Di Pasquale P. The medial cord to musculocutaneous (MCMc) nerve transfer: A new method to reanimate elbow flexion after C5-C6-C7-(C8) avulsive injuries of the brachial plexus - Technique and results. Neurosurg Rev. 2014, 37:321–9.
- [18] Bertelli J, Soldado F, Ghizoni MF, Rodriguez-Baeza A, J. B, F. S, et al. Transfer of a terminal motor branch nerve to the flexor carpi ulnaris for triceps reinnervation: Anatomical study and clinical cases. J Hand Surg Am. 2015, 40:2229-2235.
- [19] Maldonado AA, Kircher MF, Spinner RJ, Bishop AT, Shin AY. Free Functioning Gracilis Muscle Transfer With and Without Simultaneous Intercostal Nerve Transfer to Musculocutaneous Nerve for Restoration of Elbow Flexion After Traumatic Adult Brachial Pan-Plexus Injury. J Hand Surg Am 2017, 42: 293.
- [20] Ghosh S, Singh VK, Jeyaseelan L, Sinisi M, Fox M, S. G, et al. Isolated latissimus dorsi transfer to restore shoulder external rotation in adults with brachial plexus injury. Bone Jt J. 2013, 95: 660–3.
- [21] Satbhai NG, Doi K, Hattori Y, Sakamoto S, N.G. S, K. D, et al. Functional outcome and quality of life after traumatic total brachial plexus injury treated by nerve transfer or single/double free muscle transfers: A comparative study. Bone Jt J. 2016, 98: 209–17.
- [22] Mibu A, Nishigami T, Tanaka K, Osumi M, Tanabe A. Successful Graded Mirror Therapy in a Patient with Chronic Deafferentation Pain in Whom Traditional Mirror Therapy was Ineffective: A Case Report. Pain Pract. 2016, 16: E62–9.
- [23] Azab AA-H, Alsabbahi MS, A.A.-H. A, Azab AA-H, Alsabbahi MS. Bipolar Transfer of Latissimus Dorsi Myocutaneous Flap for Restoration of Elbow Flexion in Late Traumatic Brachial Plexus Injury: Evaluation of 13 Cases. Ann Plast Surg. 2017, 78: 198–201.
- [24] Tsai Y-J, Su F-C, Hsiao C-K, Tu Y-K. Comparison of objective muscle strength in C5-C6 and C5-C7 brachial plexus injury patients after double nerve transfer. Microsurgery. 2015, 35: 107–14.
- [25] Son BC, Ha SW. Phantom Remodeling Effect of Dorsal Root Entry Zone Lesioning in Phantom Limb Pain Caused by Brachial Plexus Avulsion. Stereotact Funct Neurosurg 2015, 93: 240–4.
- [26] Hu CH, Chang TN, Lu JC, Laurence VG, Chuang DC. Comparison of Surgical Strategies between Proximal Nerve Graft and/or Nerve Transfer and Distal Nerve Transfer Based on Functional Restoration of Elbow Flexion: A Retrospective Review of 147 Patients. Plast Reconstr Surg. 2018, 141: 68e-79e.
- [27] Ren G, Li R, Xiang D, Yu B. Reconstruction of shoulder abduction by multiple nerve fascicle transfer through posterior approach. Injury. 2013, 44: 492–7.
- [28] Xiao C, Lao J, Wang T, Zhao X, Liu J, Gu Y. Intercostal nerve transfer to neurotize the musculocutaneous nerve after traumatic brachial plexus avulsion: a comparison of two, three, and four nerve transfers. J Reconstr Microsurg 2014, 30: 297–304.
- [29] Resnik L, Fantini C, Latlief G, Phillips S, Sasson N, Sepulveda E, et al. Use of the DEKA Arm for

Supplementary file 4. Included Studies

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amputees with brachial plexus injury: A case series. PLoS One. 2017, 12: e0178642. Leechavengvongs S, Jiamton C, Uerpairojkit C, Malungpaishorpe K, Witoonchart K, Poonotoke P, et al. Polyester tape scapulopexy for chronic upper extremity brachial plexus injury. J Hand Surg Am. 2015, 40:1184 Wang S, Li P, Xue Y, Yiu H, Li YC, Wang H. Contralateral C7 nerve transfer with direct coaptation to restore lower trunk function after traumatic brachial plexus avulsion. J Bone Joint Surg Am. 2013, 95: 821-2. Dodakundi C, Doi K, Hattori Y, Sakamoto S, Fujihara Y, Takagi T, et al. Outcome of surgical reconstruction after traumatic total brachial plexus palsy. J Bone Joint Surg Am. 2013, 95:1505-12. Aszmann OC, Roche AD, Salminger S, Paternostro-Sluga T, Herceg M, Sturma A, et al. Bionic reconstruction to restore hand function after brachial plexus injury: a case series of three patients. Lancet. 2015, 385: 2183-9. Tsymbaliuk VI, Tretiak IB. [Surgical treatment of the plexus brachialis injury using long-lasting electrostimulation]. Klin Khirurhiia. 2013, 59-61. Flores LP, Socolovsky M. Phrenic Nerve Transfer for Reconstruction of Elbow Extension in Severe Brachial Plexus Injuries. J Reconstr Microsurg. 2016, 32: 546–50. Wang S, Li P, Xue Y, Zou J, Li W, Li Y. Direct Coaptation of the Phrenic Nerve With the Posterior Division of the Lower Trunk to Restore Finger and Elbow Extension Function in Patients With Total Brachial Plexus Injuries. Neurosurgery. 2016, 78: 208-14. Martins RS, Sigueira MG, Heise CO, Foroni L, Teixeira MJ. A prospective study comparing single and double fascicular transfer to restore elbow flexion after brachial plexus injury. Neurosurgery. 2013, 72: 709-15. Stevanato G, Devigili G, Eleopra R, Fontana P, Lettieri C, Baracco C, et al. Chronic posttraumatic neuropathic pain of brachial plexus and upper limb: a new technique of peripheral nerve stimulation. Neurosurg Rev. 2014, 37: 473-9. Wei W, Alimujiang-Abulaiti, Tuerxunjiang-Dadihan, Meihua S, Yafei L, Chunxiao Y, et al. [EFFECTIVENESS OF CONTRALATERAL C7 NERVE ROOT AND MULTIPLE NERVES TRANSFER FOR TREATMENT OF BRACHIAL PLEXUS ROOT AVULSION]. Zhongguo Xiu Fu Chong Jian Wai Ke Za Zhi. 2014, 28: 737-40. Plate JF, Ely LK, Pulley BR, Smith BP, Li Z. Combined proximal nerve graft and distal nerve transfer for a posterior cord brachial plexus injury. J Neurosurg. 2013, 118: 155-9. Maldonado AA, Kircher MF, Spinner RJ, Bishop AT, Shin AY. The role of elective amputation in patients with traumatic brachial plexus injury. J Plast Reconstr Aesthetic Surg. 2016, 69:311-7. Liu Y, Wang W, Regmi AM, Ahemaitijiang-Yusufu. Early microsurgical management of clavicular fracture combined with brachial plexus injury. Zhongguo Xiu Fu Chong Jian Wai Ke Za Zhi. 2014a,28: 1329-32. Elhassan BT, Wagner ER, Spinner RJ, Bishop AT, Shin AY. Contralateral Trapezius Transfer to Restore Shoulder External Rotation Following Adult Brachial Plexus Injury. J Hand Surg Am. 2016, 41: e45-51. Liu Y, Lao J, Gao K, Gu Y, Zhao X. Comparative study of phrenic nerve transfers with and Article title: Developing a core outcome set for Traumatic Brachial Plexus Injuries: a systematic review of outcomes For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

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without nerve graft for elbow flexion after global brachial plexus injury. Injury. 2014b, 45: 227-31. Wang J-P, Rancy SK, Lee SK, Feinberg JH, Wolfe SW. Shoulder and Elbow Recovery at 2 and 11 [45] Years Following Brachial Plexus Reconstruction. J Hand Surg Am. 2016, 41:173–9. Aras Y, Aydoseli A, Sabanci PA, Akcakaya MO, Alkir G, Imer M. Functional outcomes after [46] treatment of traumatic brachial plexus injuries: clinical study. Ulus Travma Acil Cerrahi Derg. 2013, 19: 521-8. [47] Soldado F, Bertelli J, F. S. Free gracilis transfer reinnervated by the nerve to the supinator for the reconstruction of finger and thumb extension in longstanding C7-T1 brachial plexus root avulsion. J Hand Surg Am. 2013, 38: 941-6. Zhang C-G, Dong Z, Gu Y-D. Restoration of hand function in C7-T1 brachial plexus palsies using [48] a staged approach with nerve and tendon transfer. J Neurosurg. 2014, 121: 1264–70. [49] Dv CJ. Kitav A, Garg R, Kang L, Feinberg JH. Wolfe SW. et al. Neurotization to innervate the deltoid and biceps: 3 Cases. J Hand Surg Am. 2013, 38:237–40. [50] Lenoir H, Williams T, Griffart A, Lazerges C, Chammas M, Coulet B, et al. Arthroscopic arthrodesis of the shoulder in brachial plexus palsy. J Shoulder Elb Surg. 2017, 26: e115–21. [51] Gao K, Lao J, Zhao X, Gu Y. Outcome of contralateral C7 nerve transferring to median nerve. Chin Med J (Engl). 2013, 126: 3865-8. Cho AB, Iamaguchi RB, Silva GB, Paulos RG, Kiyohara LY, Sorrenti L, et al. Intercostal nerve [52] transfer to the biceps motor branch in complete traumatic brachial plexus injuries. Microsurgery. 2015, 35: 428-31. Sano Y, Wake N, Ichinose A, Osumi M, Oya R, Sumitani M, et al. Tactile feedback for relief of [53] deafferentation pain using virtual reality system: a pilot study. J Neuroeng Rehabil. 2016, 13:61. Yang Y, Yang J-T, Fu G, Li X-M, Qin B-G, Hou Y, et al. Functioning free gracilis transfer to [54] reconstruct elbow flexion and quality of life in global brachial plexus injured patients. Sci Rep. 2016, 6: 22479. [55] Baltzer HL, Wagner ER, Kircher MF, Spinner RJ, Bishop AT, Shin AY, et al. Evaluation of infraspinatus reinnervation and function following spinal accessory nerve to suprascapular nerve transfer in adult traumatic brachial plexus injuries. Microsurgery. 2017, 37: 365–70. [56] Hu S, Chu B, Song J, Chen L. Anatomic study of the intercostal nerve transfer to the suprascapular nerve and a case report. J Hand Surg Eur. 2014, 39: 194-8. Kostas-Agnantis I, Korompilias A, Vekris M, Lykissas M, Gkiatas I, Mitsionis G, et al. Shoulder [57] abduction and external rotation restoration with nerve transfer. Injury. 2013, 44: 299–304.

- [58] Bhatia A, Doshi P, Koul A, Shah V, Brown JM, Salama M, et al. Contralateral C-7 transfer: is direct repair really superior to grafting? Neurosurg Focus. 2017, 43: E3.
- [59] Kita Y, Tajiri Y, Hoshikawa S, Hara Y, Iijima J. Impact of phrenic nerve paralysis on the surgical outcome of intercostal nerve transfer. Hand Surg. 2015, 20: 47–52.
- [60] Hou Y, Yang J, Yang Y, Qin B, Fu G, Li X, et al. Flow-through anastomosis using a T-shaped vascular pedicle for gracilis functioning free muscle transplantation in brachial plexus injury. Clinics (Sao Paulo). 2015, 70: 544–9.

#### Supplementary file 4. Included Studies

- [61] Sechachalam S, O'Byrne A, MacQuillan A. Free Functional Muscle Transfer Tendon Insertion Secondary Advancement Procedure to Improve Elbow Flexion. Tech Hand Up Extrem Surg. 2017, 21: 8–12.
- [62] Chu B, Wang H, Chen L, Gu Y, Hu S. Dual Nerve Transfers for Restoration of Shoulder Function After Brachial Plexus Avulsion Injury. Ann Plast Surg. 2016, 76: 668–73.
- [63] Bhat DI, Indira Devi B, Bharti K, Panda R. Cortical plasticity after brachial plexus injury and repair: a resting-state functional MRI study. Neurosurg Focus. 2017, 42: E14.
- [64] Bertelli JA, Ghizoni MF, J.A. B. Results of spinal accessory to suprascapular nerve transfer in 110 patients with complete palsy of the brachial plexus. J Neurosurg Spine. 2016, 24: 990–5.
- [65] Frueh FS, Ho M, Schiller A, Ducommun P, Manoliu A, Andreisek G, et al. Magnetic Resonance Neurographic and Clinical Long-Term Results After Oberlin's Transfer for Adult Brachial Plexus Injuries. Ann Plast Surg. 2017, 78: 67–72.
- [66] Maldonado AA, Kircher MF, Spinner RJ, Bishop AT, Shin AY. Free Functioning Gracilis Muscle Transfer versus Intercostal Nerve Transfer to Musculocutaneous Nerve for Restoration of Elbow Flexion after Traumatic Adult Brachial Pan-Plexus Injury. Plast Reconstr Surg. 2016, 138: 483e-488e.
- [67] Bertelli JA, Ghizoni MF, Tacca CP. Results of wrist extension reconstruction in C5-8 brachial plexus palsy by transferring the pronator quadratus motor branch to the extensor carpi radialis brevis muscle. J Neurosurg. 2016, 124: 1442–9.
- [68] Nicoson MC, Franco MJ, Tung TH. Donor nerve sources in free functional gracilis muscle transfer for elbow flexion in adult brachial plexus injury. Microsurgery. 2017, 37: 377–82.
- [69] Bhandari PS, Deb P. Use of contralateral spinal accessory nerve for ipsilateral suprascapular neurotization in global brachial plexus injury: A new technique. J Neurosurg Spine. 2016, 24: 186–8.
- [70] Maricq C, Jeunehomme M, Mouraux D, Remy P, Brassinne E, Bahm J, et al. Objective evaluation of elbow flexion strength and fatigability after nerve transfer in adult traumatic upper brachial plexus injuries. Hand Surg. 2014, 19: 335–41.
- [71] DeGeorge B, Becker H, Faryna J, Spinner R, Bishop A. Outcomes of brachialis muscle transfer to restore finger flexion in traumatic lower trunk brachial plexus palsy. J Hand Surg Am. 2017, 42: S33–4.
- [72] Liu Y, Lao J, Gao K, Gu Y, Zhao X. Functional outcome of nerve transfers for traumatic global brachial plexus avulsion. Injury. 2013, 44:655–60.
- [73] Bertelli JA, Ghizoni MF. Transfer of a flexor digitorum superficialis motor branch for wrist extension reconstruction in C5-C8 root injuries of the brachial plexus: a case series. Microsurgery. 2013, 33:39–42.
- [74] Gao K, Lao J, Zhao X, Gu Y. Outcome after transfer of intercostal nerves to the nerve of triceps long head in 25 adult patients with total brachial plexus root avulsion injury. J Neurosurg 2013, 118: 606–10.
- [75] Foroni L, Siqueira MG, Martins RS, Heise CO, Sterman HN, Imamura AY. Good sensory recovery of the hand in brachial plexus surgery using the intercostobrachial nerve as the donor. Arq Neuropsiquiatr. 2017, 75: 796–800.
- [76] Socolovsky M, di Masi G, Bonilla G, Dominguez Paez M, Robla J, Calvache Cabrera C, et al. The

phrenic nerve as a donor for brachial plexus injuries: is it safe and effective? Case series and literature analysis. Acta Neurochir (Wien). 2015, 157: 1077–86.

- [77] Hattori Y, Doi K, Sakamoto S, Satbhai NG. Complete avulsion of brachial plexus with associated vascular trauma: feasibility of reconstruction using the double free muscle technique. Plast Reconstr Surg. 2013, 132: 1504–12.
- [78] Kachramanoglou C, Carlstedt T, Koltzenburg M, Choi D, C. K, T. C, et al. Long-Term Outcome of Brachial Plexus Reimplantation After Complete Brachial Plexus Avulsion Injury. World Neurosurg. 2017, 103: 28–36.
- [79] Kodama N, Doi K, Hattori Y. Force recovery assessment of functioning free muscle transfers using ultrasonography. J Hand Surg Am. 2014, 39: 2269–76.
- [80] Goubier J, Teboul F. Rhomboid nerve transfer to the suprascapular nerve for shoulder reanimation in brachial plexus palsy: A clinical report. Hand Surg Rehabil. 2016, 35: 363–6.
- [81] Gao K, Lao J, Zhao X, Gu Y. Outcome of contralateral C7 transfer to two recipient nerves in 22 patients with the total brachial plexus avulsion injury. Microsurgery. 2013, 33: 605–11.
- [82] Liu Y, Lao J, Zhao X. Comparative study of phrenic and intercostal nerve transfers for elbow flexion after global brachial plexus injury. Injury. 2015, 46: 671–5.
- [83] Li XM, Yang JT, Hou Y, Yang Y, Qin BG, Fu G, et al. Donor-side morbidity after contralateral C-7 nerve transfer: results at a minimum of 6 months after surgery. J Neurosurg. 2016, 124: 1434–41
- [84] Rasulic L, Savic A, Zivkovic B, Vitosevic F, Micovic M, Bascarevic V, et al. Outcome after brachial plexus injury surgery and impact on quality of life. Acta Neurochir (Wien) 2017, 159: 1257–64
- [85] Yang J, Jia X, Yu C, Gu Y. Pronator teres branch transfer to the anterior interosseous nerve for treating C8T1 brachial plexus avulsion: An anatomic study and case report. Neurosurgery. 2014, 75: 375–9.
- [86] Stiasny J, Birkeland P, J. S. Operative treatment with nerve repair can restore function in patients with traction injuries in the brachial plexus. Dan Med J. 2015, 62.
- [87] Soldado F, Ghizoni MF, Bertelli J, F. S, M.F. G. Thoracodorsal nerve transfer for triceps reinnervation in partial brachial plexus injuries. Microsurgery. 2016, 36: 191–7.
- [88] Thakkar UG, Vanikar A V, Trivedi HL. Co-infusion of autologous adipose tissue derived neuronal differentiated mesenchymal stem cells and bone marrow derived hematopoietic stem cells, a viable therapy for post-traumatic brachial plexus injury: a case report. Biomed J. 2014, 37: 237–40.
- [89] Emamhadi M, Alijani B, Andalib S, M. E, B. A. Long-term clinical outcomes of spinal accessory nerve transfer to the suprascapular nerve in patients with brachial plexus palsy. Acta Neurochir (Wien). 2016, 158: 1801–6.
- [90] Tu YK, Tsai YJ, Chang CH, Su FC, Hsiao CK, Tan JS. Surgical treatment for total root avulsion type brachial plexus injuries by neurotization: a prospective comparison study between total and hemicontralateral C7 nerve root transfer. Microsurgery. 2014, 34: 91–101.
- [91] Qiu YQ, Hua XY, Zuo CT, Li T, Zheng MX, Shen YD, et al. Deactivation of distant pain-related regions induced by 20-day rTMS: a case study of one-week pain relief for long-term intractable deafferentation pain. Pain Physician. 2014, 17: E99–105.

Supplementary file 4. Included Studies

- [92] Haninec P, Mencl L, Kaiser R. End-to-side neurorrhaphy in brachial plexus reconstruction. J Neurosurg. 2013, 119: 689–94.
- [93] Flores LP. Reanimation of elbow extension with medial pectoral nerve transfer in partial injuries to the brachial plexus. J Neurosurg. 2013, 118: 588–93.
- [94] Mohammad-Reda A. Early post-operative results after repair of traumatic brachial plexus palsy. Turk Neurosurg. 2013, 23: 1–9.
- [95] van der Lingen MAJ, de Joode SGCJ, Schotanus MGM, Grimm B, van Nie FA, Speth LAWM, et al. Satisfied patients after shoulder arthrodesis for brachial plexus lesions even after 20 years of follow-up. Eur J Orthop Surg Traumatol. 2018, 28: 1089–94
- [96] Klika BJ, Spinner RJ, Bishop AT, Kircher MF, Shin AY. Posterior branch of the axillary nerve transfer to the lateral triceps branch for restoration of elbow extension: case report. J Hand Surg Am. 2013, 38: 1145–9.
- [97] Liu J, Wang X, Zhang S, Wang L, Xia D, Gao Q, et al. A clinical analysis of repairing the whole brachial plexus nerve root avulsion by transferring C7 nerve root from the uninjured side. J Neurol Sci. 2014, 31: 521–31.
- [98] Cambon-Binder A, Walch A, Marchei P, Belkheyar Z. Bipolar transfer of the pectoralis major muscle for restoration of elbow flexion in 29 cases. J Shoulder Elb Surg. 2018, 27: e330-e336
- [99] Soldado F, Ghizoni MF, Bertelli J. Thoracodorsal nerve transfer for elbow flexion reconstruction in infraclavicular brachial plexus injuries. J Hand Surg Am. 2014, 39: 1766–70.
- [100] Cho A, Paulos R, De Resende M, Kiyohara L, Sorrenti L, Wei TH, et al. Median nerve fascicle transfer versus ulnar nerve fascicle transfer to the biceps motor branch in C5-C6 and C5-C7 brachial plexus injuries: Nonrandomized prospective study of 23 consecutive patients. Microsurgery. 2014, 34: 511–5.
- [101] Kaizawa Y, Kakinoki R, Ohta S, Noguchi T. Free functional muscle transplantation of an anomalous femoral adductor with a very large muscle belly: A case report. J Brachial Plex Peripher Nerve Inj. 2013, 8: 11.
- [102] Tuohuti T, Yu Q, Yang J, Wang T. Selective neurotization of the radial nerve in the axilla using intercostal nerve to treat complete brachial plexus palsy. Int J Clin Exp Med. 2016, 9: 22880– 5.
- [103] Flores LP. Objective Predictors of Functional Recovery Associated with Intercostal Nerves Transfer for Triceps Reinnervation in Global Brachial Plexus Palsy. Brazilian Neurosurg 2016, 35: 271–8.
- [104] Emamhadi M. Nerve transfer to relieve pain in upper brachial plexus injuries: Does it work? Clin Neurol Neurosurg. 2017,163: 67–70.
- [105] Abdixbir A, Li P, Ilhamjan U, Exmetjan Y. Phrenic nerve transfer versus intercostal nerve transfer for the repair of brachial plexus root avulsion injuries. Chinese J Tissue Eng Res. 2016, 20: 7660–5.
- [106] Limthongthang R, Vathana T, Wongtrakul S, Songcharoen P. End-to-Side Neurorrhaphy to Restore Elbow Flexion in Brachial Plexus Injury. J Med Assoc Thai. 2016, 99: 1203–8.
- [107] De Oliveira C, Da Silva Melo D, Mestriner R, De Menezes M, Da Silva Filho I, Da Silva J. Chordata method combined with electrotherapy in functional recovery after brachial plexus injury: Report of three clinical cases. Sci Med (Porto Alegre). 2016, 26: 22425.

Supplementary file 4. Included Studies

- [108] Xu B, Dong Z, Zhang C-G, Gu Y-D. Clinical outcome following transfer of the supinator motor branch to the posterior interosseous nerve in patients with C7-T1 brachial plexus palsy. J Reconstr Microsurg. 2015, 31: 102–6.
- [109] Wu X, Cong XB, Huang QS, Ai FX, Liu YT, Lu XC, et al. Transposition of branches of radial nerve innervating supinator to posterior interosseous nerve for functional reconstruction of finger and thumb extension in 4 patients with middle and lower trunk root avulsion injuries of brachial plexus. J Huazhong Univ Sci Technolog Med Sci. 2017, 37: 933–7.
- [110] Kazamel M, Sorenson EJ. Electromyographic Findings in Gracilis Muscle Grafts Used to Augment Elbow Flexion in Traumatic Brachial Plexopathy. J Clin Neurophysiol. 2016. 33:549– 53.
- [111] Li Z, Reynolds M, Satteson E, Nazir O, Petit J, Smith BP. Double Distal Intraneural Fascicular Nerve Transfers for Lower Brachial Plexus Injuries. J Hand Surg Am. 2016, 41: e15-9.
- [112] Arnal M, Cambon A, Marcheix P. Restoration of elbow and hand function in total brachial plexus palsy with intercostal nerves and C5 root neurotization. Results in 21 patients. Hand Surg Rehabil. 2016, 35: 283–7.
- [113] Jiang Y, Lao J. The phrenic nerve transfer in the treatment of a septuagenarian with brachial plexus avulsion injury: a case report. Int J Neurosci. 2018, 128: 467–71.
- [114] Flores LP. Outcomes of Transferring a Healthy Motor Fascicle From the Radial Nerve to a Branch for the Triceps to Recover Elbow Extension in Partial Brachial Plexus Palsy. Neurosurgery. 2017, 80: 448–53.
- [115] Johnsen PH, Wolfe SW. Successful Nerve Transfers for Traumatic Brachial Plexus Palsy in a Septuagenarian: A Case Report. Hand (N Y). 2016, 11: NP30–3.
- [116] Maldonado AA, Romero-Brufau S, Kircher MF, Spinner RJ, Bishop AT, Shin AY. Free Functioning Gracilis Muscle Transfer for Elbow Flexion Reconstruction after Traumatic Adult Brachial Pan-Plexus Injury: Where Is the Optimal Distal Tendon Attachment for Elbow Flexion?. Plast Reconstr Surg. 2017, 139: 128–36.
- [117] Bhandari PS. Results of Distal Nerve Transfers in Restoration of Shoulder Function in C5 and C6 Root Avulsion Injury to the Brachial Plexus. Indian J Neurotrauma 2017, 14: 21–5.
- [118] Watanabe M, Yamamoto T, Fukaya C, Obuchi T, Kano T, Kobayashi K, et al. Bipolar dual-lead spinal cord stimulation between two electrodes on the ventral and dorsal sides of the spinal cord: consideration of putative mechanisms. Acta Neurochir (Wien). 2018, 160: 639–43.
- [119] Al-Qattan M, Kattan A, Al-Qahtany B, Al-Qattan O. Triceps nerve to deltoid nerve transfer after an unsatisfactory intra-plexus neurotization of the posterior division of the upper trunk. Int J Surg Case Rep. 2017, 37: 124–6.
- [120] Alrabai H, Gesheff G, Hammouda A, Conway J. Trapezius Muscle Transfer for Restoration of Elbow Extension in a Traumatic Brachial Plexus Injury. J Hand Surg Am. 2018, 43: 872.
- [121] Bertelli JA. Transfer of the radial nerve branch to the extensor carpi radialis brevis to the anterior interosseous nerve to reconstruct thumb and finger flexion. J Hand Surg Am. 2015, 40: 323-328.
- [122] Magistroni E, Ciclamini D, Panero B. Ultrasound-guided pulse-dose radiofrequency: Treatment of neuropathic pain after brachial plexus lesion and arm revascularization. Case Rep Med. 2014, 201:429618.

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#### Supplementary file 4. Included Studies

- [123] Liu Y, Xu X, Zou Y, Li S, Zhang B. Phrenic nerve transfer to the musculocutaneous nerve for the repair of brachial plexus injury: Electrophysiological characteristics. Neural Regen Res. 2015, 10: 328–33.
- [124] Le Hanneur M, Walch A, Gerosa T, Grandjean A, Masmejean E. Postoperative motor deficits following elbow flexion reanimation by nerve transfer. Hand Surg Rehabil 2018, 37: 289-294
- [125] Liu Y, Zhuang Y, Yu H, Xiong H. Comparative study of phrenic and partial ulnar nerve transfers for elbow flexion after upper brachial plexus avulsion: A retrospective clinical analysis. J Plast Reconstr Aesthetic Surg. 2018, 71: 1245–51.
- [126] Yavari M, Mahmoudvand H, Nadri S. Contralateral medial pectoral nerve transfer with free gracilis muscle transfer in old brachial plexus palsy. J Surg Res. 2018, 231: 94–8.
- [127] Yanagisawa T, Fukuma R, Seymour B, Hosomi K, Kishima H, Shimizu T, et al. MEG-BMI to control phantom limb pain. Neurol Med Chir (Tokyo). 2018, 58: 327–33.
- [128] Choong C, Shalimar A. Complete brachial plexus injury An amputation dilemma. A case report. Malaysian Orthop J. 2015, 9: 52–4.
- [129] Tsao J, Finn S. Reversal of phantom pain and hand-to-face remapping after brachial plexus avulsion. Ann Clin Transl Neurol. 2016, 3: 463–4..
- [130] Kubota S, Hara Y, Shimizu Y, Kadone H, Kubo T, Marushima A, et al. A newly developed upper limb single-joint HAL in a patient with elbow flexion reconstruction after traumatic brachial plexus injury: A case report. Interdiscip Neurosurg Adv Tech Case Manag. 2017, 10: 66–8.
- [131] Bertelli JA. Free Reverse Gracilis Muscle Combined With Steindler Flexorplasty for Elbow Flexion Reconstruction After Failed Primary Repair of Extended Upper-Type Paralysis of the Brachial Plexus. J Hand Surg Am. 2019, 44: 112-120
- [132] Xu B, Dong Z, Zhang C. Multiple nerve and tendon transfers: A new strategy for restoring hand function in a patient with C7-T1 brachial plexus avulsions. J Neurosurg. 2017, 127: 837–42.

Online Supplementary file 5. Table: Unique outcomes mapped to potential domains and core areas according to COMET(Dodd et al., 2018)

Outcomes ( n=157)	Subdomains	Domains	Core Areas
Isometric muscle	Muscle strength/	Musculoskeletal and	Physiological/Clinica
strength	function	connective tissue	
Concentric strength		domain	
Eccentric strength			
Muscle			
flicker/contraction			
Anti-gravity muscle			
activity			
Muscle endurance			
Muscle fatigue			
Muscle torque	D.		
Active range of	Active movement		
movement			
Perception of			
movement			
Antigravity			
movement			
Independent		D.	
movement without			
donor			
Passive range of	Passive movement		
movement			
Movement	Control of		
control/stability	movement/stability		
. ,			
Muscle mass	Muscle mass		
Bony union	Bone		
Joint position	structure/position		
Joint stability			
General sensory	General sensory	Nervous system	
recovery	recovery		
Feeling of numbness	1		
Proprioception	1		
		1	
Light touch	Discriminative		

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#### Vibration **Object recognition** Pain Protective touch Temperature Deep pressure Brachial plexus Peripheral nervous structure system structure Level of Reinnervation reinnervation Time to reinnervation Progression of Progression of regeneration regeneration Speed of motor Speed of motor sensory conduction and sensory conduction Pain intensity Pain intensity/relief General outcomes/symptoms Pain relief / reduction Pain duration Pain Pain frequency duration/frequency Pain quality Pain quality and Pain interference interference with with walking life Pain interference in mood Pain interference with work Pain interference in activities of daily living Pain interference with relationships Pain interference with enjoyment of life Pain interference with sleep Pain when arm Sensitivity to cold exposed to cold Paraesthesia Paraesthesia and Itchiness itchiness

### Supplementary file 5: Unique outcomes mapped to potential domains and core areas according to COMET

60

Soncitivity to	Concitivity to touch		
Sensitivity to	Sensitivity to touch,		
pressure	pressure etc		
Sensitivity to touch			
Pain location	Location of pain		
Pain relief from	Pain medication		
medication	use		
Stiffness	Stiffness		
Impact on general	Impact on sleep		
sleep			
Impact on sleep on			
affected side			
Frequency sleep			
disturbed by injury			
General physical	Physical function	Physical functioning	Life Impact
function	non-specific		
Patient led functional	non speene		
outcome			
	Laurar linch and		
Walking short	Lower limb and		
distance	non -upper limb		
Balance	function		
Running			
Climbing stairs			
Bending			
Kneeling			
Reaching	Reaching, pulling,		
Pulling	pushing, carrying		
Pushing	etc		
Carrying			
Throwing			
Lifting			
General function of			
arm			
	Turning twisting,		
	gripping and		
Grip and release	releasing with the		
	arm		
Pinching	Fine hand		
Fine hand movement	movement		
(writing/buttons)	including writing		
Returning to work	Impact on paid or	Role functioning	
_	unpaid work or role		
	•		
Ability to do work	in education		
Ability to do work Usual time at work	in education		

## Supplementary file 5: Unique outcomes mapped to potential domains and core areas according to COMET

#### Article title: Developing a core outcome set for Traumatic Brachial Plexus Injuries: a systematic review of outcomes For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

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Usual school activities			
	Role function -	-	
General rating to			
perform a patient	patient specific		
specific activity			
Impact on ADL	Carrying out daily		
(general)	routine, (including		
Return to ADL	food preparation,		
(general)	housework,		
	garden, plants)		
Impact on food			
preparation and	$\wedge$		
feeding			
Housework (washing,			
cleaning, ironing,			
folding, vacuuming)			
Gardening (Includes			
indoor plants)			
Using a phone			
Maintaining personal			
hygiene		-	
Maintaining personal	Maintaining		
appearance	personal hygiene		
(grooming hair)			
Dressing	Maintaining	<b>C</b> .	
	personal		
	appearance		
Transport needs (e.g	Dressing	4	
driving)			
Impact on normal	Transport needs		
hobbies			
Time doing normal	Impact on		
hobbies	recreational		þ
Playing instrument in	activities and sport		
usual way			
Ability to play			
instrument			
Impact on time spent			
playing instrument			
Impact on time spent			
doing sport	4		
Impact on			
participation in sport			
Social activities with	Effect on	Social functioning	
friends	relationship with		

### Supplementary file 5: Unique outcomes mapped to potential domains and core areas according to COMET

	ocial activities with	family, friends,		
	eighbours	neighbours and		
	ocial activities with	groups		
	mily			
Sc	ocial activities with			
gr	oups			
D	ependence on			
fa	mily and friends			
A	ppearance			
in	terferes with social			
ac	ctivities			
In	timate	Effect on intimate		
	lationships	relationships		
	notional impact on /	Emotional	Emotional	
	ork	distress/mood	functioning	
	nergy levels			
	notional impact on			
	DL			
	appiness			
	npact on life			
	njoyment /			
	itisfaction			
	notional impact on			
	lationships			
	nxiety	-		
	epression			
	cceptance/	Thoughts and		
A	djustment	beliefs	7	
Co	oping with trauma	(acceptance,		
		coping)		
	onfidence	Self esteem and		
Se	elf esteem	confidence		
Bo	ody image	Body image		
Q	uality of life	Quality of Life	Global Quality of Life	Quality of Life
Ra	ating of health	Perceived Health	Health status	Health status
		status		
G	eneral patient	Patient satisfaction	Delivery of Care	Delivery of Care
sa	itisfaction			
	atisfaction with	1		
ar	opearance of arm			
	atisfaction with			
	inction			
	atisfaction with	4		
	ovement			
	atisfaction with			
SU	rength			

### Supplementary file 5: Unique outcomes mapped to potential domains and core areas according to

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### Supplementary file 5: Unique outcomes mapped to potential domains and core areas according to COMET

Satisfaction with pain			
Satisfaction with			
colour			
Satisfaction with			
shape			
Satisfaction with			
feeling			
Satisfaction with			
procedure			
Patient preference	Patient preference		
Quality of	Accessibility,		
intervention	quality and		
	adequacy of		
	intervention		
Time to surgery	Time to surgery		
Operation time	Operation time	Resource Use	Resource Use
Motor morbidity	Donor site	Adverse Events	Adverse Events
Sensory morbidity	morbidity		
Pain			
General	General		
complications	complications		
Pneumothorax	Respiratory	<b>b</b>	
Respiratory function	complications		
Respiratory		4.	
symptoms			
Pneumonia			
Arterial thrombosis	Vascular	4	
Venous thrombosis	complications		
Haematoma			
Venous spasm			
latrogenic vascular			•
injury			
Vascularity of flap			
Swelling			
Fracture	Musculoskeletal		
	complications		
Passive range of			
motion loss			
Co-contraction			
Bowstringing			
Failure of tendon			
attachment			
Joint Instability		]	
Scapula crepitus			

### Supplementary file 5: Unique outcomes mapped to potential domains and core areas according to COMET

Infection	Infection	
complications	complications	

Dodd, S. et al. A taxonomy has been developed for outcomes in medical research to help improve knowledge discovery. Journal of clinical epidemiology. 2018, 96: 84–92.

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 Supplementary file 6. Measurement of outcomes and measurement tools used
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 56 outcome subdomains in 4 core areas (Physiological/clinical, Life Impact, Resource Use and Adverse events) and within the following COMET domains

Musculoskeletal/connective tissue, Nervous system outcome domain, General outcome and symptom domain, Paysical functioning, Role functioning, Emotional functioning, Global quality of life, Perceived health status, Delivery of care, Hospital resources and Advarse events uly 202 Eras relatec

Core Area	Outcome subdomains	Patient reported	ent type used Clinician reported	Perfomanc e	Not Clear	Measurements used ( number of studies ) Measurements used ( number of studies )
_	Musculoskeletal/connective tissue	Outcome	Outcome	Outcome		
	Muscle strength	30	129	19	3	DASH (n= 23, USFI (n=2), MHQ (n=1),
PHYSIOLOGICAL /CLINICAL					24	Manual Muscle Testing Manual muscle Testing MRC muscle grading (n=61, including UCLA) MRC muscle grading modified (n= 22), MRC modified, enclear how (n= 5) MRC modified, adde 3 active must equal passive (n=2) MRC modified, adde 3 active must equal passive movement ( n=2) MRC modified, by 3+ contraction with resistance against a finger for less than 30 seconds, M4 contraction of resistance against a finger against a finger for more than 30 seconds (n=1) MRC modified: 0, M1+, M1, M1+, M2-, M2, M2+, M3-, M3, M3+, M4-, M4, 64+, M5-, M5 ( n=6) MRC modified, finger flexion tested with wrist extended 20-30 degrees ( n=1)

Page	67	of	72
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	by copyright in 202 MRC modified, Addition of M4.5 (n=1)
	MRC modified, fager extension tested with wrist extension at 20-30 degrees (\$=1) MRC modified, fager extension tested with wrist extension at 20-30 degrees (\$=1) MRC modified, in DS tested by stabilising LF and IF to table and testing MF at the process of the proces of the process of the proces of the process of the

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Supplementary file 6. Measurement of outo	comes and mea	surement too	ls used		rigt
					nt, ir 200
					Force recovery: Gross sectional area of the muscle under
					isometric contraction divided by cross sectional area at rest
					(n=1) <sup>9</sup> 7
Active movement	5	103	3	63	SST(n=1), MgQ 🛱=1), UCLA shoulder rating scale (n=1),
					MPI(n=2), CONSTANT- MURLEY(n=2) (2xPRO, 8x ClinRO), AR
					(PerfO, n=1爰说성 (PerfO, n=2), Goniometry(n=48), Visual
					assessment ភ្លឺឝ្ទី 🕺 ), First web space in cm (n=3), Total active
					movement(සු-මූ) pPulp to palm distance (n=2)
					Months to for the movement (n=1)
					Months to a vity movement (n=3)
					Months to i Big Base movement (n= 1)
					Months to independent movement without donor (n=1)
Dessitive response of resources to				7	Not clear (n 63)
Passive range of movement		6		7	Not defined n=Z, Goniometry(n=6)
Movement control and stability		1	1	2	MPI (ClinRozn=1, ULM (PerfO, n=1), Not clear (n=2)
Bone structure/position/healing				4	Not clear (na 4) = =
Muscle mass				4	Not clear(n 4)
Nervous system outcome subdomains					
General sensory recovery including		9		8	Sensory BMBC (a=5), Modified Sensory BMRC (n= 2), Highet
proprioception					classificatio릝(n=之), Not clear (n=8)
Discriminative touch (light touch, two point	1	14			MHQ (n=1), Coteon wool (n=3), Semmes Weinstein
discrimination, vibration, object recognition)					Monofilam ts = 4), Two point discrimination( n=2), Tunin
					fork (n=4), Not gefined (ClinRo, n=1)
Protective touch (pain, temperature, deep pressure)		3		7	Blunt pin (ne3), Not clear (n=7)
Structure of peripheral nervous system		1			MRI (n=1) 🎽
Reinnervation (level of reinnervation, time		54			Two point scale on EMG(n=1) Four point scale on EMG (n=4
to innervation)					Not clear EMG (🛱= 49)
Progression of regeneration		5			Tinel sign (n=5)
Speed of motor and sensory conduction		9			EMG (n=9)
General outcomes / symptoms					je za jeza jeza jeza jeza jeza jeza jeza

# Supplementary file 6. Measurement of outcomes and measurement tools used

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	Pain intensity/ relief	73			3	DASH (n=27 A S S (n=1), TAPES (n=1), VAS(n=18), NRS(n=12), HC (n=1) WBFRS(n=1), BPI (n= 1), UNWNS (n=1 McGill Pain Questionnaire SF (n=2), McGill pain questionnair (n= 1), MPI D = 1, CONSTANT-MURLEY (n=2), 4 point scale (r Author deveoped questionnaire(n=1), Not Clear (n=3)
-	Pain duration or frequency	12	0	0	0	SST (n=1), SB36 (n=5), MHQ (n=1), TAPES(n=1), NPSI (n=1), BI (n= 1), UCLA showlder rating score (n=1), Not described PRO (n=1)
	Pain quality	7				TAPES (n= 1, BESI(n=1), UWNS(n= 1), McGill SF(n=2), McGil (n=1), Non descepted PRO (n =1)
Ī	Pain when arm exposed to cold	1				NPSI (n=1) a 8 0
Ī	Paraesthesia	27				DASH (n=278 g g
Ī	Sensitivity to touch, pressure, vibration etc	3				NPSI (n=1) យ៉ីហ៊ីស៊ីទី (n= 1), NRS (n=1)
Ī	Location of pain	1	-NL			BPI (n=1) 5 3
Ī	Pain medication use	1				BPI (n=1) ni ni BPI(n=1) g
Ī	Stiffness	27				DASH (n=27≱ 🛓
	Physical functioning			C/.		
	Physical function non-specific	2				PSFS (n=1), FAPES (n=1)
Ī	Lower limb and non-upper limb function	7			1	SF36 (n=5), SAPES (n= 1), BPI (n=1)
	(walking, running, climbing stairs etc)				1//	Non describad 🛱 O (n=1)
Ī	Reaching, pulling, pushing, carrying,	37		3		DASH (n=27 U I (n=2), MHQ(n=1), ASES(n=1), SST (n=1),
	throwing , lifting					SF36(n=5), 🛱 A 🛱 n=1), AMULA ( n=1) UNBtP ( n=1)
	Turning twisting, gripping and releasing with	30		5	1	DASH (n=27 UFI (n=2), MHQ (n=1), ARAT(n=1), SHAP(n=1),
	the arm					JHFT (n=1),
1	Fine hand movement include writing	30		6		DASH (n=27多U貳I (n=2), MHQ (n=1),ARAT(n=1), SHAP(n=1), JHFT (n=1) 詹ud隆e Peg test (n=1),AMULA (n=1), UNBtP (n=1)
	Role Functioning					s. 25
	Impact on return to work	41				DASH (n =27), UFFI (n=2),MHQ (n=1), ASES (n=1), SST (n=1), SF36 (n=5), TAPES (n=1), MPI (n=1) No description PRO (n=1), Questionnaire no data ( n=1)
╞	Role function patient specific	1				PSFS(n=1)
	, per -	1		1		nt GEZ-LTA

	Supplementary file 6 Measurement of outs	omos and r	noocuromont to	laurod		njor pyr
	Supplementary file 6. Measurement of outo	omes and r	neasurement tot	ns useu		bmjopen-
	Carrying out daily routine, (including food	36	1	5		
	preparation, housework, garden, plants)	50		5		UCLA (n=1), HAP (n=1), Jebsen (n=1), ULM (n=1) Questionnage national defined (n=2), No description PRO (n=1)
						Unclear CLinROສ=1), AMULA (n=1), UNBtP (n=1)
ſ	Maintaining personal hygiene	35		2		DASH (n=27岁 A等 S (n=1), SST(n=1), SF36(n=5), MHQ(n=1) AMULA (n=到J M BtP (n=1)
ſ	Maintaining personal appearance 🛛 💦 🥂	3		1		UEFI (n=2), 🛱 🚆 n= 1), AMULA (n=1)
[	Dressing	32		2		DASH (n =27, )) AMULA (n=1), SST (n=2), MHQ (n=1), ASES (n= 1), SST (n=2) AMULA (n=1)
٦	Transport needs	29	6			DASH (n =2 4, 8) gFI (n=2),
I	mpact on recreational activities and sport	34	20			DASH (n =2 ), J = FI (n=2), ASES (n= 1), TAPES(n=1), CONST MURLEY (n=2), Mot described PRO (n=1)
5	Social functioning		TN2			
	Effect on relationship with family, friends, neighbours and groups	34		6		DASH (n =2), SB 6 (n=5), TAPES (n=1), MHQ (n=1)
	Effect on intimate relationships	27		C1.		DASH (n =2រភ្នំ 🦉
E	Emotional Functioning					
E	Emotional distress/ mood	11		1	4	SF36 (n=5), 유유통S (n= 1), BPI(n=1), UWNS(n=1), Self-rated anxiety scale (n=1), Self-rated depression scale (n=1), MH( (n=1) 쪽 응
	Thoughts and beliefs ( acceptance and adjustment)	1				TAPES (n=1)
S	Self-esteem and self confidence	28				DASH (n=27 🖁 T 👰 ES(n= 1)
E	Body image	3				MHQ (n= 2) Not described (n=1)
5	Sleep and overall health					gie 20
I	mpact on sleep	37				DASH (n=27), UBI (n=3), ASES(n= 1), MHQ (n=1), SST (n=1 BPI(n=1), CONS ANT- MURLEY(n=2),Not described PRO (n
(	General Quality of life	1				Not described P <b>B</b> O (n=1)
F	Perceived Health Status	6				SF36 (n=5), TAPES (n=1)
(	Delivery of Care					
F	Patient satisfaction	10				TAPES (n=1), UC (n=1), MHQ (n=1), 10-point scale (n=1)

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	Supplementary file 6. Measurement of outo	omes and mea	surement tool	s used		4 point scale (n=2), 3 point likert scale (n=1), Questionnaire not		
						4 point scale (n=2), 3 point likert scale (n=1), Questionnaire not described (r댤1) 이 defined PRO(n=2)		
┢	Patient preference for treatment	1				Not described (141)		
	Accessibility, quality and adequacy of	-			1	4 point scale (n=1) 4 point scale (n=1) ses o Luiv Telated mus to t		
	intervention					ses r		
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	Adverse Events					gies. 225		
_	Donor site motor morbidity to include		18		19	BMRC (n=7), BMRC modified(n=2), Dynanometry (n=8),		
	weakness					EMG(n=1)		
	Donor site sensory morbidity	1	3		4	10-point scale P		
	bonor site sensory morbiaity	1				Not defined $(n=\frac{1}{2})$ , 2PD $(n=2)$ , Monofilaments $(n=1)$		
2	Donor site morbidity -pain	3				Not defined PRO((n=3)		

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# Supplementary file 6. Measurement of outcomes and measurement tools used

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General complication	ns				2	Unclear (n=2)
Respiratory complic	ations	1	5		4	4 point scale PRe (n=1), x-ray (n=2), FEV (n=1), TLC(n=1), MVV (n-1), Not defined (n=4),
Vascular complication	ons		2		13	Not defined $\vec{I}$ n= $\vec{I}$ 3), Visual assessment (n=1), USS (n=1)
Musculoskeletal cor	nplications		2		19	Not defined CLin RO(n=2), Unclear (n=19)
Infection complicati	ons		1		2	Not defined Ro(n=1), Unclear (n=2)
		669	366	46	168	a Hi te 32 pairs RMPC Privice Partial Persoarch Council ///MUlapar Limb

DASH Disabilities of the arm shoulder and hand, UEFI Upper Extremity Functional Index, MHQ Michigan Hand Questionnaire, BMRC Britis Details Council, ULM Upper Limb Module, SHAP Southampton Hand Assessment Procedure, SST Simple Shoulder Test, MPI Mayo clinic Performance Index for the elbow, ARA Totion Research Arm Test, ClinRO Clinician Experience Scales, VAS Visual Analogue Scale, NRS Numerical Rating Scale, WBFRS Wong Baker Faces Rating Scale, UNWNS University of Wa and the scale of the scale 36 health survey, NPSI Neuropathic Pain Symptom Inventory, BPI Brief Pain Inventory, PSFS Pain Specific Functional Scale, AMULA America Beau Survey for Upper Limb Amputees, UNBPT University of New Brunswick test of Prosthetics function, JHFT Jebsen Hand Function Test, FEV Forced Expiratory Volume, TLC Tidal Lung C , MVV maximal voluntary ventilation, USS Ultrasound Scan.

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# **BMJ Open**

# Developing a core outcome set for traumatic brachial plexus injuries: a systematic review of outcomes.

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3 4	1	Title Page
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9 10	3	Title of article
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12 13	4	Developing a core outcome set for traumatic brachial plexus injuries: a
14 15	5	systematic review of outcomes.
15 16	5	systematic review of outcomes.
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5 6	2	ABSTRACT
7		
8	3	<b>Objective</b> To identify what outcomes have been assessed in traumatic brachial plexus injury
9	5	
10	4	(TBPI) research to inform the development of a Core Outcome Set for TBPI.
11	4	(TBFI) research to inform the development of a core outcome set for TBFI.
12		
13 14	5	Design Systematic review
15		
16	6	Method Medline (OVID), EMBASE, CINAHL, and AMED were systematically searched for
17	0	wethod wednine (OVID), EMBASE, CINAILE, and AMED were systematically searched for
18	7	studies avaluating the divided offectiveness of interventions in adult traumatic brachiel
19 20	7	studies evaluating the clinical effectiveness of interventions in adult traumatic brachial
20 21	0	alaura iniurina francia la rua 2012 ta Cantorah an 2010 un data dia May 2021 Tura authora
22	8	plexus injuries from January 2013 to September 2018 updated in May 2021.Two authors
23	-	
24	9	independently screened papers. Outcome reporting bias was assessed. All outcomes were
25		$\sim$
26 27	10	extracted verbatim from studies. Outcomes from patient reported or performance outcome
27		
29	11	measures were extracted directly from the instrument. Variation in outcome reporting was
30		
31	12	determined by assessing the number of unique outcomes reported across all included
32		
33 34	13	studies. Outcomes were categorized into domains using a prespecified taxonomy.
35		
36	14	<b>Results</b> Verbatim outcomes (n= 1491) were extracted from 138 studies including 32
37	14	Results verbatim outcomes (n= 1451) were extracted nom 150 studies meluding 52
38	15	questionnaires. Unique outcomes $(n - 157)$ were structured into four core areas and 11
39 40	15	questionnaires. Unique outcomes (n= 157) were structured into four core areas and 11
40 41	10	demains. Outcomes within the much labeletel demain wave processed in OCOV of studies
42	16	domains. Outcomes within the musculoskeletal domain were measured in 86% of studies,
43	47	
44	17	physical functioning in 25%, emotional functioning in 25% and adverse events in 33%. We
45		
46 47	18	identified 63 different methods for measuring muscle strength, 16 for range of movement
48		
49	19	and 63 studies did not define how they measured movement. Over 2/3rds of outcomes
50		
51	20	were
52		
53 54	21	incompletely reported in prospective studies.
55		
56	~ -	
57	22	Conclusion This review of outcome reporting in traumatic brachial plexus injury research
58	<i></i>	
59 60	23	demonstrated an impairment focus and heterogeneity. A core outcome set would ensure
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2 3		
4	1	standardized and relevant outcomes are reported to facilitate future systematic review and
5		
6	2	meta-analysis.
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9 10	Ū.	
11	4	Prospero registration number: CRD42018109843
12	-	
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14	5	
15 16		
17	6	Strengths and limitations of this study
18		
19	7	This study is a several product operation of all reported aliginal
20	7	<ul> <li>This study is a comprehensive and systematic review of all reported clinical</li> </ul>
21 22	0	automa and arted in traumatic brachiel aloung studies from 2012, 2021 in dusing
22	8	outcomes reported in traumatic brachial plexus studies from 2013- 2021 inclusive.
24		
25	9	<ul> <li>Unique outcomes were systematically categorized into a clear taxonomy to inform</li> </ul>
26		
27 28	10	the development of a core outcome set.
29		
30	11	<ul> <li>Definition of unique outcomes and categorisation was conducted by researchers and</li> </ul>
31		
32 33	12	clinicians to account for multidisciplinary perspectives.
33 34		
35	13	<ul> <li>Outcome reporting bias was assessed in included prospective and randomized</li> </ul>
36		
37	14	controlled trials
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2	INTRODUCTION
3	A traumatic brachial plexus injury (TBPI) is a major injury to the brachial plexus. It can result
4	in significant functional, social, psychological and economic effects, [1,2] with most
5	occurring in young men as a result of motorbike accidents,[3]. Survival from major trauma is
6	increasing,[4] and with this an increase in the incidence of TBPI,[5] which accounts for 1.2%
7	of polytrauma,[6].The complex and chronic nature of the injury is associated with significant
8	healthcare costs,[7] in addition to indirect costs estimated at up to \$2.34 million (in 2017
9	dollars) over the lifetime of an manual labourer in the USA with a TBPI,[8]. There are
10	multiple strategies for managing a patient with a TBPI with recent advancements in nerve
11	microsurgery,[9] and robotics,[10] resulting in increased treatment options. The choice of
12	treatment should be made using up-to-date, high quality scientific evidence,[11,12].
13	
14	Ideally, a meta-analysis would identify the most effective treatment for an individual with a
15	TBPI, however, such analysis requires homogenous outcome measurement and reporting
16	across studies to enable optimum synthesis. Indeed, despite increasing numbers of TBPI
17	studies, outcome heterogeneity and poorly defined outcomes has been highlighted as a
18	significant challenge to evidence synthesis in two recent systematic reviews,[13,14]. There is
19	now international agreement that the definition of a core outcome set (COS) for TBPI is a
20	priority,[15,16]. A COS is a minimum agreed set of outcomes to be reported and measured
21	in all studies,[17,18]. Development of a COS has been shown to reduce heterogeneity of

23 (RA) now measuring the COS for RA,[19].

outcome reporting in other health conditions, with 81% of trialists in rheumatoid arthritis

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To date a minimum set of outcomes, important to patients and professionals for reporting in TBPI studies, has not been agreed. The choice of what are important outcomes to measure in TBPI is complex due to patient heterogeneity with different mechanisms, locations and severity of injury. COS methodology is continuously being refined and promoted by the Core Outcome Measures in Effectiveness Trials (COMET) initiative [20]. Development of a COS usually begins with identification of a long list of outcomes which is then prioritised through a consensus process. This systematic review sits within the larger global COMBINE project to identify a COS for TBPI. A Delphi study and consensus meeting, informed by data from this systematic review and interviews with people with the injury, will prioritise the final COS for TBPI. As a first step in the development of an international COS for TBPI we conducted a systematic review to identify outcomes reported and measurement instruments used and their timing in the literature. The final step of the global project will match the COS to existing validated measurement instruments and make recommendations on when they should be collected, therefore it was necessary to identify currently used instruments and their timepoints also. 

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3 4	1	The aim of this review was to:
5		
6 7	2	1. Identify what outcome domains are assessed in studies evaluating surgical and non-
8 9	3	surgical treatment for TBPI.
10 11	4	2. Compare the definitions of outcomes and time points of outcomes assessed.
12 13 14	5	3. Assess selective reporting bias in included prospective studies and randomized
15 16	6	controlled trials.
17		
18 19	7	4. Identify how the outcomes were measured, that is what validated or non-validated
20 21	8	instruments are used.
22 23	9	
23	10	
25	11	
26	12	
27		
28 29	13	
30 31	14	METHODS
32 33	15	We followed the methods described in the Cochrane Handbook for Systematic Reviews of
34 35	16	Interventions, [21] and report in accordance with the Preferred Reporting Items for
36 37	17	Systematic Reviews and Meta-Analysis (PRISMA) guidelines, [22]. The systematic review
38 39 40	18	protocol was prospectively registered with PROSPERO (PROSPERO registration number:
40 41 42	19	CRD42018109843). Deviations from the protocol are reported in supplementary file 1.
43		
44 45	20	
46 47	21	Identification of studies
48 49 50	22	We conducted an electronic search of Medline (OVID), EMBASE (OVID), CINAHL and AMED
51 52	23	on the 18 <sup>th</sup> September 2018. Studies published between 01 Jan 2013 and 18 September
53 54 55	24	2018 were included to reflect outcomes employed in current TBPI care. An example of the
56 57	25	search strategy for Ovid MEDLINE is presented in supplementary file 2. The thesaurus
58 59 60	26	vocabulary of each database was used to adapt search terms. Boolean operators (AND, OR)

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1 2		
2 3	1	were used to narrow or widen the search and no language restrictions were applied. The
4	Ŧ	were used to harrow of widen the search and no language restrictions were applied. The
5 6 7	2	search was rerun on the 07 May 2021 to identify any additional outcomes.
8	3	
9 10 11	4	Study eligibility
12 13	5	Studies were included if they met the following criteria:
14 15 16	6	Study type: Any controlled and uncontrolled experimental and observational studies
17 18	7	evaluating interventions in traumatic brachial plexus injury including case reports, case
19 20	8	series, case studies, prospective and retrospective cohort studies, randomized and non-
21 22 23	9	randomized clinical trials. When the search was rerun in May 2021 only prospective cohort
24 25	10	and clinical trials were included. We excluded conference proceedings, abstract only
26 27 28	11	publications and those not involving human subjects.
29 30	12	Participants: Studies reporting outcomes in individuals with traumatic brachial plexus injury
31 32 33	13	aged 16 years or over. Studies of patients with obstetric brachial plexus injuries were
34 35	14	excluded.
36 37 38	15	Interventions: Any surgical or non-surgical intervention for TBPI.
39 40	16	<i>Outcomes:</i> All outcomes reported in the published abstract, methods or results. These
41 42 43	17	included physiological and functional outcomes, adverse events and patient reported
44 45	18	outcomes (PROs) either reported in the study or subsequently extrapolated from the PRO
46 47 48	19	instruments.
49 50	20	Language: Non-English language publications were included
51 52	21	
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# Study selection process

The reference management software Mendeley was used to compile the literature, with duplicates removed. Authors (X and X) independently screened the titles and then the abstracts against the eligibility criteria. Disagreements were discussed and a third reviewer (x) was involved where required. Studies appearing to meet the inclusion criteria based on title and abstract were retrieved as full text articles, and were read to assess for eligibility with decisions on inclusion and exclusion recorded. Disagreements in study selection were resolved by discussion within the research team (x, x, x).

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# 11 Quality assessment

12 The aim of this review was to identify outcomes reported in studies rather than synthesise data on intervention effectiveness. However, selective outcome reporting can provide 13 information on what outcomes authors prioritize. We used a modified version of Kirkham et 14 al's matrix [23, 24] to assess outcome reporting bias (ORB) in prospective studies and 15 randomized controlled trials (See ORB instrument in supplementary file 3). Two 16 17 independent reviewers (XX &XX) performed the assessment of ORB for all outcomes. 18 19 20 **Data Extraction** 21 Data were extracted into a piloted data extraction sheet (Microsoft Excel). General data 22 extracted from each study included author, study design, recruiting country, publication year, number of participants, gender, mean age, level of TBPI and intervention tested. The 23 24 following information was extracted regarding outcomes: each outcome reported

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2 3 4	1	(verbatim), area of body assessed if relevant (shoulder, elbow, wrist or hand), method of
5 6	2	administration, name of measure, timepoints of measure and reported complications. The
7 8 9	3	number of outcomes per study was also documented.
10 11	4	
12 13 14	5	Data extraction was performed independently by X and X for the first 20% of included
15 16	6	studies. These were compared, and disagreements discussed and resolved through debate
17 18 19	7	or discussion with a third reviewer (X). Following this a further ten percent of studies had
20 21	8	data extracted by both X and X. Due to the high level of agreement between reviewers (
22 23	9	91% agreement) on outcomes extracted, at this stage, the remaining studies underwent
24 25 26	10	extraction by a single reviewer (X).
27 28	11	
29 30 31	12	Where a validated PRO or performance outcome measurement was used and composed of
32 33	13	multiple items, the following data was extracted by the first author: verbatim name of the
34 35 36	14	instrument, verbatim wording for each individual item. A performance outcome
37 38	15	measurement was defined as "A measurement based on a standardized task performed by
39 40 41	16	a patient that is administered and evaluated by an appropriately trained individual or is
42 43	17	independently completed" [25]. The frequency of use of instruments was noted and
44 45 46	18	compared between studies. The instruments were categorized as: (i) General Health
40 47 48	19	(generic - for use with any patient); (ii) Upper limb physical function (region-specific); (iii)
49 50	20	Symptom or domain specific (to assess a single symptom e.g. pain) and (iv) Condition
51 52 53	21	Specific. Timepoints of measurement of all outcomes were noted. If the outcome was
54 55	22	assessed at different timepoints then all timings were recorded.
56 57 58	23	
59 60		

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# Classification of outcomes into domains and defining unique outcomes 1 2 Identically worded and spelled verbatim outcomes were removed at this stage. Identical 3 outcomes measured over different time points were noted as one outcome. Where 4 outcomes were assessed using an instrument containing several items, each individual item 5 was assigned an outcome name using the International Classification of Functioning and 6 following standard linking rules, [26]. 7 8 X categorized all outcomes into an outcome taxonomy developed by COMET for 9 categorizing outcomes for core outcome set development, [27]. These included 5 core areas 10 and 38 outcome domains. This is presented in supplementary file 4. A long list of all categorized outcomes was presented to researchers (X and X) at a face to face meeting 11 12 where the categorization of all outcomes was reviewed using the recommended taxonomy. 13 Subdomains were created within the larger taxonomy to manage the large variation in TBPI 14 clinical outcomes extracted. Disagreements not resolved at this stage were discussed

15 further with subject experts (for example, the Adverse Event domain was discussed with a

) 16 surgeon).

Due to the diversity in terminology used to report outcomes, we grouped similar outcomes within each subdomain. It is recommended that outcomes with different words, phrasing, or spelling addressing the same concept should be categorized as a unique outcome,[28]. For example, active range of motion of shoulder abduction and active goniometry of shoulder abduction were named as active shoulder abduction range and grasp strength and grip strength were named as grip strength. Independent meetings were held with four subject experts to ratify and define unique outcome names within each domain.

Patient and public involvement
The need for a COS in TBPI care was conceived following discussions with patients and
health professionals. Patients highlighted the diverse effect the injury has on their life and
that often these outcomes were overlooked by professionals, such as body image. There is a
patient advisory group for the COS and the systematic review was discussed at these
meetings. Patients were not actively involved in data collection or analysis of this review.
Dissemination will occur at the annual traumatic brachial plexus charity UK meeting where
updates from the project are presented yearly and through a six monthly newsletter.
RESULTS
health professionals. Patients highlighted the diverse effect the injury has on their life and that often these outcomes were overlooked by professionals, such as body image. There is a patient advisory group for the COS and the systematic review was discussed at these meetings. Patients were not actively involved in data collection or analysis of this review. Dissemination will occur at the annual traumatic brachial plexus charity UK meeting where updates from the project are presented yearly and through a six monthly newsletter. RESULTS
Included studies
The coarches retrieved 2010 studies, atter removing duplicates 2051 studies remained
Titles and abstract review identified 243 potentially relevant articles. Of these, 105 studies did not meet the inclusion criteria and were excluded (PRISMA flow diagram; figure 1) thus, 138 studies formed the basis of this review. All included studies are presented in supplementary file 5.
did not meet the inclusion criteria and were excluded (PRISMA flow diagram; figure 1) thus,
138 studies formed the basis of this review. All included studies are presented in
supplementary file 5.
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Place figure 1 here
Figure 1. Preferred Reporting Items for Systematic Reviews and meta-analysis flow diagram.

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6	2	Study characteristics
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8	3	Thirty-three countries from six continents recruited 3328 participants into the 138 studies
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11	4	(Table 1). Of the 138 studies, 87 (63%) were retrospective case series with most studies
12		
13	5	published from Asia (n=62, 45%). The most frequently studied surgical intervention was
14		
15	c	nome transform (n. CC. 400())
16	6	nerve transfers (n=66, 48%).
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	Study number (%)
Number of retrospective studies	87/138(63)
Number of prospective studies	24/138 (17)
Number of case studies	23/138(17)
Randomized controlled trial	4/138 (3)
World region recruitment	
Asia	62/138(45)
North America	20/138(14)
South America	23/138(17)
Europe	28/138(20)
Africa	3/138(2.2)
Australasia	2/138(1.5)
Year published	
2013	25/138(18)
2014	24/138(17)
2015	15/138(11)
2016	30/138(22)
2017	27/138(20)
2018	11/138(8)
2019 (prospective only)	3/138 (2.2)
2020 (prospective only)	3/138 (2.2) 2/138 (1.5)
2020 (prospective only) 2021 (prospective only)	1/138 (0.7)
Gender (total 3328)	1/138 (0.7)
Male	1227/2220(02)
	2737/3328(82)
Female	335/3328(10)
Not stated	256/3328(7.7)
Site of plexus injury per study (n=13	(8)

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37         38         39         40         41         42         43         44         45         46         47         48         49         50         51         52         53         54         55         56         57	1 2 3 4 5 6 7 8 9 10 11 12 13 14
58 59	

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Lower trunk10/138(7.2)Pan plexus (all avulsed)52/138(38)Infraclavicular7/138(5)Mixture35/138(25)Unclear7/138(5)Interventions (n=138)118/138(86)Surgical118/138(86)Electrotherapy3/138(2.2)Pain treatments11/138 (8)Rehabilitation4/138(2.9)Orthotic1/138(0.7)Stem cell1/138(0.7)Types of surgical intervention (n=118)Neurotization66/118(56)Tendon transfer8/118(6.8)Free flap17/118(14)Multiple surgeries12/118(10)Contralateral C78/118(6.8)Other7/118(5.9)		
Infraclavicular       7/138(5)         Mixture       35/138(25)         Unclear       7/138(5)         Interventions (n=138)       7/138(80)         Surgical       118/138(86)         Electrotherapy       3/138(2.2)         Pain treatments       11/138 (8)         Rehabilitation       4/138(2.9)         Orthotic       1/138(0.7)         Stem cell       1/138(0.7)         Types of surgical intervention (n=118)       1/138(0.7)         Neurotization       66/118(56)         Tendon transfer       8/118(6.8)         Free flap       17/118(14)         Multiple surgeries       12/118(10)         Contralateral C7       8/118(6.8)	Lower trunk	10/138(7.2)
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Unclear7/138(5)Interventions (n=138)Surgical118/138(86)Electrotherapy3/138(2.2)Pain treatments11/138 (8)Rehabilitation4/138(2.9)Orthotic1/138(0.7)Stem cell1/138(0.7)Types of surgical intervention (n=118)Neurotization66/118(56)Tendon transfer8/118(6.8)Free flap17/118(14)Multiple surgeries12/118(10)Contralateral C78/118(6.8)	Infraclavicular	7/138(5)
Interventions (n=138)         Surgical       118/138(86)         Electrotherapy       3/138(2.2)         Pain treatments       11/138 (8)         Rehabilitation       4/138(2.9)         Orthotic       1/138(0.7)         Stem cell       1/138(0.7)         Types of surgical intervention (n=118)       1/138(0.7)         Neurotization       66/118(56)         Tendon transfer       8/118(6.8)         Free flap       17/118(14)         Multiple surgeries       12/118(10)         Contralateral C7       8/118(6.8)	Mixture	35/138(25)
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Types of surgical intervention (n=118)Neurotization66/118(56)Tendon transfer8/118(6.8)Free flap17/118(14)Multiple surgeries12/118(10)Contralateral C78/118(6.8)	Orthotic	1/138(0.7)
Neurotization66/118(56)Tendon transfer8/118(6.8)Free flap17/118(14)Multiple surgeries12/118(10)Contralateral C78/118(6.8)	Stem cell	1/138(0.7)
Tendon transfer8/118(6.8)Free flap17/118(14)Multiple surgeries12/118(10)Contralateral C78/118(6.8)	Types of surgical intervention (	n=118)
Free flap17/118(14)Multiple surgeries12/118(10)Contralateral C78/118(6.8)	Neurotization	66/118(56)
Multiple surgeries12/118(10)Contralateral C78/118(6.8)	Tendon transfer	8/118(6.8)
Contralateral C7 8/118(6.8)	Free flap	17/118(14)
	Multiple surgeries	12/118(10)
Other 7/118(5.9)	Contralateral C7	8/118(6.8)
	Other	7/118(5.9)

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51 52	21
53 54 55	22
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# 1 **Outcomes** 2 Extraction of each

Extraction of each verbatim outcome domain from each study (e.g range of movement and
muscle strength) and those extracted from measures composed of several items identified a
total of 1491 verbatim outcomes. After removing duplicates 157 different unique outcomes
remained. No single outcome was reported across all 138 studies.

- 6 *Outcome definition variation*. Many outcomes were not clearly defined and different terms
- 7 were frequently found for the same concept. For example, shoulder abduction strength was
- 8 described in eleven different ways including 'deltoid strength', 'motor function of axillary
- 9 nerve', 'motor recovery of shoulder abductors', 'muscle power supraspinatus', 'motor
- 10 function of deltoid', 'motor function of supraspinatus'.
- 11 *Outcome timing variation:* Forty percent of outcomes were measured between one and
  - 12 three years following intervention. For over 6% of outcomes the timing of the measurement

13 was not stated. See Figure 2.

15 Place Figure 2 here

16 Figure 2. Outcome measurement timepoints

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1	Outcome domains: The 157 different types of outcomes were categorized into four core
2	areas (Physiological and Clinical, Life Impact, Resource Use, Adverse Events/Complications)
3	and 11 domains according to the COMET recommendations,[24]. See supplementary file 6.
4	The core area Physiological/Clinical included three domains: musculoskeletal and connective
5	tissue outcomes, nervous system outcomes and general/symptom outcomes. The core area
6	Life Impact included seven domains: physical functioning, social functioning, role
7	functioning, emotional functioning, global quality of life, perceived health status and
8	delivery of care. The core area Resource Use included one domain: hospital resources. The
9	core area Adverse Events included one domain: adverse events. No outcome could be
10	placed into the core area Death.
11	
12	Tables 2 to 4 summarise the number of unique outcomes within each domain and the
13	number of studies reporting these outcomes in each core area. The most frequently
14	reported domains were all in the Physiological/ Clinical core area and included
15	musculoskeletal and connective tissue (86%), nervous system (33%) and symptoms (38%).
16	Forty-six studies (33%) reported complications/ adverse events.
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#### Table 2. Physiological /Clinical Core Area

	,			
	Outcome Domains	Number of unique outcomes reported within domain	Examples of unique outcomes	Number of studies reporting outcomes in domain (%)
	Musculoskeletal and connective tissue	18	Active range of movement, muscle strength, muscle fatigue	119/138 (86%)
	Nervous system	15	Progression of nerve regeneration, ability to feel light touch, ability to feel pain	46/138 (33%)
	General/ symptoms	23	Pain intensity/relief, pain duration, pain quality, pain when arm exposed to cold, stiffness, sleep, paresthesia	52/138 (38%)
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# 1 Table 3. Life Impact Core Area

·			
Outcome Domains	Number of unique outcomes reported within domain	Examples of unique outcomes	Number of studies reporting outcomes within domain (%)
Physical functioning	19	Reaching, fine hand movement	35/138 (25%)
Role functioning	23	Return to work, Impact on normal hobbies	38/138 (27%)
Social functioning	7	Social activities with family	32/138 (23%)
Emotional functioning	13	Body image, acceptance	34/138 (25%)
Global quality of life	1	Quality of life	2/138 (1.5%)
Perceived health Status	1	Health status rating	9/138 (6%)
Delivery of care	13	Patient satisfaction, quality of care, patient preference, time to surgery	11/138(8%)

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(	Number of unique outcomes reported within domain	Examples of unique outcomes	Number of studies reporting outcomes within domain
Adverse Events Core A	rea		
Donor site morbidity	3	Motor weakness, sensory loss	24/138(17%)
Musculoskeletal	7	Co -contraction, Passive movement	12/138 (8.7%)
Respiratory	4	Pneumothorax	6/138 (4.4%)
Vascular	7	Hematoma	7/138 (5.1%)
Infection	1	Infection	3/138 (2.2%)
General non specified complications	1	General complications	3/138 (2.2%)
Resource Use Core Area	a		
Hospital resource use	1	Operation time	1/138 (.7%)

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# 1 Outcome Measurement

2	In addition to extraction of standalone clinician reported and patient reported outcomes
3	such as muscle power, range or movement or return to work, outcomes were also extracted
4	from individual items contained in a total of 32 different instruments; PRO measures (n=
5	22), combined clinician-reported and patient-reported measures (n= 3) and performance
6	measures (n= 7). See table 5. These measures were reported 98 times in the included
7	publications. Most outcome measures were used once (n= 22/32, 69%). The most
8	frequently reported measures were the Disabilities of the Arm Shoulder and Hand
9	(DASH,[29]) questionnaire (n=28 studies, 29%) and the Visual Analogue Scale (n=20, 20%).
10	The median number of items per instrument was 15 ranging from one (Visual Analogue
11	Scale, Numerical Rating Scale and Wong Baker Faces rating scale),[30] to 54,[31]. These
12	items mapped to 34 different outcome domains.
13	
14	There was wide variation in the methods used to measure outcomes. This is presented in
15	supplementary file 7

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(Measureme	ent instruments mapped to domains). For example	; 63 differ	ent meas	urements
were used to evaluate muscle function, including the British Medical Research Council,[32]				
twelve differ	twelve different modifications of the British Medical Council, Isokinetics, Dynanometry and			
Constant - N	lurley score,[33]. In addition, it was often not clear	which ins	trument	was used
for measure	ment of the outcomes. For example, the instrumer	nt used to	measure	active
range of mov	vement was not reported in 34% of total times (63	/ 186) the	outcome	was
assessed. Fir	ally with regards to method of measurement 61 st	tudies em	ployed a F	PRO
instrument t	o evaluate the intervention. Prospective and rando	omized co	ntrolled ti	rials were
more likely t	o evaluate outcomes with a PRO (58%;15/26) com	pared to 3	86% (31/8	7) of
retrospective studies.				
Table 5: Out	come measures used in included studies			
	C2	r of	r of	Frequency (n=98)
		items	scales	
PRO Measures				20
				28
			3	1
	Upper Extremity Functional Index	20	0	2
	American Shoulder and Elbow Score	15	0	1
	American Shoulder and Elbow Score Modified American Shoulder and Elbow Score	15 13	0 0	1 1
	Modified American Shoulder and Elbow Score	13	0	1
PRO & ClinRO Measure	Modified American Shoulder and Elbow Score Simple Shoulder test	13 12	0 0	1 1
	were used to twelve differ Constant - M for measurer range of mov assessed. Fin instrument t more likely to retrospective Table 5: Outo	were used to evaluate muscle function, including the British Metical Council, Is twelve different modifications of the British Medical Council, Is Constant - Murley score, [33]. In addition, it was often not clear for measurement of the outcomes. For example, the instrumer range of movement was not reported in 34% of total times (63) assessed. Finally with regards to method of measurement 61 st instrument to evaluate the intervention. Prospective and rando more likely to evaluate outcomes with a PRO (58%;15/26) com retrospective studies. Table 5: Outcome measures used in included studies	were used to evaluate muscle function, including the British Medical Res         twelve different modifications of the British Medical Council, Isokinetics,         Constant - Murley score,[33]. In addition, it was often not clear which ins         for measurement of the outcomes. For example, the instrument used to         range of movement was not reported in 34% of total times (63/ 186) the         assessed. Finally with regards to method of measurement 61 studies empirish         instrument to evaluate the intervention. Prospective and randomized co         more likely to evaluate outcomes with a PRO (58%;15/26) compared to 3         retrospective studies.         Table 5: Outcome measures used in included studies         PRO       Upper limb physical function measures (n= 17)         Measures       Disabilities of Arm Shoulder and Hand       38         Quick DASH       19	twelve different modifications of the British Medical Council, Isokinetics, Dynanom Constant - Murley score,[33]. In addition, it was often not clear which instrument of for measurement of the outcomes. For example, the instrument used to measure range of movement was not reported in 34% of total times (63/186) the outcome assessed. Finally with regards to method of measurement 61 studies employed a R instrument to evaluate the intervention. Prospective and randmized controlled to more likely to evaluate outcomes with a PRO (58%;15/26) compared to 36% (31/8 retrospective studies. Table 5: Outcome measures used in included studies PRO Measures Upper limb physical function measures (n= 17) Measures Disabilities of Arm Shoulder and Hand 38 3 Quick DASH 19 3 Upper Extremity Functional Index 20 0

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2					
3 4 5		MAYO Performance Index	4	0	1
5 6 7	Performan	Jebsen Taylor	7	0	1
, 8 9 10	ce Measures	University of New Brunswick Test of Prosthetic Function for Unilateral Amputees (UNB)	30	3	1
11 12		Upper Limb Module Questionnaire	22	3	1
13		Action Reach Arm Test	19	4	2
14 15		Southampton Hand Assessment Procedure	26	0	2
16 17		Purdue Peg test	3	0	1
18 19		Activities Measure for Upper Limb Amputees	24	0	1
20 21	PRO	Generic questionnaires (n=3)			
22 23	Measures	36 item short form survey (SF36)	36	8	8
24		Patient Specific Functional Score	4	0	2
25 26		EQ5D-3L	6	0	1
27 28		Condition specific questionnaires (n=1)			
29 30		Trinity Amputation and Prosthesis scale	54	5	1
31 32		Symptom specific questionnaires (n=10)			
33 34		Visual Analogue Scale	1	0	20
35		Numerical Rating Scale	1	0	6
36 37		Wong Baker Faces rating scale	1	0	1
38 39		Brief pain inventory	- 15	6	-
40 41		Neuropathic pain symptom inventory	10	5	1
42 43		University of Washington Neuropathic score	10	3	1
44 45		McGill Pain Questionnaire	28	3	2
46		McGill Pain Questionnaire SF	28 17	3	2
47 48					
49 50		McGill Pain Questionnaire (Japanese version)	17	3	1
51 52		Self- rating anxiety scale	20	0	1
53 54		Zung Self rating Depression scale	20	0	1
55 56	1				
57	1 2				
58 50	3				

2		
3 4	1 2	Outcome Reporting Bias
5 6 7	3	Figure 3. illustrates the reporting status of outcomes (n=173) across the included
, 8 9	4	prospective case series, cohort and randomized controlled studies (n=26). None of the
10 11	5	studies were prospectively registered. Fewer than one third of the outcomes in the
12 13 14	6	prospective case series and cohort studies and half of outcomes in randomized controlled
15 16	7	studies were "completely" reported.
17 18 19 20 21	8 9 10	
22	11	
23 24 25	12	Place Figure 3 here.
26	13	Figure 3. Cumulative bar chart showing number of outcomes within each reporting bias
27 28 20	14	category across study types.
29 30	15	
31 32	16	
33 34	17	
35 36	18	
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38 39 40	20	
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2 3		
5 4	1	DISCUSSION
5	2	This sustainable review simpled to identify what autoence demains have been reported in
6 7	3	This systematic review aimed to identify what outcome domains have been reported in
8 9	4	studies evaluating interventions for TBPI, examine outcome definitions and timepoints and
10 11 12	5	identify the instruments used to assess outcomes. We found a wide variation in reported
13 14	6	outcomes, timing of outcomes and outcome instruments used. Furthermore, a lack of
15 16 17	7	standardized definition for commonly reported outcomes was observed. This heterogeneity
18 19	8	in outcome reporting across studies hinders evidence synthesis and results in research
20 21 22	9	waste,[34].
23 24	10	
25 26 27	11	The most commonly reported core area was Physiological/ Clinical including
28 29	12	musculoskeletal, nervous system and symptom domains. Eighty-six percent of studies
30 31 32	13	reported musculoskeletal outcomes. However, there were 21 different outcomes reported
33 34	14	in this category making comparison between studies difficult. Furthermore, the diversity of
35 36 37	15	measures used to assess the outcomes increases the difficulty with synthesis. For example,
38 39	16	muscle function/ strength was assessed using 59 different measures, whilst 10 studies did
40 41	17	not report what measure they used. To compound this muscle strength was assessed by
42 43 44	18	both physical examination by a clinician (86%) and also by asking the patient(10%).
45 46	19	
47 48 49	20	Only 44% of studies (61/138) evaluated PROs and within these studies there was significant
50 51	21	heterogeneity in the measurement instrument used. Twenty-five different instruments
52 53 54	22	were used with 17 only ever used once. The DASH was the most common instrument
55 56	23	employed, in almost half the studies evaluating a PRO. The PRO instruments also varied
57 58 59	24	greatly in terms of content with some as simple as a single item whilst others included up to
59 60	25	54 items. Over 408 individual questionnaire items were evident from the 25 PRO

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1	instruments mapping to 34 different outcomes domains. This highlighted a lack of
2	consistency with no domain being measured by all PRO instruments. None of the included
3	PRO assessments were designed specifically for individuals with a TBPI. Although this may
4	be beneficial in terms of comparison with other conditions, such instruments may not be
5	sensitive to issues of importance to patients with TBPI. Finally, it was evident that
6	prospective studies and randomized controlled trials were more likely to use patient
7	reported outcomes to evaluate interventions. This may correspond with the higher
8	methodological rigour associated with these study designs. However the majority of studies
9	evaluating interventions in TBPI were retrospective (63%). These issues combined pose
10	major questions regarding the clinical interpretation of results from TBPI studies.
11	
12	
13	It is clear that that individuals with a TBPI suffer significant emotional and psychoscocial
14	issues,[1,35]. However such issues were infrequently and inconsistently measured within
15	this review. Only two studies evaluated Quality of Life [36,37] . Similarly, physical, role and
16	social functioning outcomes were reported in 25%, 27% and 23% of studies respectively.
17	This relates strongly to the use of the DASH within the studies. Indeed, emotional
18	functioning was reported in 34 studies, 28 of these studies used the DASH which has one
19	item on confidence and capability mapping to this domain. If the DASH was excluded, only
20	six studies would assess outcomes within the emotional functioning domain. This is
21	surprising considering the existing literature which evidences the complex emotional and
22	
	psychological factors, individuals face when adjusting to their injury, [1,38].
23	psychological factors, individuals face when adjusting to their injury,[1,38].

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Complications/adverse events were reported in one third of studies. Documentation of complications is crucial to improve patient care and gather data for benchmarking. In 1992, the Clavien-Dindo classification, [39] was introduced to assist with classification of complications to enable comparison between studies, [39]. However, within the adverse events outcomes identified in this review there was heterogeneity. Of the 37 verbatim outcomes reported within the donor morbidity (motor) outcome 19 did not define how this was assessed. Outcome Reporting Bias Only four studies included in this review were randomized controlled trials [40,41,42,43]. However despite prospective trial registration on a public registry being a condition of publication [44] none of the randomized trials on TBPI were registered. We also found marked selective outcome reporting in the included prospective and randomized TBPI studies. Most outcomes were only partially reported, frequently lacking specific detail about the outcome result or time of measurement, omitting certain outcome results or lacking detail needed for meta-analysis. This outcome reporting bias identified in current TBPI literature threatens the validity of the evidence based practice in TBPI because it potentially overestimates the effect of treatments or distorts results of studies. This contributes to research waste and critically delays advancement of care for patients. There are some limitations in this review. We excluded outcomes from older studies to

ensure we identified outcomes relevant to contemporary TBPI care. Detailed risk of bias
assessment was not undertaken, however the review was designed to identify the breadth
of reporting in the literature and not to examine the effectiveness of interventions. The

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strengths of this review are that the protocol and the data extraction form were prespecified, prospectively registered and the literature search systematic. To account for
multidisciplinary perspectives, researchers and clinicians where involved in categorizing
outcomes into domains. It is the first review to detail the extent of outcome heterogeneity
in TBPI research using a systematic method. International and non-English publications
were included to reduce the risk of selection bias.

Variation in definitions and measurement of outcomes has been found within other areas of healthcare. Outcome heterogeneity is found in the reporting of outcomes relating to burn care, [45] breast reconstruction, [46] and spinal cord injury, [47] amongst others. A recent review of outcome reporting within burns illustrated wound healing was defined in 166 different ways across 147 studies, [45]. A solution to the variation in outcome reporting across studies in TBPI is the development of a COS, [20]. This has been shown to improve consistency of outcome reporting, [19,48]. Development of a COS in TBPI would not restrict the range of outcomes that can be measured. Researchers and clinicians would still be free to select additional outcomes but the inclusion of such a COS would facilitate synthesis of evidence, [49,50]. Whilst work has begun in obstetric brachial plexus injuries to develop a minimum data set[51], there is no COS for TBPI.

Considerable work has been done by the Core Outcome Measures in Effectiveness Trials
 (COMET) initiative through dissemination of resources for COS development and support for
 methodological development. COMET recommends a five step process to develop a COS:
 define the scope, assess the need, develop the protocol, determine what to measure and
 determine how to measure,[52]. This systematic review addresses these first two steps for

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the development of the COS in TBPI care. This review has shown the majority of TBPI studies use only clinician reported outcomes to evaluate interventions. However they do not adequately capture patients' health related guality of life, [53] and may underestimate the impact of a condition, [54]. Concurrent qualitative work to identify outcomes which are important to individuals with a TBPI has been completed by this group. The next stage involves integration of all potential outcomes from this review and the qualitative work into a long list of domains. Healthcare professionals and patients will be invited to prioritize these outcomes during a three round international online Delphi process and consensus meeting. This will strengthen the case for uptake of a COS for TBPI as it represents patients' and clinicians' perspectives on what outcomes are important. The final stage will map existing validated measures to the outcome domains in the final COS. A future study will evaluate the psychometric properties of those mapped measurement instruments and identify where new measures need to be developed. 

2 3		
4	1	CONCLUSION
5 6 7	2	This systematic review has shown that outcome reporting in TBPI care is heterogenous and
8 9	3	impairment focused with a lack of standardized definitions for commonly reported
10 11 12	4	outcomes. This makes it difficult to compare and combine data from studies to inform
13 14	5	decision making in clinical practice. The measurement instruments used in the studies were
15 16	6	also often not clear, particularly when range of movement was assessed. In future studies,
17 18 19	7	authors need to be clearer with descriptions of outcomes assessed and how they were
20 21	8	measured. Less than half the studies in this review evaluated outcomes using PRO
22 23 24	9	measures. Given that TBPI has a significant impact on health-related quality of life, it is
25 26	10	recommended that authors of future studies include PROs in future studiesWe have
27 28 29	11	identified a list of potentially relevant outcomes and categorized these into a clear
30 31	12	taxonomy. This will inform the next stage of developing a COS for TBPI where patients,
32 33 34	13	surgeons and therapists will be involved in a consensus process to decide the final outcomes
34 35 36	14	included in a COS for TBPI.
37 38	15	
39 40 41	16	
42 43	17	Acknowledgements
44 45 46	18	Acknowledgements
47 48 49	19	We would like to thank Colin Shirley for his assistance and guidance categorising
50 51 52	20	neurophysiological outcomes
53 54 55	21	
55 56 57	22	
58 59 60	23	

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4	1	
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6	2	Competing Interests
7		
8	2	Conflicting interactor CNA, CHILLIC, DNAD and IOC declars no notantial conflicts of interact
9	3	Conflicting interests: CM, CJH, JC, DMP and JOS declare no potential conflicts of interest
10 11		
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13		
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20		
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22	-	
23	9	submitted work; .
24	5	Submitteed worky.
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20	10	
28		
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40 41	15	
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43	16	Ethical approval
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45	17	Ethical approval was not sought for the present study because it was a systematic review
46	1/	Ethical approval was not sought for the present study because it was a systematic review
47 49	4.0	
48 49	18	and did not involve human or animal subjects.
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54	20	Informed consent
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58	21	Informed consent was not sought for the present study because it was a systematic review
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60	22	and did not involve human participation

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3	1	Data availability
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6	2	All data relevant to the study are included in the article or uploaded as supplementary
7	2	All data relevant to the study are included in the article of uploaded as supplementary
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9	3	information.
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15	5	Contributorship
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18	6	CM, CJH and JC conceived and designed the review. CM and JOS reviewed the titles,
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20	_	
21	7	abstracts and full text papers for eligibility. Authors resolved disagreements by discussion or
22		
23	8	where necessary CJH and DMP offered their view. CM and JOS were responsible for
24	0	where hecessary with and binn offered their view. On and you were responsible for
25	-	
26	9	extracting data and data extraction was verified by CJH. CM and JOS independently
27		
28	10	reviewed outcome reporting bias. CM, CJH and JC categorised outcomes. Categorisation was
29	10	reviewed battome reporting bias. etw, esh and se categorised battomes. categorisation was
30		
31	11	reviewed and edited by DMP and DK. CM prepared the manuscript. CJH,JC, DMP, DK and
32		
33	12	JOS reviewed and edited the manuscript.
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2 3 4 5	1		References
6 7	2		
9	3	[1]	Brito S, White J, Thomacos N, et al. The lived experience following free functioning
3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37	4		muscle transfer for management of pan-brachial plexus injury: reflections from a
13	5		long-term follow-up study. <i>Disabil Rehabil</i> 2019;1:1–9.
16	6	[2]	Morris M, Daluiski A, Dy C. A thematic analysis of online discussion boards for
18	7		brachial plexus injury. J Hand Surg AM 2016;41(8):813-8.
20 21	8	[3]	Kaiser R, Waldauf P, Ullas G, et al. Epidemiology, etiology, and types of severe adult
22 23 24 25 26 27 28 29 30 31 32	9		brachial plexus injuries requiring surgical repair: systematic review and meta-analysis.
	10		Neurosurg Rev 2020;43(2):443-452.
	11	[4]	Moran CG, Lecky F, Bouamra O, et al. Changing the system - major trauma patients
30	12		and their outcomes in the NHS (England) 2008-17. EClinicalMedicine 2018;13–21.
33	13	[5]	Dy CJ, Peacock K, Olsen MA, et al. Incidence of surgically treated brachial plexus injury
33 34 35 36 37 38	14		in privately insured adults under 65 years of age in the USA. <i>Hosp Spec Surg J</i>
	15		2020;online.
39 40 41	16	[6]	Midha R. Epidemiology of brachial plexus injuries in a multitrauma population.
41 42 43 44 45 46	17		Neurosurgery 1997;40:1182–8
	18	[7]	Felici N, Zaami S, Ciancolini G, et al. Cost analysis of brachial plexus injuries: Variability
40 47 48	19		of compensation by insurance companies before and after surgery. Handchir
48 49 50	20		Mikrochir Plast Chir 2014;46:85–9.
51 52 53	21	[8]	Hong TS, Tian A, Sachar R, et al. Indirect cost of traumatic brachial plexus injuries in
54 55	22		the United States. J Bone Joint Surg Am 2019;101:e80.
56 57 58	23	[9]	Bhandari PS, Maurya S. Recent advances in the management of brachial plexus
59 60	24		injuries. <i>Indian J Plast Surg</i> 2014;47:191–8.

Page 35 of 80

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ngle-joint HAL in a	
olexus injury: A	
6–8.	-
approach. <i>Int J</i>	-
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2014;17(7):A435	techno
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1 2								
3 4	1	[10]	Kubota S, Hara Y, Shimizu Y, et al. A newly developed upper limb single-joint HAL in a					
5 6 7	2		patient with elbow flexion reconstruction after traumatic brachial plexus injury: A					
8 9	3		case report. Interdiscip Neurosurg Adv Tech Case Manag 2017;10:66–8.					
10 11 12	4	[11]	Dickinson HD. Evidence-based decision-making: an argumentative approach. Int J					
12 13 14	5		Med Inform 1998;51:71–81.					
15 16 17	6	[12]	Sackett DL, Rosenberg WM, Gray JA, et al . Evidence based medicine: what it is and					
17 18 19	7		what it isn't. <i>BMJ</i> 1996;312:71–2.					
20 21 22	8	[13]	Ayhan E, Soldado F, Fontecha CG, et al. Elbow flexion reconstruction with nerve					
22 23 24	9		transfer or grafting in patients with brachial plexus injuries: A systematic review and					
25 26	10		comparison study. <i>Microsurgery</i> 2020;40:79–86.					
27 28 29	11	[14]	Donnelly MR, Rezzadeh KT, Vieira D et al. Is one nerve transfer enough? A systematic					
30 31	12		review and pooled analysis comparing ulnar fascicular nerve transfer and double					
32 33 34	13		ulnar and median fascicular nerve transfer for restoration of elbow flexion after					
35 36	14		traumatic brachial plexus injury. <i>Microsurgery</i> 2020;40:361–9.					
37 38 39	15	[15]	Dy CJ, Garg R, Lee SK, et al. A systematic review of outcomes reporting for brachial					
40 41	16		plexus reconstruction. J Hand Surg Am 2015;40:308–13.					
42 43	17	[16]	Hill B, Williams G, Olver J, et al. Letter regarding outcome reporting for brachial					
44 45 46	18		plexus reconstruction. J Hand Surg Am 2015;40:1504.					
47 48	19	[17]	Gargon E, Gurung B, Medley N, et al. Choosing important health outcomes for					
49 50 51	20		comparative effectiveness research: a systematic review. PLoS One 2014;17(7):A435					
52 53	21	[18]	Williamson P, Altman D, Blazeby J et al. Driving up the quality and relevance of					
54 55 56	22		research through the use of agreed core outcomes. J Health Serv Res Policy					
57 58	23		2012;17:1–2.					
59 60	24							

Page 36 of 80

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BMJ Open

1 2			
3 4	1	[19]	Kirkham JJ, Bracken M, Hind L, et al. Industry funding was associated with increased
5 6 7	2		use of core outcome sets. <i>J Clin Epidemiol</i> 2019;115:90–7.
, 8 9	3	[20]	Williamson PR, Altman DG, Blazeby JM et al. The COMET (Core Outcome Measures in
10 11	4		Effectiveness Trials) Initiative. Trials 2011;12:A70.
12 13 14	5	[21]	Higgins J, Green S. Cochrane Handbook for Systematic Reviews of Interventions
15 16	6		Version (updated March 2011). version 5. 2011.
17 18 19	7	[22]	Shamseer L, Moher D, Clarke M, et al. Preferred reporting items for systematic review
20 21	8		and meta-analysis protocols (PRISMA-P) 2015: elaboration and explanation. BMJ
22 23 24	9		2015;349:g7647.
24 25 26	10	[23]	Kirkham JJ, MDwan K, Altman DG et al. The impact of outcome reporting bias in
27 28	11		randomised controlled trials on a cohort of systematic reviews. BMJ 2010;340:637-
29 30 31	12		40.
32 33	13	[24]	Deshmukh SR, Mousoulis C, Marson BA et al. Developing a core outcome set for hand
34 35 36	14		fractures and joint injuries in adults: a systematic review. Journal of Hand
37 38	15		Surgery(Eur) 2021; 46(5):488-495.
39 40 41	16	[25]	Richardson E, Burnell J, Adams HR, et al. Developing and implementing performance
42 43	17		outcome assessments: evidentiary, methodologic, and operational considerations.
44 45 46	18		Ther Innov Regul Sci.2019;53(1):146-153.
47 48	19	[26]	Cieza A, Geyh S, Chatterji S, et al. ICF linking rules: an update based on lessons
49		[20]	
50	20	[20]	learned. J Rehabil Med 2005;37:212–8.
	20 21	[27]	
50 51 52 53 54 55			learned. J Rehabil Med 2005;37:212–8.
50 51 52 53 54	21		learned. <i>J Rehabil Med</i> 2005;37:212–8. Dodd S, Clarke M, Becker L, et al. A taxonomy has been developed for outcomes in

BMJ Open

2			
3 4	1		development studies demonstrates difficulties in defining unique outcomes. J Clin
5 6 7	2		<i>Epidemiol</i> 2019;115:14–24.
8 9	3	[29]	Hudak PL, Amadio PC, Bombardier C, et al. Development of an upper extremity
10 11	4		outcome measure: The DASH (disabilities of the arm, shoulder, and head). Am J Ind
12 13 14	5		<i>Med</i> 1996;29:602–8.
14 15 16	6	[30]	Baker C, Wong D. Q.U.E.S.T: a process of pain assessment in children (continuing
17 18	7		eductation credit). Orthop Nurs 1987;6:11–21.
19 20 21	8	[31]	Gallagher P, MacLachlan M. Development and psychometric evaluation of the trinity
22 23	9		amputation and prosthesis experience scales (TAPES). Rehabil Psychol 2000;45:130–
24 25	10		54.
26 27 28	11	[32]	Medical Research Council. Aids to the investigation of the peripheral nervous system.
29 30	12		London: Her Majesty's stationary office; 1943.
31 32	13	[33]	Constant CR, Murley AH (1987) A clinical method of functional assessment of the
33 34		[55]	
35 36	14		shoulder. Clinical Orthopaedics & Related Research 1987;214:160-164
37 38	15	[34]	Chalmers I, Glasziou P. Avoidable waste in the production and reporting of research
39 40 41	16		evidence. <i>Lancet</i> 2009;374:86–9.
42 43	17	[35]	McDonald J, Pettigrew J. Traumatic brachial plexus injury: the lived experience. British
44 45	18		Journal of Occupational Therapy 2014;77(3):147-154.
46 47 48	19	[36]	Kim JH, Shin SH, Lee YR, et al. Ultrasound-guided peripheral nerve stimulation for
49 50	20		neuropathic pain after brachial plexus injury: two case reports. J Anesth 2017;31:453-
51 52 53	21		7.
53 54 55	22	[37] (	Cole T, Nicks R, Ferris S et al. Outcomes after occupational therapy intervention for
56 57	23		traumatic brachial plexus injury: A prospective longitudinal cohort study. Journal of
58 59	24		Hand Therapy 2020;33:528-539
60			

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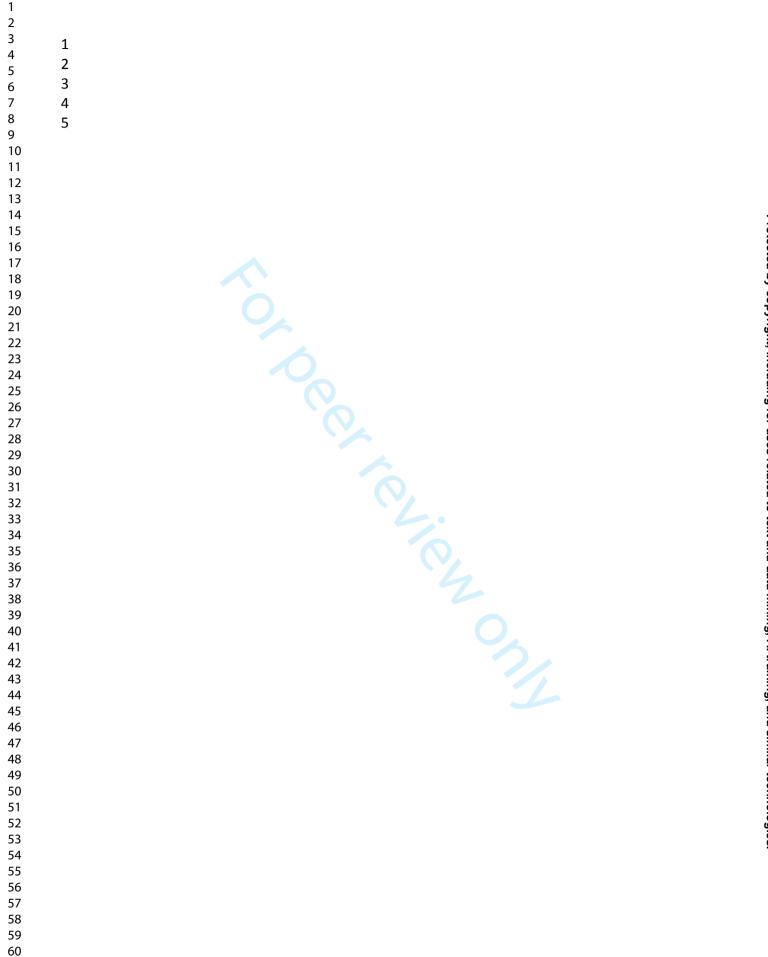
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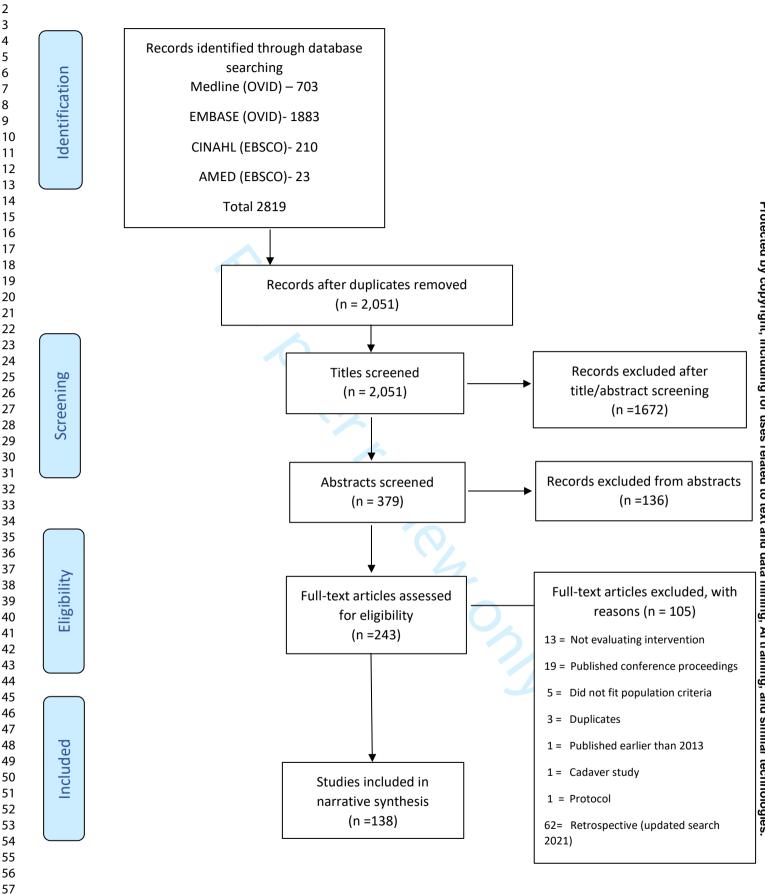
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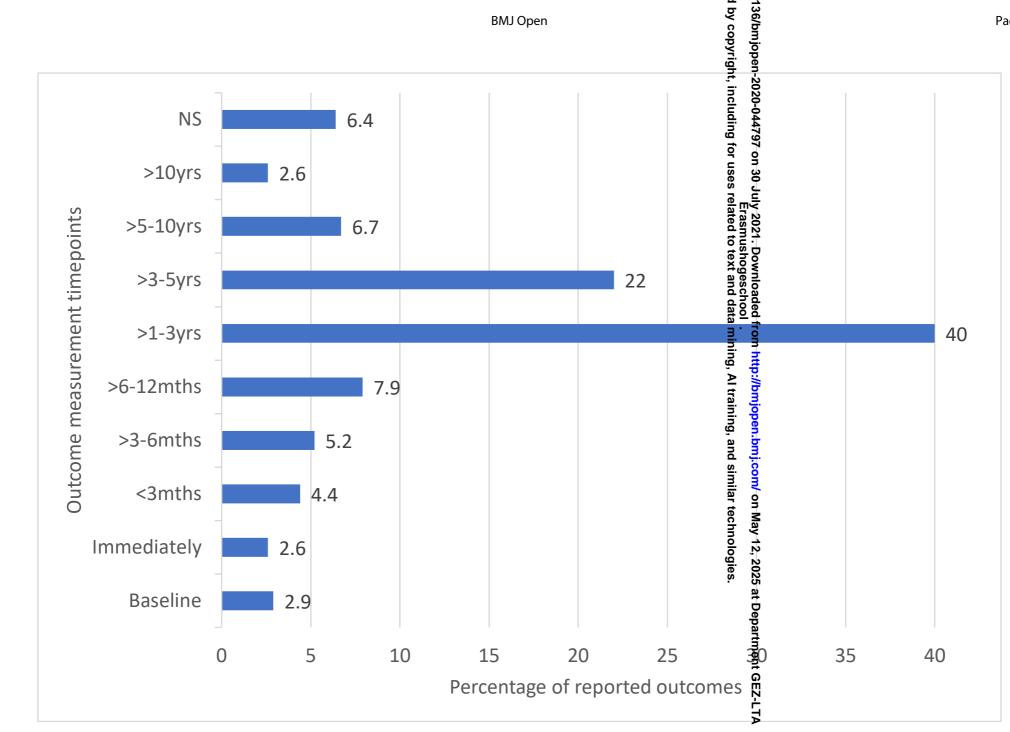
1 2 3	1		
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6 7	2	[38]	Miller C, Peek AL, Power D, et al. Psychological consequences of traumatic upper limb
8 9	3		peripheral nerve injury: A systematic review. Hand Ther 2017;22:35–45.
10 11 12	4	[39]	Clavien P, Sanabria J, Strasberg S. Proposed classification of complications of surgery
12 13 14	5		with examples of utility in cholecystectomy. Surgery 1992;111(5):518-26
15 16	6	[40]	Razak I, Chung TY, Ahmad S et al. A comparative study of two modalities in pain
17 18 19	7		management of patients presenting with chronic brachial neuralgia. Journal of
20 21	8		Alternative and Complementary Medicine 2019; 1-7
22 23 24	9	[41]	Ferreira CM, de Carvalho CD, Gomes R et al. Transcranial direct current stimulation
24 25 26	10		and mirrir therapy for neuropathic pain after brachial plexus avulsion: A randomised
27 28	11		double-blind, controlled pilot study. Frontiers in Neurology 2020; 11:1-10
29 30 31	12	[42]	Martins RS, Siqueira MG, Heise CO et al. A prospective study comparing single and
32 33	13		double fascicular transfer to restore elbow flexion after brachial plexus injury.
34 35 36	14		Neurosurgery 2013;72:709-715
37 38	15	[43]	Tu YK. Tsai YJ, Chang CH et al. Surgical treatment for total root avulsion type brachial
39 40 41	16		plexus injuries by neurotization: a prospective comparison study between total and
42 43	17		hemicontralateral C7 nerve root transfer. Microsurgery 2014; 34:91-101
44 45 46	18	[44]	Angelis CD, Drazen JM, Frizelle FA et al. Clinical trial registration: a statement from the
47 48	19		international committee of medical journal editors. The New England Journal of
49 50	20		Medicine 2004; 351:1250-1251
51 52 53	21	[45]	Young AE, Davies A, Bland S et al. Systematic review of clinical outcome reporting in
54 55	22		randomised controlled trials of burn care. BMJ Open 2019;15;9(2):e025135
56 57 58	23	[46]	Potter S, Brigic A, Whiting PF, et al. Reporting clinical outcomes of breast
59 60	24		reconstruction: a systematic review. J Natl Cancer Inst 2011;103:31–46.

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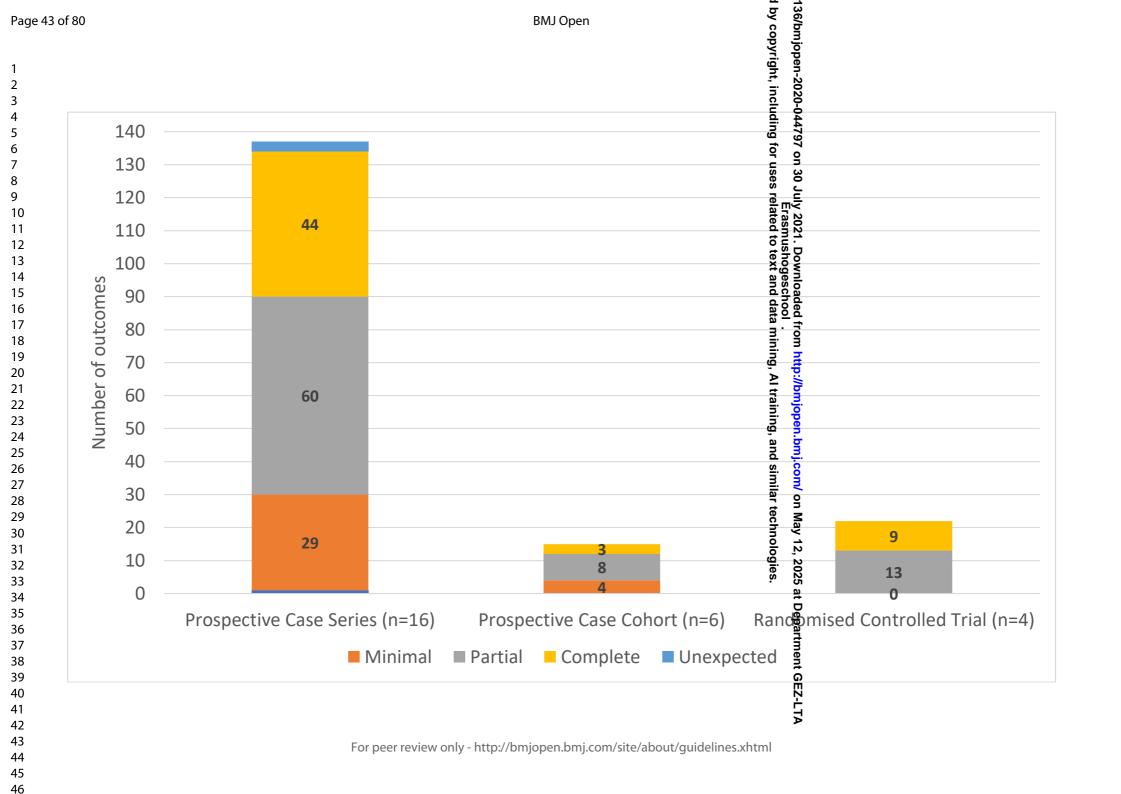
1 2			
3 4	1	[47]	Watzlawick R, Antonic A, Sena ES, et al. Outcome heterogeneity and bias in acute
5 6 7	2		experimental spinal cord injury A meta-analysis. Neurology 2019;2;93(1):e40-e51
8 9	3	[48]	Bautista-Molano W, Navarro-Compán V, Landewé RBM, et al. How well are the
10 11 12	4		ASAS/OMERACT core outcome sets for ankylosing spondylitis implemented in
12 13 14	5		randomized clinical trials? A systematic literature review. Clin Rheumatol
15 16	6		2014;33:1313–22.
17 18 19	7	[49]	Clarke M, Williamson PR. Core outcome sets and systematic reviews. Syst Rev
20 21	8		2016;5:11.
22 23 24	9	[50]	Clarke M. Standardising outcomes for clinical trials and systematic reviews. Trials
25 26	10		2007;8:39.
27 28 29	11	[51]	Pondaag W, Malessy MJA. Outcome assessment for Brachial Plexus birth injury.
30 31	12		Results from the iPluto world-wide consensus survey. <i>J Orthop Res</i> 2018;36:2533–41.
32 33	13	[52]	Williamson PR, Altman DG, Bagley H, et al. The COMET Handbook: version 1.0. Trials
34 35 36	14		2017;18:280.
37 38	15	[53]	Pakhomov S, Jacobsen SJ, Chute CG, et al. Agreement between patient-reported
39 40 41	16		symptoms and their documentation in the medical record. Am J Manag Care
42 43	17		2008;14:530–9.
44 45 46	18	[54]	Turner GM, Slade A, Retzer A, et al. An Introduction to Patient Reported Outcome
47 48	19		Measures (PROMs) in Trauma. J Trauma Acute Care Surg 2019;86(2):314-320
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# Developing a core outcome set for traumatic brachial plexus injuries: a systematic review of outcomes

Supplementary file 1. Deviations from study protocol

Journal of Hand Surgery (Eur) and The Journal of Hand Surgery (American).for MEDLINE.We planned to include studies with participants aged 18 and over within the review.We reduced the age of include participants to 16 or over as a studies included older teenagers with adults in their studies. discussion with the research team we concluded that there were no difference between treatment of those aged 16 and over versus aged 18. If we excluded these studies many outcomes used across these age ranges would have been lost.One search date was originally proposed in the study protocolWe updated the search in May 2021, including prospective a randomized controlled trials to ensure that the outcomes identified and reported in the publication reflected current outcomes in the literature and to ensure that no outcomes w omitted.No quality assessment wasOutcome reporting bias was assessed in the included prospective	rotocol method	Deviation from protocol method with justification
We planned to include studies with participants aged 18 and over within the review.We reduced the age of include participants to 16 or over as a studies included older teenagers with adults in their studies. discussion with the research team we concluded that there were no difference between treatment of those aged 16 and over versus aged 18. If we excluded these studies many outcomes used across these age ranges would have been lost.One search date was originally proposed in the study protocolWe updated the search in May 2021, including prospective a randomized controlled trials to ensure that the outcomes identified and reported in the publication reflected current outcomes in the literature and to ensure that no outcomes wo omitted.No quality assessment wasOutcome reporting bias was assessed in the included prospective	ournal of Hand Surgery (Eur) nd The Journal of Hand	We did not hand search these Journals as they were all indexed for MEDLINE.
originally proposed in the study protocolrandomized controlled trials to ensure that the outcomes identified and reported in the publication reflected current outcomes in the literature and to ensure that no outcomes v 	Ve planned to include tudies with participants ged 18 and over within the	We reduced the age of include participants to 16 or over as man studies included older teenagers with adults in their studies. Or discussion with the research team we concluded that there was no difference between treatment of those aged 16 and over versus aged 18. If we excluded these studies many outcomes used across these age ranges would have been lost.
	riginally proposed in the	identified and reported in the publication reflected current outcomes in the literature and to ensure that no outcomes wer
	roposed in the original	Outcome reporting bias was assessed in the included prospective and randomized controlled trials. This was included as it was thought this could improve understanding on what outcomes authors prioritise.

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## BMJ Open

Supplementary file 2. Search strategy systematic review outcome reporting traumatic brachial plexus injuries

Search strategy 10/09/2018 COMBINE systematic review (reran 07 May 2021)

## MEDLINE (OVID)

1.(brachial plexus adj3 injur\*).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]

2 (brachial plexus adj3 pals\*).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]

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7 Brachial Plexus/in, su, tr [Injuries, Surgery, Transplantation]

8 1 or 2 or 3 or 4 or 5 or 6 or 7

9 limit 8 to (humans and "all adult (19 plus years)")

10. limit 9 to yr="2013 -Current

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#### **BMJ** Open

Supplementary file 2. Search strategy systematic review outcome reporting traumatic brachial plexus injuries

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Page	47 of 80				BMJ Open		136/brr 1 by co	
1 2		Supplementary file	3. Outcome reporting	bias assessment instrur	nent		njopen-2 pyright,	
2 3 4 5 6 7 8		Outcome Reportin	g Bias assessment inst	rument (adapted from	<u>Deshmukh et al 2021)</u>		136/bmjopen-2020-044797 on 30 1 by copyright, including for use	
9 10 11 12 13 14 15 16 17 18 19	Study ID	Author	Registered	No clear reporting of outcome through description/table/f igure	Outcome only by summary comment (e.g. there was no significant difference), no numerical values provided, lack of information so that reporting not meaningful (outcomes but no timepoints)	Outcome reported but not at all timepoints; lacks detail to be included in review	Selicitation of the second sec	Outcome not specified in registration or prior to results
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 Deshmukh SR, Mousoulis C, Marson BA et al. Developing a core outcome set for hand fractures and joint injuries in agults: a systematic review. Journal of Hand Surgery (Eur) 2021;46(5):488-495 Int GEZ-LTA

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## Supplementary File 4 COMET outcome taxonomy

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Core Area	Outcome Domain			
Death	1. Mortality/ survival			
Physiological/clinical	2. Blood and lymphatic system outcomes			
	3. Cardiac outcomes			
	4. Congenital, familial and genetic outcomes			
	5. Endocrine outcomes			
	6. Ear and labyrinth outcomes			
	7. Eye outcomes			
	8. Gastrointestinal outcomes			
	9. General outcomes			
	10. Hepatobilary outcomes			
	11. Immune system outcomes			
	12. Infection and infestation outcomes			
	13. Injury and poisoning outcomes			
	14. Metabolism and nutrition outcomes			
	15. Musculoskeletal and connective tissue outcomes			
	16. Outcomes, relating to neoplasms: benign, malignant and			
	unspecified (including cysts and polyps)			
	17. Nervous system outcomes			
	18. Pregnancy, puerperium and perinatal outcomes			
	19. Renal and urinary outcomes			
	20. Reproductive system and breast outcomes			
	21. Psychiatric outcomes			
	22. Respiratory, thoracic and mediastinal outcomes			
	23. Skin and subcutaneous tissue outcomes			
	24. Vascular outcomes			
Life Impact	Functioning			
	25. Physical functioning			
	26. Social functioning			
	27. Role functioning			
	28. Emotional functioning/ well being			
	29. Cognitive functioning			
	30. Global quality of life			
	31. Perceived health status			
	32. Delivery of care			
	33. Personal circumstances			
Resource use	Resource Use			
	34. Economic			
	35. Hospital			
	36. Need for further intervention			
	37. Societal/ carer burden			
Adverse Events	38. Adverse Events / effects			

Dodd S, Clarke M, Becker L et al. A taxonomy has been developed for outcomes in medical research to help improve knowledge discovery. *J Clin Epidemiol*. 2018;96:84-92.

## Supplementary file 5. Included Studies

1			publicatio
	Effectiveness and safety of home-based muscle electrical stimulator in	Limthongthang	2014
	brachial plexus Injury patient		2014
2	Elbow proprioception sense in total arm -type brachial plexus injured	Homreprasert	2014
	patients after neurotisation: a preliminary study		
3	Comparison between the anterior and posterior approach for transfer	Souza	2014
	of the spinal accessory nerve to the suprascapular nerve in late		
	traumatic brachial plexus injuries		
4	Ultrasound-guided peripheral nerve stimulation for neuropathic pain	Kim	2017
	after brachial plexus injury: two case reports		
5	Contralateral lower trapezius transfer for restoration of shoulder	Satbhai	2014
	external rotation in traumatic brachial plexus palsy: preliminary report		
	and literature review		
6	Restoration of shoulder abduction in brachial plexus avulsion injuries	Huan	2017
	with double neurotization from the spinal accessory nerve: a report of		
	13 cases		
7	Transfer of the musculocutaneous nerve branch to the brachialis	Bertelli	2017
	muscle to the triceps for elbow extension: anatomical study and report		
	of five cases		
8	Posterior approach for accessory to suprascapular nerve transfer: an	Rui	2013
	electrophysiological outcomes study		
9	Reliability of functioning free muscle transfer and vascularized ulnar	Potter	2017
	nerve grafting for elbow flexion in complete brachial plexus palsy		
10	Management of infraclavicular (Chuang Level IV) brachial plexus	Lam	2015
	injuries: A single surgeon experience with 75 cases		
11	Functioning free muscle transfer for the restoration of elbow flexion in	Estrella	2016
	brachial plexus injury patients		
12	Radial to axillary nerve transfers: A combined case series	Desai	2016
13	Thalamic deep brain stimulation for neuropathic pain after amputation	Pereira	2013
	or brachial plexus avulsion		
14	Nerve transfers for shoulder function for traumatic brachial plexus	Estrella	2014
	injuries		
15	Results of operative treatment of brachial plexus injury resulting from	Gutkowska	2017
	shoulder dislocation: A study with a long-term follow-up		
16	Surgical treatment of brachial plexus posterior cord lesion: A	Oberlin	2013
	combination of nerve and tendon transfers, about nine patients		
17	The medial cord to musculocutaneous (MCMc) nerve transfer: a new	Ferraresi	2014
	method to reanimate elbow flexion after C5-C6-C7-(C8) avulsive		
	injuries of the brachial plexus—technique and results		
18	Transfer of a terminal motor branch nerve to the flexor carpi ulnaris	Bertelli	2015
	for triceps reinnervation: anatomical study and clinical cases		
19	Free functioning gracilis muscle transfer with and without	Maldonado	2017(a)
-	simultaneous intercostal nerve transfer to musculocutaneous nerve for		()
	restoration of elbow flexion after traumatic adult brachial pan-plexus		
	restoration of elbow flexion after traumatic adult brachial pan-plexus injury		

## Supplementary file 5. Included Studies

transfer through posterior approachXiao201428Intercostal nerve transfer to neurotize the musculocutaneous nerve after traumatic brachial plexus avulsion: A comparison of two, three, and four nerve transfersXiao201429Use of the DEKA Arm for amputees with brachial plexus injury: A case seriesResnik201730Polyester tape scapulopexy for chronic upper extremity brachial plexus injuryLeechavengvon gs201531Contralateral C7 nerve transfer with direct coaptation to restore lower trunk function after traumatic brachial plexus avulsionWang201332Outcome of surgical reconstruction after traumatic total brachial plexus palsyDodakundi201333Bionic reconstruction to restore hand function after brachial plexus injury: a case series of three patientsAszmann201534Surgical treatment of the plexus brachialis injury using long-lasting electrostimulationTsymbalyuk201335Phrenic nerve transfer for reconstruction of elbow extension in severe brachial plexus injuriesFlores201636Direct coaptation of the phrenic nerve with the posterior division of the lower trunk to restore finger and elbow extension function in patients with total brachial plexus injuriesWang201637A prospective study comparing single and double fascicular transfer to restore elbow flexion after brachial plexus injuryMartins2013	20	Isolated latissimus dorsi transfer to restore shoulder external rotation in adults with brachial plexus injury	Ghosh	2013
22       Successful graded mirror therapy in a patient with chronic       Mibu       2016         deafferentation pain in whom traditional mirror therapy was       ineffective: A case report       2017         Bipolar Transfer of Latissimus Dorsi Myocutaneous Flap for Restoration of 13 Cases       2017         23       Bipolar Transfer of Latissimus Dorsi Myocutaneous Flap for Restoration of 13 Cases       2014         24       Comparison of objective muscle strength in C5-C6 and C5-C7 brachial plexus injury patients after double nerve transfer       Tsai       2014         25       Phantom remodeling effect of dorsal root entry zone lesioning in phantom limb pain caused by brachial plexus avulsion       Son       2015         26       Comparison of surgical strategies between proximal nerve graft and/or nerve transfer and distal nerve transfer based on functional restoration of elbow flexion: A retrospective review of 147 patients       2018         27       Reconstruction of shoulder abduction by multiple nerve fascicle and four nerve transfers       Ren       2013         28       Intercostal nerve transfers       2014       after traumatic brachial plexus avulsion: A comparison of two, three, and four nerve transfers       2014         29       Use of the DEKA Arm for amputees with brachial plexus injury: A case series       2017       gs         20       Outcome of surgical reconstruction after traumatic total brachial plexus avulsion       2017	21	Functional outcome and quality of life after traumatic total brachial plexus injury treated by nerve transfer or single/double free muscle	Satbhai	2016
23Bipolar Transfer of Latissimus Dorsi Myocutaneous Flap for Restoration of Elbow Flexion in Late Traumatic Brachial Plexus Injury: Evaluation of 13 Cases201724Comparison of objective muscle strength in C5-C6 and C5-C7 brachial plexus injury patients after double nerve transferTsai201425Phantom remodeling effect of dorsal root entry zone lesioning in 	22	Successful graded mirror therapy in a patient with chronic deafferentation pain in whom traditional mirror therapy was	Mibu	2016
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38Chronic post-traumatic neuropathic pain of brachial plexus and upperStevanato2014	37		Martins	2013
	38	Chronic post-traumatic neuropathic pain of brachial plexus and upper	Stevanato	2014

## Supplementary file 5. Included Studies

39	Effectiveness of contralateral C7 nerve root and multiple nerve transfer for treatment of brachial plexus root avulsion	Wei	2014
40	Combined proximal nerve graft and distal nerve transfer for a posterior cord brachial plexus injury	Plate	2013
41	The role of elective amputation in patients with traumatic brachial plexus injury	Maldonado	2016
42	Early microsurgical management of clavicular fracture combined with brachial plexus injury	Liu	2014(a)
43	Contralateral trapezius transfer to restore shoulder external rotation following adult brachial plexus injury	Elhassan	2016
44	Comparative study of phrenic nerve transfers with and without nerve graft for elbow flexion after global brachial plexus injury	Liu	2014
45	Shoulder and elbow recovery at 2 and 11 years following brachial plexus reconstruction	Wang	2016
46	Functional outcomes after treatment of traumatic brachial plexus injuries: clinical study	Aras	2013
47	Free gracilis transfer reinnervated by the nerve to the supinator for the reconstruction of finger and thumb extension in longstanding C7-T1 brachial plexus root avulsion	Soldado	2013
48	Restoration of hand function in C7–T1 brachial plexus palsies using a staged approach with nerve and tendon transfer	Zhang	2014
49	Neurotization to innervate the deltoid and biceps: 3 cases	Dy	2013
50	Arthroscopic arthrodesis of the shoulder in brachial plexus palsy	Lenoir	2017
51	Outcome of contralateral C7 nerve transferring to median nerve	Gao	2013
52	Intercostal nerve transfer to the biceps motor branch in complete traumatic brachial plexus injuries	Cho	2015
53	Tactile feedback for relief of deafferentation pain using virtual reality system: a pilot study	Sano	2016
54	Functioning free gracilis transfer to reconstruct elbow flexion and quality of life in global brachial plexus injured patients	Yang	2016
55	Evaluation of infraspinatus reinnervation and function following spinal accessory nerve to suprascapular nerve transfer in adult traumatic brachial plexus injuries	Baltzer	2017
56	Anatomic study of the intercostal nerve transfer to the suprascapular nerve and a case report	Hu	2014
57	Shoulder abduction and external rotation restoration with nerve transfer	Kostas- Agnantis	2013
58	Contralateral C-7 transfer: is direct repair really superior to grafting?	Bhatia	2017
59	Impact of phrenic nerve paralysis on the surgical outcome of intercostal nerve transfer	Kita	2015
60	Flow-through anastomosis using a T-shaped vascular pedicle for gracilis functioning free muscle transplantation in brachial plexus injury	Hou	2015
61	Free functional muscle transfer tendon insertion secondary advancement procedure to improve elbow flexion	Sechachalam	2017

## Supplementary file 5. Included Studies

62	Dual nerve transfers for restoration of shoulder function after brachial	Chu	2016
	plexus avulsion injury		
63	Cortical plasticity after brachial plexus injury and repair: a resting-state	Bhat	2017
	functional MRI study		
64	Results of spinal accessory to suprascapular nerve transfer in 110	Bertelli	2016
	patients with complete palsy of the brachial plexus		
65	Magnetic resonance neurographic and clinical long-term results after	Frueh	2017
	oberlins transfer for adult brachial plexus injuries		
66	Free functioning gracilis muscle transfer versus intercostal nerve	Maldonado	2016
	transfer to musculocutaneous nerve for restoration of elbow flexion		
	after traumatic adult brachial pan-plexus injury		
67	Results of wrist extension reconstruction in C5–8 brachial plexus palsy	Bertelli	2016
	by transferring the pronator quadratus motor branch to the extensor		
	carpi radialis brevis muscle		
68	Donor nerve sources in free functional gracilis muscle transfer for	Nicoson	2017
_	elbow flexion in adult brachial plexus injury		
69	Use of contralateral spinal accessory nerve for ipsilateral suprascapular	Bhandari	2016
	neurotization in global brachial plexus injury: a new technique		
70	Objective evaluation of elbow flexion strength and fatigability after	Marciq	2014
	nerve transfer in adult traumatic brachial plexus injuries	·	
71	Outcomes of muscle brachialis transfer to restore finger flexion in	DeGeorge	2017
	brachial plexus palsy	0	
72	Functional outcome of nerve transfers for traumatic global brachial	Liu	2013
	plexus avulsion		
73	Transfer of a flexor digitorum superficialis motor branch for wrist	Bertelli	2013
	extension reconstruction in C5-C8 root injuries of the brachial plexus: a		
	case series		
74	Outcome after transfer of intercostal nerves to the nerve of triceps	Gao	2013
	long head in 25 adult patients with total plexus root avulsion injury		
75	Good sensory recovery of the hand in brachial plexus surgery using the	Foroni	2017
	intercostobrachial nerve as the donor		
76	The phrenic nerve as a donor for brachial plexus injuries: is it safe and	Socolovsky	2015
	effective? Case series and literature analysis		
77	Complete avulsion of brachial plexus with associated vascular trauma:	Hattori	2013
	Feasibility of reconstruction using the double free muscle technique		2010
78	Long-term outcome of brachial plexus re-implantation after complete	Kachramanoglo	2017
/0	brachial plexus avulsion injury	u	2017
79	Force recovery assessment of functioning free muscle transfers using	Kodama	2014
15	ultrasonography	Noutha	2014
80	Rhomboid nerve transfer to the suprascapular nerve for shoulder	Goubier	2016
00	reanimation in brachial plexus palsy: A clinical report	JUUDICI	2010
81	Outcome of contralateral C7 transfer to two recipient nerves in 22	Gao	2013
01	•	Gau	2013
07	patients with the total brachial plexus avulsion injury	Liu	2015
82	Comparative study of phrenic and intercostal nerve transfers for elbow	Liu	2015
	flexion after global brachial plexus injury		
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## Supplementary file 5. Included Studies

<ul> <li>Bonor-side morbidity after contralateral C-7 nerve transfer: results at a Li 2016 minimum of 6 months after surgery</li> <li>Outcome after brachial plexus injury surgery and impact on quality of Rasulić 2017 life</li> <li>Pronator teres branch transfer to the anterior interosseous nerve for treating C811 brachial plexus avulsion: An anatomic study and case report</li> <li>Operative treatment with nerve repair can restore function in patients Stiasny 2015 with traction injuries in the brachial plexus</li> <li>Thoracodorsal nerve transfer for triceps reinnervation in patients Stiasny 2016 brachial plexus injuries</li> <li>Co-infusion of autologous adipose tissue derived neuronal Thakkar 2014 differentiated mesenchymal stem cells and bone marrow derived hematopoietic stem cells, a viable therapy for post-traumatic brachial plexus injury: a case report</li> <li>Long-term Clinical outcomes of spinal accessory nerve transfer to the suprascapular nerve in patients with brachial plexus injuries Tu 2014 by neurotisation: a prospective comparison study between total and hemicontralateral C7 nerve root transfer</li> <li>Deactivation of distant pain-related regions induced by 20-day rTMS: a Qiu 2014 case study of one-week pain relief for long-term intractable deafferentation pain</li> <li>Early post-operative results after repair of traumatic brachial plexus lesions van der Lingen 2013 partial injuries to the brachial plexus reconstruction Haninec 2013</li> <li>Reanimation of elbow extension with medial plexus lesions van der Lingen 2018 even after 20 years of follow-up</li> <li>Postorior branch of the axillary nerve transfer to the lateral triceps Kilka 2013 partial injuries to the brachial plexus</li> <li>Postorior branch of the axillary nerve transfer to the lateral triceps Kilka 2013 branch for restoration of elbow extension: case report</li> <li>Postorior branch of the axillary nerve transfer to the lateral triceps Kilka 2013 branch for restoration of elbow</li></ul>				
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## Supplementary file 5. Included Studies

103	Objective predictors of functional recovery associated with intercostal nerves transfer for triceps reinnervation in global brachial plexus palsy	Flores	2016
104	Nerve transfer to relieve pain in upper brachial plexus injuries: does it work?	Emamhadi	2017
105	Phrenic nerve transfer versus intercostal nerve transfer for the repair of brachial plexus root avulsion injuries	Abdixbir	2016
106	End-to-side neurorrhaphy to restore elbow flexion in brachial plexus injury	Limthongthang	2016
107	Chordata method combined with electrotherapy in functional recovery after brachial plexus injury:report of three clinical cases	De Oliveira	2016
108	Clinical outcome following transfer of the supinator motor branch to the posterior interosseous nerve in patients with C7-T1 brachial plexus palsy	Xu	2015
109	Transposition of branches of radial nerve innervating supinator to posterior interosseous nerve for functional reconstruction of finger and thumb extension in 4 patients with middle and lower trunk root avulsion injuries of brachial plexus	Wu	2017
110	Electromyographic findings in gracilis muscle grafts used to augment elbow flexion in traumatic brachial plexopathy	Kazamel	2016
111	Double distal intraneural fascicular nerve transfers for lower brachial plexus injuries	Li	2016
112	Restoration of elbow and hand function in total brachial plexus palsy with intercostal nerves and C5 root neurotisation. Results in 21 patients	Amal	2016
113	The phrenic nerve transfer in the treatment of a septuagenarian with brachial plexus avulsion injury: a case study	Jiang	2018
114	Outcomes of transferring a healthy motor fascicle from the radial nerve to a branch for the triceps to recover elbow extension in partial brachial plexus palsy	Flores	2017
115	Successful nerve transfers for traumatic brachial plexus palsy in a septuagenarian	Johnsen	2016
116	Free functioning gracilis muscle transfer for elbow flexion reconstruction after traumatic brachial pan-plexus injury: Where is the optimal distal tendon attachment for elbow flexion?	Maldonado	2017(b)
117	Results of distal nerve transfers in restoration of shoulder function in C5 and C6 root avulsion injury to the brachial plexus	Bhandari	2017
118	Bipolar dual-lead spinal cord stimulation between two electrodes on the ventral and dorsal sides of the spinal cord: consideration of putative mechanisms	Watanabe	2018
119	Triceps nerve to deltoid nerve transfer after an unsatisfactory intra- plexus neurotisation of the posterior division of the upper trunk	Al-Qattan	2017
120	Trapezius muscle transfer for restoration of elbow extension in a traumatic brachial plexus injury	Alrabai	2018
121	Transfer of the radial nerve branch to the extensor carpi radialis brevis to the anterior interosseous nerve to reconstruct thumb and finger flexion	Bertelli	2015
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## Supplementary file 5. Included Studies

122	Ultrasound-guided pulse-dose radiofrequency: treatment of neuropathic pain after brachial plexus lesion and arm vascularisation	Magistroni	2014
123	Phrenic nerve transfer to the musculocutaneous nerve for the repair	Liu	2015
	of brachial plexus injury: electrophysiological characteristics		
124	Postoperative motor deficits following elbow flexion reanimation by nerve transfer	Hanneur	2018
125	Comparative study of phrenic and partial ulnar nerve transfers for elbow flexion after upper brachial plexus avulsion-a retrospective	Liu	2018
120	clinical analysis	Variati	2010
126	Contralateral medial pectoral nerve transfer with free gracilis muscle transfer in old brachial plexus injury	Yavari	2018
127	MEG-BMI to control phantom limb pain	Yanagisawa	2018
128	Complete brachial plexus injury- an amputation dilemma, A case report	Choong	2015
129	Reversal of phantom pain and hand-to-face remapping after brachial plexus avulsion	Tsao	2016
130	A newly developed upper limb single-joint HAL in a patient with elbow flexion reconstruction after traumatic brachial plexus injury: A case	Kubota	2017
101	report Free reverse gracilis muscle combined with steindler flexorplasty for	Bertelli	2018
131		Dertein	2018
	elbow flexion reconstruction after failed primary repair of extended		
122	upper-type paralysis of the brachial plexus	V	2017
132	Multiple nerve and tendon transfers – a new strategy for restoring	Xu	2017
C+	hand function in a patient with C7-T1 brachial plexus avulsions		
133	es included following updated review May 2021	Colo	2020
133	Outcomes after occupational therapy intervention for traumatic brachial plexus injury: A prospective longitudinal cohort study	Cole	2020
134	Lower trapezius transfer for patients with brachial plexus injury	Crepaldi	2019
135	Bionic upper limb reconstruction: A valuable alternative in global	Hruby	2019
	brachial plexus avulsion injuries—a case series		
136	Transcranial Direct Current Stimulation and mirror therapy for neuropathic pain after brachial plexus avulsion: A randomised double- blind, controlled pilot study	Ferreira	2020
137	A comparative study of two modalities in pain management of patients presenting with chronic brachial neuralgia	Razak	2019
138	Do technical components of microanastomoses influence the functional outcome of free gracilis muscle transfer for elbow flexion in traumatic brachial plexus injury	Martins-Filho	2021

## Supplementary file 5. Included Studies

## References

- [1] Limthongthang R, Muennoi P, Phoojaroenchanachai R et al. Effectiveness and safety of home-based muscle electrical stimulator in brachial plexus injury patients. *J Med Assoc Thail* 2014;97:S56–61.
- [2] Homsreprasert T, Limthongthang R, Vathana T et al. Elbow joint proprioceptive sense in total arm-type brachial plexus injured patients after neurotization: a preliminary study. *J Med Assoc Thail* 2014;97:S103–7.
- [3] Souza F, Bernardino S, Filho H et al. Comparison between the anterior and posterior approach for transfer of the spinal accessory nerve to the suprascapular nerve in late traumatic brachial plexus injuries. *Acta Neurochir (Wien)* 2014;156: 2345–9.
- [4] Kim JH, Shin SH, Lee YR et al. Ultrasound-guided peripheral nerve stimulation for neuropathic pain after brachial plexus injury: two case reports. *J Anesth* 2017; 31:453–7.
- [5] Satbhai NG, Doi K, Hattori Y, Sakamoto S et al. Contralateral lower trapezius transfer for restoration of shoulder external rotation in traumatic brachial plexus palsy: a preliminary report and literature review. *J Hand Surg Eur* 2014;39:861–7.
- [6] Huan KWSJ, Tan JSW, Tan SH et al. Restoration of shoulder abduction in brachial plexus avulsion injuries with double neurotization from the spinal accessory nerve: a report of 13 cases. *J Hand Surg Eur* 2017;42:700–5.
- [7] Bertelli JA, Soldado F, Ghizoni MF et al. Transfer of the musculocutaneous nerve branch to the brachialis muscle to the triceps for elbow extension: anatomical study and report of five cases. *J Hand Surg Eur* 2017;42:710–4.
- [8] Rui J, Zhao X, Zhu Y et al. Posterior approach for accessory-suprascapular nerve transfer: an electrophysiological outcomes study. *J Hand Surg Eur* 2013;38:242–7.
- [9] Potter SM, Ferris SI. Reliability of functioning free muscle transfer and vascularized ulnar nerve grafting for elbow flexion in complete brachial plexus palsy. *J Hand Surg Eur* 2017; 42: 693–9.
- [10] Lam WL, Fufa D, Chang N-J et al. Management of infraclavicular (Chuang Level IV) brachial plexus injuries: A single surgeon experience with 75 cases. *J Hand Surg Eur* 2015; 40:573–82.
- [11] Estrella EP, Montales TD. Functioning free muscle transfer for the restoration of elbow flexion in brachial plexus injury patients. *Injury* 2016;47:2525–33.
- [12] Desai MJ, Daly CA, Seiler JG et al. Radial to Axillary Nerve Transfers: A Combined Case Series. J Hand Surg Am 2016; 41:1128–34.
- [13] Pereira EAC, Boccard SG, Linhares P et al. Thalamic deep brain stimulation for neuropathic pain after amputation or brachial plexus avulsion. *Neurosurg Focus* 2013;35:E7.
- [14] Estrella EP, Favila AS . Nerve transfers for shoulder function for traumatic brachial plexus injuries. *J Reconstr Microsurg* 2014;30:59-64.
- [15] Gutkowska O, Martynkiewicz J, Mizia S et al. Results of Operative Treatment of Brachial Plexus Injury Resulting from Shoulder Dislocation: A Study with A Long-Term Follow-Up. *World Neurosurg* 2017;105:623–31.
- [16] Oberlin C, Chino J, Belkheyar Z. Surgical treatment of brachial plexus posterior cord lesion: A combination of nerve and tendon transfers, about nine patients. *Chir Main* 2013;32:141–6.

- [17] Ferraresi S, Garozzo D, Basso E et al. The medial cord to musculocutaneous (MCMc) nerve transfer: A new method to reanimate elbow flexion after C5-C6-C7-(C8) avulsive injuries of the brachial plexus Technique and results. *Neurosurg Rev* 2014;37:321–9.
- [18] Bertelli J, Soldado F, Ghizoni MF et al. Transfer of a terminal motor branch nerve to the flexor carpi ulnaris for triceps reinnervation: Anatomical study and clinical cases. *J Hand Surg Am* 2015;40:2229-2235.
- [19] Maldonado AA, Kircher MF, Spinner RJ et al. Free Functioning Gracilis Muscle Transfer With and Without Simultaneous Intercostal Nerve Transfer to Musculocutaneous Nerve for Restoration of Elbow Flexion After Traumatic Adult Brachial Pan-Plexus Injury. J Hand Surg Am 2017;42:293.
- [20] Ghosh S, Singh VK, Jeyaseelan L, et al. Isolated latissimus dorsi transfer to restore shoulder external rotation in adults with brachial plexus injury. *Bone Jt J* 2013;95:660–3.
- [21] Satbhai NG, Doi K, Hattori Y et al. Functional outcome and quality of life after traumatic total brachial plexus injury treated by nerve transfer or single/double free muscle transfers: A comparative study. *Bone Jt J* 2016;98:209–17.
- [22] Mibu A, Nishigami T, Tanaka K et al. Successful Graded Mirror Therapy in a Patient with Chronic Deafferentation Pain in Whom Traditional Mirror Therapy was Ineffective: A Case Report. *Pain Pract* 2016;16:E62–9.
- [23] Azab AA-H, Alsabbahi MS. Bipolar Transfer of Latissimus Dorsi Myocutaneous Flap for Restoration of Elbow Flexion in Late Traumatic Brachial Plexus Injury: Evaluation of 13 Cases. *Ann Plast Surg* 2017;78:98–201.
- [24] Tsai YJ, Su FC, Hsiao CK et al. Comparison of objective muscle strength in C5-C6 and C5-C7 brachial plexus injury patients after double nerve transfer. *Microsurgery* 2015;35:107–14.
- [25] Son BC, Ha SW. Phantom Remodeling Effect of Dorsal Root Entry Zone Lesioning in Phantom Limb Pain Caused by Brachial Plexus Avulsion. *Stereotact Funct Neurosurg* 2015;93:240–4.
- [26] Hu CH, Chang TN, Lu JC et al. Comparison of Surgical Strategies between Proximal Nerve Graft and/or Nerve Transfer and Distal Nerve Transfer Based on Functional Restoration of Elbow Flexion: A Retrospective Review of 147 Patients. *Plast Reconstr Surg* 2018;141:68e-79e.
- [27] Ren G, Li R, Xiang D, Yu B. Reconstruction of shoulder abduction by multiple nerve fascicle transfer through posterior approach. *Injury* 2013;44:492–7.
- [28] Xiao C, Lao J, Wang T et al. Intercostal nerve transfer to neurotize the musculocutaneous nerve after traumatic brachial plexus avulsion: a comparison of two, three, and four nerve transfers. *J Reconstr Microsurg* 2014;30:297–304.
- [29] Resnik L, Fantini C, Latlief G et al. Use of the DEKA Arm for amputees with brachial plexus injury: A case series. *PLoS One* 2017; 12: e0178642.
- [30] Leechavengvongs S, Jiamton C, Uerpairojkit C et al. Polyester tape scapulopexy for chronic upper extremity brachial plexus injury. *J Hand Surg Am* 2015;40:1184
- [31] Wang S, Li P, Xue Y et al. Contralateral C7 nerve transfer with direct coaptation to restore lower trunk function after traumatic brachial plexus avulsion. *J Bone Joint Surg Am* 2013;95: 821–2.
- [32] Dodakundi C, Doi K, Hattori Y et al. Outcome of surgical reconstruction after traumatic total brachial plexus palsy. *J Bone Joint Surg Am* 2013;95:1505–12.

#### BMJ Open

Supplementary file 5. Included Studies

- [33] Aszmann OC, Roche AD, Salminger S et al. Bionic reconstruction to restore hand function after brachial plexus injury: a case series of three patients. *Lancet* 2015; 385:2183–9.
- [34] Tsymbaliuk VI, Tretiak IB. [Surgical treatment of the plexus brachialis injury using long-lasting electrostimulation]. *Klin Khirurhiia* 2013;59–61.
- [35] Flores LP, Socolovsky M. Phrenic Nerve Transfer for Reconstruction of Elbow Extension in Severe Brachial Plexus Injuries. *J Reconstr Microsurg* 2016;32:546–50.
- [36] Wang S, Li P, Xue Y et al. Direct Coaptation of the Phrenic Nerve With the Posterior Division of the Lower Trunk to Restore Finger and Elbow Extension Function in Patients With Total Brachial Plexus Injuries. *Neurosurgery* 2016;78:208–14.
- [37] Martins RS, Siqueira MG, Heise CO et al. A prospective study comparing single and double fascicular transfer to restore elbow flexion after brachial plexus injury. *Neurosurgery* 2013; 72:709–15.
- [38] Stevanato G, Devigili G, Eleopra R et al. Chronic post-traumatic neuropathic pain of brachial plexus and upper limb: a new technique of peripheral nerve stimulation. *Neurosurg Rev* 2014;37:473–9.
- [39] Wei W, Meihua S, Yafei L et al. [EFFECTIVENESS OF CONTRALATERAL C7 NERVE ROOT AND MULTIPLE NERVES TRANSFER FOR TREATMENT OF BRACHIAL PLEXUS ROOT AVULSION]. Zhongguo Xiu Fu Chong Jian Wai Ke Za Zhi 2014;28:737–40.
- [40] Plate JF, Ely LK, Pulley BR et al. Combined proximal nerve graft and distal nerve transfer for a posterior cord brachial plexus injury. *J Neurosurg* 2013;118: 155–9.
- [41] Maldonado AA, Kircher MF, Spinner RJ et al. The role of elective amputation in patients with traumatic brachial plexus injury. *J Plast Reconstr Aesthetic Surg* 2016;69:311–7.
- [42] Liu Y, Wang W, Regmi AM et al. Early microsurgical management of clavicular fracture combined with brachial plexus injury. *Zhongguo Xiu Fu Chong Jian Wai Ke Za Zhi* 2014;28:1329–32.
- [43] Elhassan BT, Wagner ER, Spinner RJ et al. Contralateral trapezius transfer to restore shoulder external rotation following adult brachial plexus injury. *J Hand Surg Am* 2016;41:e45-51.
- [44] Liu Y, Lao J, Gao K et al. Comparative study of phrenic nerve transfers with and without nerve graft for elbow flexion after global brachial plexus injury. *Injury* 2014;45:227–31.
- [45] Wang JP, Rancy SK, Lee SK et al. Shoulder and Elbow Recovery at 2 and 11 Years Following Brachial Plexus Reconstruction. *J Hand Surg Am* 2016;41:173–9.
- [46] Aras Y, Aydoseli A, Sabanci PA et al. Functional outcomes after treatment of traumatic brachial plexus injuries: clinical study. *Ulus Travma Acil Cerrahi Derg* 2013;19:521–8.
- [47] Soldado F, Bertelli J. Free gracilis transfer reinnervated by the nerve to the supinator for the reconstruction of finger and thumb extension in longstanding C7-T1 brachial plexus root avulsion. *J Hand Surg Am* 2013;38: 941–6.
- [48] Zhang CG, Dong Z, Gu YD. Restoration of hand function in C7-T1 brachial plexus palsies using a staged approach with nerve and tendon transfer. *J Neurosurg* 2014;121:1264–70.
- [49] Dy CJ, Kitay A, Garg R et al. Neurotization to innervate the deltoid and biceps: 3 Cases. J Hand Surg Am 2013;38:237–40.
- [50] Lenoir H, Williams T, Griffart A et al. Arthroscopic arthrodesis of the shoulder in brachial

Supplementary file 5. Included Studies

plexus palsy. J Shoulder Elb Surg 2017; 26: e115-21.

- [51] Gao K, Lao J, Zhao X et al. Outcome of contralateral C7 nerve transferring to median nerve. *Chin Med J (Engl)* 2013;126:3865–8.
- [52] Cho AB, Iamaguchi RB, Silva GB et al. Intercostal nerve transfer to the biceps motor branch in complete traumatic brachial plexus injuries. *Microsurgery* 2015;35:428–31.
- [53] Sano Y, Wake N, Ichinose A et al. Tactile feedback for relief of deafferentation pain using virtual reality system: a pilot study. *J Neuroeng Rehabil* 2016;13:61.
- [54] Yang Y, Yang JT, Fu G et al. Functioning free gracilis transfer to reconstruct elbow flexion and quality of life in global brachial plexus injured patients. *Sci Rep* 2016;6:22479.
- [55] Baltzer HL, Wagner ER, Kircher MF, et al. Evaluation of infraspinatus reinnervation and function following spinal accessory nerve to suprascapular nerve transfer in adult traumatic brachial plexus injuries. *Microsurgery* 2017;37:365–70.
- [56] Hu S, Chu B, Song J, et al. Anatomic study of the intercostal nerve transfer to the suprascapular nerve and a case report. *J Hand Surg Eur* 2014;39:194–8.
- [57] Kostas-Agnantis I, Korompilias A, Vekris M et al. Shoulder abduction and external rotation restoration with nerve transfer. *Injury* 2013;44:299–304.
- [58] Bhatia A, Doshi P, Koul A, et al. Contralateral C-7 transfer: is direct repair really superior to grafting? *Neurosurg Focus* 2017;43:E3.
- [59] Kita Y, Tajiri Y, Hoshikawa S et al. Impact of phrenic nerve paralysis on the surgical outcome of intercostal nerve transfer. *Hand Surg* 2015; 20:47–52.
- [60] Hou Y, Yang J, Yang Y, et al. Flow-through anastomosis using a T-shaped vascular pedicle for gracilis functioning free muscle transplantation in brachial plexus injury. *Clinics (Sao Paulo)* 2015;70:544–9.
- [61] Sechachalam S, O'Byrne A, MacQuillan A. Free Functional Muscle Transfer Tendon Insertion Secondary Advancement Procedure to Improve Elbow Flexion. *Tech Hand Up Extrem Surg* 2017;21: 8–12.
- [62] Chu B, Wang H, Chen L, et al. Dual Nerve Transfers for Restoration of Shoulder Function After Brachial Plexus Avulsion Injury. *Ann Plast Surg* 2016;76: 668–73.
- [63] Bhat DI, Indira Devi B, Bharti K, et al. Cortical plasticity after brachial plexus injury and repair: a resting-state functional MRI study. *Neurosurg Focus* 2017;42: E14.
- [64] Bertelli JA, Ghizoni MF. Results of spinal accessory to suprascapular nerve transfer in 110 patients with complete palsy of the brachial plexus. *J Neurosurg Spine* 2016;24:990–5.
- [65] Frueh FS, Ho M, Schiller A, et al. Magnetic Resonance Neurographic and Clinical Long-Term Results After Oberlin's Transfer for Adult Brachial Plexus Injuries. *Ann Plast Surg* 2017;78:67– 72.
- [66] Maldonado AA, Kircher MF, Spinner RJ, et al. Free Functioning Gracilis Muscle Transfer versus Intercostal Nerve Transfer to Musculocutaneous Nerve for Restoration of Elbow Flexion after Traumatic Adult Brachial Pan-Plexus Injury. *Plast Reconstr Surg* 2016;138:483e-488e.
- [67] Bertelli JA, Ghizoni MF, Tacca CP. Results of wrist extension reconstruction in C5-8 brachial plexus palsy by transferring the pronator quadratus motor branch to the extensor carpi radialis brevis muscle. *J Neurosurg* 2016;124:1442–9.

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Supplementary file 5. Included Studies

- [68] Nicoson MC, Franco MJ, Tung TH. Donor nerve sources in free functional gracilis muscle transfer for elbow flexion in adult brachial plexus injury. *Microsurgery* 2017;37:377–82.
- [69] Bhandari PS, Deb P. Use of contralateral spinal accessory nerve for ipsilateral suprascapular neurotization in global brachial plexus injury: A new technique. J Neurosurg Spine 2016;24: 186–8.
- [70] Maricq C, Jeunehomme M, Mouraux D, et al. Objective evaluation of elbow flexion strength and fatigability after nerve transfer in adult traumatic upper brachial plexus injuries. *Hand Surg* 2014;19:335–41.
- [71] DeGeorge B, Becker H, Faryna J, et al. Outcomes of brachialis muscle transfer to restore finger flexion in traumatic lower trunk brachial plexus palsy. *J Hand Surg Am* 2017;42:S33–4.
- [72] Liu Y, Lao J, Gao K, et al. Functional outcome of nerve transfers for traumatic global brachial plexus avulsion. *Injury* 2013;44:655–60.
- [73] Bertelli JA, Ghizoni MF. Transfer of a flexor digitorum superficialis motor branch for wrist extension reconstruction in C5-C8 root injuries of the brachial plexus: a case series. *Microsurgery* 2013;33:39–42.
- [74] Gao K, Lao J, Zhao X, et al. Outcome after transfer of intercostal nerves to the nerve of triceps long head in 25 adult patients with total brachial plexus root avulsion injury. *J Neurosurg* 2013;118:606–10.
- [75] Foroni L, Siqueira MG, Martins RS, et al. Good sensory recovery of the hand in brachial plexus surgery using the intercostobrachial nerve as the donor. Arq Neuropsiquiatr 2017;75:796– 800.
- [76] Socolovsky M, di Masi G, Bonilla G, et al. The phrenic nerve as a donor for brachial plexus injuries: is it safe and effective? Case series and literature analysis. Acta Neurochir (Wien) 2015;157:1077–86.
- [77] Hattori Y, Doi K, Sakamoto S, et al. Complete avulsion of brachial plexus with associated vascular trauma: feasibility of reconstruction using the double free muscle technique. *Plast Reconstr Surg* 2013;132:1504–12.
- [78] Kachramanoglou C, Carlstedt T, Koltzenburg M, et al. Long-Term Outcome of Brachial Plexus Reimplantation After Complete Brachial Plexus Avulsion Injury. World Neurosurg 2017;103:28–36.
- [79] Kodama N, Doi K, Hattori Y. Force recovery assessment of functioning free muscle transfers using ultrasonography. *J Hand Surg Am* 2014;39:2269–76.
- [80] Goubier J, Teboul F. Rhomboid nerve transfer to the suprascapular nerve for shoulder reanimation in brachial plexus palsy: A clinical report. *Hand Surg Rehabil* 2016;35:363–6.
- [81] Gao K, Lao J, Zhao X, et al. Outcome of contralateral C7 transfer to two recipient nerves in 22 patients with the total brachial plexus avulsion injury. *Microsurgery* 2013;33:605–11.
- [82] Liu Y, Lao J, Zhao X. Comparative study of phrenic and intercostal nerve transfers for elbow flexion after global brachial plexus injury. *Injury* 2015;46:671–5.
- [83] Li XM, Yang JT, Hou Y, et al. Donor-side morbidity after contralateral C-7 nerve transfer: results at a minimum of 6 months after surgery. *J Neurosurg* 2016;124:1434–41
- [84] Rasulic L, Savic A, Zivkovic B, et al. Outcome after brachial plexus injury surgery and impact on

1	Supp	lementary file 5. Included Studies
2 3		quality of life. Acta Neurochir (Wien,
4 5 6 7 8	[85]	Yang J, Jia X, Yu C, et al. Pronator ter treating C8T1 brachial plexus avulsic 2014;75:375–9.
8 9 10 11	[86]	Stiasny J, Birkeland P, J. S. Operative patients with traction injuries in the
12 13	[87]	Soldado F, Ghizoni MF, Bertelli J, et a in partial brachial plexus injuries. <i>Mi</i>
14 15 16 17 18 19	[88]	Thakkar UG, Vanikar A V, Trivedi HL. neuronal differentiated mesenchym stem cells, a viable therapy for post- 2014;37:237–40.
20 21 22 23	[89]	Emamhadi M, Alijani B, Andalib S,et transfer to the suprascapular nerve (Wien) 2016;158:1801–6.
23 24 25 26 27	[90]	Tu YK, Tsai YJ, Chang CH et al. Surgic injuries by neurotization: a prospect hemicontralateral C7 nerve root tran
28 29 30 31	[91]	Qiu YQ, Hua XY, Zuo CT et al. Deactiv rTMS: a case study of one-week pair Pain Physician 2014;17:E99–105.
32 33 34	[92]	Haninec P, Mencl L, Kaiser R. End-to Neurosurg 2013;119:689–94.
34 35 36 37	[93]	Flores LP. Reanimation of elbow extension of elbow extension injuries to the brachial plexus. <i>J Neu</i>
38 39	[94]	Mohammad-Reda A. Early post-oper palsy. <i>Turk Neurosurg</i> 2013;23:1–9.
40 41 42 43	[95]	van der Lingen MAJ, de Joode SGCJ, arthrodesis for brachial plexus lesior <i>Traumatol</i> 2018;28:1089–94
44 45 46 47	[96]	Klika BJ, Spinner RJ, Bishop AT et al. lateral triceps branch for restoration 2013;38:1145–9.
48 49 50 51	[97]	Liu J, Wang X, Zhang S, et al. A clinica root avulsion by transferring C7 nerv 31.
52 53 54	[98]	Cambon-Binder A, Walch A, Marche for restoration of elbow flexion in 29
55 56 57	[99]	Soldado F, Ghizoni MF, Bertelli J. The reconstruction in infraclavicular brac
58 59	[100]	Cho A, Paulos R, De Resende M, et a

- [85] Yang J, Jia X, Yu C, et al. Pronator teres branch transfer to the anterior interosseous nerve for treating C8T1 brachial plexus avulsion: An anatomic study and case report. Neurosurgery 2014;75:375-9.
- [86] Stiasny J, Birkeland P, J. S. Operative treatment with nerve repair can restore function in patients with traction injuries in the brachial plexus. Dan Med J 2015;62.
- [87] Soldado F, Ghizoni MF, Bertelli J, et al. Thoracodorsal nerve transfer for triceps reinnervation in partial brachial plexus injuries. *Microsurgery* 2016;36:191-7.
- Thakkar UG, Vanikar AV, Trivedi HL. Co-infusion of autologous adipose tissue derived [88] neuronal differentiated mesenchymal stem cells and bone marrow derived hematopoietic stem cells, a viable therapy for post-traumatic brachial plexus injury: a case report. Biomed J 2014:37:237-40.
- [89] Emamhadi M, Alijani B, Andalib S, et al. Long-term clinical outcomes of spinal accessory nerve transfer to the suprascapular nerve in patients with brachial plexus palsy. Acta Neurochir (Wien) 2016;158:1801-6.
- [90] Tu YK, Tsai YJ, Chang CH et al. Surgical treatment for total root avulsion type brachial plexus injuries by neurotization: a prospective comparison study between total and hemicontralateral C7 nerve root transfer. Microsurgery 2014;34:91–101.
- [91] Qiu YQ, Hua XY, Zuo CT et al. Deactivation of distant pain-related regions induced by 20-day rTMS: a case study of one-week pain relief for long-term intractable deafferentation pain. Pain Physician 2014;17:E99-105.
- [92] Haninec P, Mencl L, Kaiser R. End-to-side neurorrhaphy in brachial plexus reconstruction. J Neurosurg 2013;119:689-94.
- [93] Flores LP. Reanimation of elbow extension with medial pectoral nerve transfer in partial injuries to the brachial plexus. J Neurosurg 2013;118:588–93.
- [94] Mohammad-Reda A. Early post-operative results after repair of traumatic brachial plexus palsy. Turk Neurosurg 2013;23:1-9.
- van der Lingen MAJ, de Joode SGCJ, Schotanus MGM, et al. Satisfied patients after shoulder [95] arthrodesis for brachial plexus lesions even after 20 years of follow-up. Eur J Orthop Surg Traumatol 2018;28:1089-94
- [96] Klika BJ, Spinner RJ, Bishop AT et al. Posterior branch of the axillary nerve transfer to the lateral triceps branch for restoration of elbow extension: case report. J Hand Surg Am 2013;38:1145-9.
- [97] Liu J, Wang X, Zhang S, et al. A clinical analysis of repairing the whole brachial plexus nerve root avulsion by transferring C7 nerve root from the uninjured side. J Neurol Sci 2014;31:521-31.
- [98] Cambon-Binder A, Walch A, Marchei P et al. Bipolar transfer of the pectoralis major muscle for restoration of elbow flexion in 29 cases. J Shoulder Elb Surg 2018;27:e330-e336
- [99] Soldado F, Ghizoni MF, Bertelli J. Thoracodorsal nerve transfer for elbow flexion reconstruction in infraclavicular brachial plexus injuries. J Hand Surg Am 2014;39:1766–70.
- [100] Cho A, Paulos R, De Resende M, et al. Median nerve fascicle transfer versus ulnar nerve

## Supplementary file 5. Included Studies

 fascicle transfer to the biceps motor branch in C5-C6 and C5-C7 brachial plexus injuries: nonrandomized prospective study of 23 consecutive patients. *Microsurgery* 2014;34:511–5.

- [101] Kaizawa Y, Kakinoki R, Ohta S, et al. Free functional muscle transplantation of an anomalous femoral adductor with a very large muscle belly: A case report. *J Brachial Plex Peripher Nerve* Inj 2013;8:11.
- [102] Tuohuti T, Yu Q, Yang J, et al. Selective neurotization of the radial nerve in the axilla using intercostal nerve to treat complete brachial plexus palsy. *Int J Clin Exp Med* 2016;9:22880–5.
- [103] Flores LP. Objective Predictors of Functional Recovery Associated with Intercostal Nerves Transfer for Triceps Reinnervation in Global Brachial Plexus Palsy. *Brazilian Neurosurg* 2016;35:271–8.
- [104] Emamhadi M. Nerve transfer to relieve pain in upper brachial plexus injuries: Does it work? *Clin Neurol Neurosurg* 2017;163:67–70.
- [105] Abdixbir A, Li P, Ilhamjan U, et al. Phrenic nerve transfer versus intercostal nerve transfer for the repair of brachial plexus root avulsion injuries. *Chinese J Tissue Eng Res* 2016;20:7660–5.
- [106] Limthongthang R, Vathana T, Wongtrakul S, et al. End-to-Side Neurorrhaphy to Restore Elbow Flexion in Brachial Plexus Injury. *J Med Assoc Thai* 2016;99:1203–8.
- [107] De Oliveira C, Da Silva Melo D, et al. Chordata method combined with electrotherapy in functional recovery after brachial plexus injury: Report of three clinical cases. *Sci Med (Porto Alegre)* 2016;26:22425.
- [108] Xu B, Dong Z, Zhang CG, et al. Clinical outcome following transfer of the supinator motor branch to the posterior interosseous nerve in patients with C7-T1 brachial plexus palsy. J Reconstr Microsurg 2015;31:102–6.
- [109] Wu X, Cong XB, Huang QS, et al. Transposition of branches of radial nerve innervating supinator to posterior interosseous nerve for functional reconstruction of finger and thumb extension in 4 patients with middle and lower trunk root avulsion injuries of brachial plexus. J Huazhong Univ Sci Technolog Med Sci 2017;37:933–7.
- [110] Kazamel M, Sorenson EJ. Electromyographic Findings in Gracilis Muscle Grafts Used to Augment Elbow Flexion in Traumatic Brachial Plexopathy. J Clin Neurophysiol 2016;33:549– 53.
- [111] Li Z, Reynolds M, Satteson E, et al. Double Distal Intraneural Fascicular Nerve Transfers for Lower Brachial Plexus Injuries. *J Hand Surg Am* 2016;41:e15-9.
- [112] Arnal M, Cambon A, Marcheix P. Restoration of elbow and hand function in total brachial plexus palsy with intercostal nerves and C5 root neurotization. Results in 21 patients. *Hand Surg Rehabil* 2016;35:283–7.
- [113] Jiang Y, Lao J. The phrenic nerve transfer in the treatment of a septuagenarian with brachial plexus avulsion injury: a case report. *Int J Neurosci* 2018;128:467–71.
- [114] Flores LP. Outcomes of Transferring a Healthy Motor Fascicle From the Radial Nerve to a Branch for the Triceps to Recover Elbow Extension in Partial Brachial Plexus Palsy. *Neurosurgery* 2017;80:448–53.
- [115] Johnsen PH, Wolfe SW. Successful Nerve Transfers for Traumatic Brachial Plexus Palsy in a Septuagenarian: A Case Report. *Hand (N Y)* 2016;11:NP30–3.

- [116] Maldonado AA, Romero-Brufau S, Kircher MF, et al. Free Functioning Gracilis Muscle Transfer for Elbow Flexion Reconstruction after Traumatic Adult Brachial Pan-Plexus Injury: Where Is the Optimal Distal Tendon Attachment for Elbow Flexion? *Plast Reconstr Surg* 2017;139: 128– 36.
- [117] Bhandari PS. Results of Distal Nerve Transfers in Restoration of Shoulder Function in C5 and C6 Root Avulsion Injury to the Brachial Plexus. *Indian J Neurotrauma* 2017;14:21–5.
- [118] Watanabe M, Yamamoto T, Fukaya C, et al. Bipolar dual-lead spinal cord stimulation between two electrodes on the ventral and dorsal sides of the spinal cord: consideration of putative mechanisms. *Acta Neurochir (Wien)* 2018;160:639–43.
- [119] Al-Qattan M, Kattan A, Al-Qahtany B et al. Triceps nerve to deltoid nerve transfer after an unsatisfactory intra-plexus neurotization of the posterior division of the upper trunk. Int J Surg Case Rep 2017;37:124–6.
- [120] Alrabai H, Gesheff G, Hammouda A, et al. Trapezius Muscle Transfer for Restoration of Elbow Extension in a Traumatic Brachial Plexus Injury. *J Hand Surg Am* 2018;43:872.
- [121] Bertelli JA. Transfer of the radial nerve branch to the extensor carpi radialis brevis to the anterior interosseous nerve to reconstruct thumb and finger flexion. *J Hand Surg Am* 2015;40:323-328.
- [122] Magistroni E, Ciclamini D, Panero B. Ultrasound-guided pulse-dose radiofrequency: Treatment of neuropathic pain after brachial plexus lesion and arm revascularization. Case Rep Med 2014;201:429618.
- [123] Liu Y, Xu X, Zou Y, et al. Phrenic nerve transfer to the musculocutaneous nerve for the repair of brachial plexus injury: Electrophysiological characteristics. *Neural Regen Res* 2015;10:328– 33.
- [124] Le Hanneur M, Walch A, Gerosa T et al. Postoperative motor deficits following elbow flexion reanimation by nerve transfer. *Hand Surg Rehabil* 2018;37:289-294
- [125] Liu Y, Zhuang Y, Yu H, et al. Comparative study of phrenic and partial ulnar nerve transfers for elbow flexion after upper brachial plexus avulsion: A retrospective clinical analysis. *J Plast Reconstr Aesthetic Surg* 2018;71:1245–51.
- [126] Yavari M, Mahmoudvand H, Nadri S. Contralateral medial pectoral nerve transfer with free gracilis muscle transfer in old brachial plexus palsy. *J Surg Res* 2018;231:94–8.
- [127] Yanagisawa T, Fukuma R, Seymour B, et al. MEG-BMI to control phantom limb pain. *Neurol Med Chir (Tokyo)* 2018;58:327–33.
- [128] Choong C, Shalimar A. Complete brachial plexus injury An amputation dilemma. A case report. *Malaysian Orthop J* 2015;9:52–4.
- [129] Tsao J, Finn S. Reversal of phantom pain and hand-to-face remapping after brachial plexus avulsion. *Ann Clin Transl Neurol* 2016;3:463–4..
- [130] Kubota S, Hara Y, Shimizu Y, et al. A newly developed upper limb single-joint HAL in a patient with elbow flexion reconstruction after traumatic brachial plexus injury: A case report. *Interdiscip Neurosurg Adv Tech Case Manag* 2017;10:66–8.
- [131] Bertelli JA. Free Reverse Gracilis Muscle Combined With Steindler Flexorplasty for Elbow Flexion Reconstruction After Failed Primary Repair of Extended Upper-Type Paralysis of the Brachial Plexus. J Hand Surg Am 2019;44:112-120

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## Supplementary file 5. Included Studies

- [132] Xu B, Dong Z, Zhang C. Multiple nerve and tendon transfers: A new strategy for restoring hand function in a patient with C7-T1 brachial plexus avulsions. *J Neurosurg* 2017;127:837– 42.
- [133] Cole T, Nicks R, Ferris S et al. Outcomes after occupational therapy intervention for traumatic brachial plexus injury: A prospective longitudinal cohort study. *Journal of Hand Therapy*. 2020;33:528-539
- [134] Crepaldi BE, Neto JQL, Rezende MR et al. Hand.2019;14(2):179-186
- [135] Hruby LA, Gstoettner C, Sturma A et al. Journal of Clinical Medicine. 2020;9(23):1-14
- [136] Ferreira CM, de Carvalho CD, Gomes R et al. Transcranial direct current stimulation and mirror therapy for neuropathic pain after brachial plexus avulsion: A randomised doubleblind, controlled pilot study. Frontiers in *Neurology*. 2020;11:1-10
- [137] Razak I, Chung TY, Ahmad S et al. A comparative study of two modalities in pain managementof patients presenting with chronic brachial neuralgia. *Journal of Alternative* and Complementary Medicine. 2019;1-7
- [138] Martins-Filho FVF, de Carmo Iwase F, Silva GB et al. Do technical components of microanastomosis influence the functional outcome of free gracilis muscle transfer for elbow flexion in traumatic brachial plexus injury? Orthopaedics & Traumatology: Surgery & Research.2021;107:1-5

Online Supplementary file 4. Table: Unique outcomes mapped to potential domains and core areas according to COMET(Dodd et al., 2018)

Outcomes ( n=157)	Subdomains	Domains	Core Areas
Isometric muscle	Muscle strength/	Musculoskeletal and	Physiological/Clinic
strength	function	connective tissue	
Concentric strength		domain	
Eccentric strength			
Muscle			
flicker/contraction			
Anti-gravity muscle			
activity			
Muscle endurance			
Muscle fatigue			
Muscle torque	$\mathbf{O}_{\mathbf{A}}$		
Active range of	Active movement		
movement			
Perception of			
movement			
Antigravity			
movement			
Independent	-		
movement without			
donor			
Passive range of	Passive movement		
movement			
Movement	Control of		
control/stability	movement/stability		
· ·	, ,		
Muscle mass	Muscle mass		
Bony union	Bone		
Joint position	structure/position		
Joint stability			
General sensory	General sensory	Nervous system	
recovery	recovery		
Faaling of such as a	4		
Feeling of numbness	4		
Proprioception	<b>D</b>	-	
Light touch	Discriminative		
2 PD	touch		

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### Vibration **Object recognition** Pain Protective touch Temperature Deep pressure Brachial plexus Peripheral nervous structure system structure Level of Reinnervation reinnervation Time to reinnervation Progression of Progression of regeneration regeneration Speed of motor Speed of motor sensory conduction and sensory conduction Pain intensity Pain intensity/relief General outcomes/symptoms Pain relief / reduction Pain duration Pain Pain frequency duration/frequency Pain quality Pain quality and Pain interference interference with with walking life Pain interference in mood Pain interference with work Pain interference in activities of daily living Pain interference with relationships Pain interference with enjoyment of life Pain interference with sleep Pain when arm Sensitivity to cold exposed to cold Paraesthesia Paraesthesia and Itchiness itchiness

### Supplementary file 6: Unique outcomes mapped to potential domains and core areas according to COMET

60

Supplementary file 6: Uni COMET	ique outcomes mappeu		
Sensitivity to	Sensitivity to touch,		
pressure	pressure etc		
Sensitivity to touch			
Pain location	Location of pain		
Pain relief from	Pain medication		
medication	use		
Stiffness	Stiffness		
Impact on general	Impact on sleep		
sleep			
Impact on sleep on	-		
affected side			
Frequency sleep			
disturbed by injury			
General physical	Physical function	Physical functioning	Life Impact
function	non-specific		
Patient led functional			
outcome			
Walking short	Lower limb and		
distance	non -upper limb		
Balance	function		
Running			
Climbing stairs			
Bending			
Kneeling			
Reaching	Reaching, pulling,	6.	
Pulling	pushing, carrying		
Pushing	etc		
		4	
Carrying			
Throwing	4		
Lifting	4		
General function of			
arm			
Turning and twisting	Turning twisting,		
arm	gripping and		
Grip and release	releasing with the		
	arm		
Pinching	Fine hand		
Fine hand movement	movement		
(writing/buttons)	including writing		
Returning to work	Impact on paid or	Role functioning	
	unpaid work or role		
Ability to do work	in education		
Usual time at work			
		1	1

## Supplementary file 6: Unique outcomes mapped to potential domains and core areas according to

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Usual school activities			
General rating to	Role function -		
-			
perform a patient	patient specific		
specific activity			
Impact on ADL	Carrying out daily		
(general)	routine, (including		
Return to ADL	food preparation,		
(general)	housework,		
	garden, plants)		
Impact on food			
preparation and			
feeding			
Housework (washing,			
cleaning, ironing,			
folding, vacuuming)			
Gardening (Includes			
indoor plants)			
Using a phone			
Maintaining personal			
hygiene	Maintaining	-	
Maintaining personal	Maintaining		
appearance	personal hygiene		
(grooming hair)			
Dressing	Maintaining		
	personal		
	appearance		
Transport needs (e.g	Dressing	4	
driving)			
Impact on normal	Transport needs		
hobbies			
Time doing normal	Impact on		
hobbies	recreational		
Playing instrument in	activities and sport		
usual way			
Ability to play			
instrument			
Impact on time spent	1		
playing instrument			
Impact on time spent			
doing sport			
Impact on	4		
•			
• • •	Effect on	Social functioning	4
participation in sport Social activities with friends	Effect on relationship with	Social functioning	-

## Supplementary file 6: Unique outcomes mapped to potential domains and core areas according to COMET

1 2	COMET			
3	Social activities with	family, friends,		
4 5	neighbours	neighbours and		
6	Social activities with	groups		
7	family			
8	Social activities with			
9 10	groups			
11	Dependence on			
12	family and friends			
13	Appearance			
14 15	interferes with social			
16	activities			
17	Intimate	Effect on intimate		
18	relationships	relationships		
19 20	Emotional impact on	Emotional	Emotional	
20 21	work	distress/mood	functioning	
22	Energy levels			
23	Emotional impact on			
24	ADL			
25 26	Happiness			
27	Impact on life			
28	enjoyment /			
29	satisfaction			
30 31	Emotional impact on			
32	relationships			
33	Anxiety		6.	
34	Depression			
35 36	Acceptance/	Thoughts and		
37	Adjustment	beliefs	4	
38	Coping with trauma	(acceptance,		
39		coping)		
40 41	Confidence	Self esteem and		
42	Self esteem	confidence		
43	Body image	Body image		
44	Quality of life	Quality of Life	Global Quality of Life	Quality of Life
45 46	Rating of health	Perceived Health	Health status	Health status
40 47		status		
48	General patient	Patient satisfaction	Delivery of Care	Delivery of Care
49	satisfaction			
50 51	Satisfaction with	1		
52	appearance of arm			
53	Satisfaction with	1		
54	function			
55	Satisfaction with	1		
56 57	movement			
58	Satisfaction with	1		
59	strength			
60		1		

### Supplementary file 6: Unique outcomes mapped to potential domains and core areas according to CONACT

# Supplementary file 6: Unique outcomes mapped to potential domains and core areas according to COMET

-		
	-	
-	-	
Accessibility,		
	-	
Time to surgery		
Operation time	Resource Use	Resource Use
	Adverse Events	Adverse Events
morbidity		
General		
complications		
Respiratory	D	
complications		
	<b>C</b> .	
Vascular	4	
complications		
Musculoskeletal		
complications		
	quality and adequacy of interventionTime to surgeryOperation timeDonor site morbidityGeneral complicationsRespiratory complicationsVascular complicationsVascular complicationsMusculoskeletal	Accessibility, quality and adequacy of intervention Time to surgery Operation time Donor site morbidity General complications Respiratory complications Vascular complications

## Supplementary file 6: Unique outcomes mapped to potential domains and core areas according to COMET

Infection	Infection	
complications	complications	

Dodd, S. et al. A taxonomy has been developed for outcomes in medical research to help improve knowledge discovery. Journal of clinical epidemiology. 2018, 96: 84–92.

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 Supplementary file 7. Measurement instruments mapped to domains
 Supplementary file 7. Measurement instruments mapped to domains

 Supplementary file 7. Measurement instruments mapped to domains
 Supplementary file 7. Measurement instruments mapped to domains

 56 outcome subdomains in 4 core areas (Physiological/clinical, Life Impact, Resource Use and Adverse events) and within the following COMET domains

Musculoskeletal/connective tissue, Nervous system outcome domain, General outcome and symptom domain, Pagysical functioning, Role functioning, Emotional functioning, Global quality of life, Perceived health status, Delivery of care, Hospital resources and Advarse events Eras Eras

Core Area	Outcome subdomains	Measureme Patient reported	ent type used Clinician reported	(N) Performance Outcome	Not Clear	Measurements used (number of studies) Measurements used (number of studies) A minorade A
		Outcome	Outcome			n htt
	Musculoskeletal/connective tissue					, p://
_	Muscle strength	31	131	20	3	DASH (n= 28), USFI (n=2), MHQ (n=1)
/CLINICAL						
I						Manual muscle setting undefined (n=5)
						MRC musclegrading (n=62, including UCLA)
ÄL						MRC musclegrading modified (n= 24) MRC modified, පුnclear how (n= 6)
00						MRC modified, Fade 3 active must equal passive (n=2)
Õ						
PHYSIOLOGICAL						<i>MRC modified</i> , grade 2 active must equal passive movement (n=2)
ΡH						MRC modified, 🛱 + contraction with resistance against a finger
						for less than 30 geconds, M4 contraction of resistance against a
						finger against a grager for more than 30 seconds (n=1)
						MRC modified: 🛱 0, M1+, M1, M1+, M2-, M2, M2+, M3-, M3,
						M3+, M4-, M4, 🙀 4+, M5-, M5 (n=6)
						MRC modified, Hanger flexion tested with wrist extended 20-30
						degrees ( n=1) 😭
						Z-LTA

Page 73 of 80	)	BMJ Open	У 6/bт со	
1 2	Supplementary file 7. Measurement instruments	s mapped to domains	6/bmjopen-20; vy copyright, ir	
3         4         5         6         7         8         9         10         11         12         13         14         15         16         17         18         19         20         21         22         23         24         25         26         27         28         29         30         31         32         33         34         35         36         37			MRC modified, Addition of M4.5 (n=1) MRC modified, Higer extension tested with wrist ex 20-30 degrees (n=1) MRC modified, Higer extension tested with wrist ex 20-30 degrees (n=1) MRC modified, DS tested by stabilising LF and IF to testing MF Higher Provide tests (n=1) Lovett & Suffer Provide tests (n=3) Kendall and Kereary testing procedure (n=1) Oxford must resting frequencies (n=1) Modification of the standardisation (n=1) Oxford must resting frequencies (n=1) Modification of the standardisation (n=1) Time to (n=22) contraction of the standardise that or equal to moc n=1); Time to intervent in MRC scale (n= 1) Dynanometry (n=23) Dynanometry (n=23) Dynanometry (n=23) Dynanometry (n=2); Grip strength , PABLO undefined (n=1); Pistor strength , hand held dynamometry (n=2); Isometric strength , through range, Isokinetics (n=1) Combined action of using elbow and hand on digital Combined action of using elbow and hand on digital	ical Centre or equal to dified M3 ( hod (n =1) ook grip – strength O system, 3), Pinch and held d ngth , Kendall surement on 1)

у Г 

ent<mark>| GEZ-LTA</mark>

scale (n=1)

BMJ Open Supplementary file 7. Measurement instruments mapped to domains
BMJ Open     by open is provided by open
Constant-Merley Score: dynanometry 90 degrees abduction(r=2) 4 5 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7
Thoaraco brown of the second s
Wrist extension     Wrist extension       Wrist extension     Wrist extension       Fist power     Wrist extension       Pinch power     Pinch power
ULM (one study)         Shoulder flegion to shoulder height with 500g (n=1)         Shoulder flegion to shoulder height with 500g (n=1)         Shoulder flegion to shoulder height with 500g (n=1)         Shoulder flegion to shoulder with 1kg (n=1)
Move weight onetable (100g) (n=1) Move weight onetable (500g) (n=1) Move weight onetable (1KG) (n=1)
SHAP (two studies) Grip strengta (n=2) Pinch strength g=2) Diach grip ((trength) (re-2))
Pinch grip (leterar) (n=2) Pinch grip (tep) (f=2) Grip strengta (power) (n=2) Heavy exteraris
Ability to lift weight, undefined (n=1) Number of repetitions movement can be performed in 10
seconds (n=1) Seconds (n=1) Seconds (n=1)

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					136/bmjope I by copyrig
Supplementary file 7. Measurement instrum	ents mapped t	o domains			36/bmjopen-2 by copyright,
					<u>ଗ୍</u> Unclear (n=ଅ) - ସ୍ୱ: 44
					Force recovery: $\vec{k}$ ross sectional area of the muscle under isometric contraction divided by cross sectional area at rest (n=1)
Activo movement	<b>F</b>	105	4	62	s re
Active movement	5	105	4	63	SST(n=1), Marchine (n=1), UCLA shoulder rating scale (n=1), MPI(n=2), Chastrant MURLEY(n=2) (2xPRO, 8x ClinRO), A (PerfO, n=2), Guiometry(n=50), MALLE (n=1), Visua sssment (n=32), First web space in cm (n=3) Total active and sement(n=2), Pulp to palm distance (n=2)
		.er	-		Months to fail a first we movement (n=1) Months to a first avity movement (n=3) Months to i first a movement (n= 1) Months to i first a movement without donor (n=1) Not clear (n=63)
Passive range of movement		6	$\mathbf{C}$	7	Not defined (n=3), Goniometry(n=6)
Movement control and stability		1	1	2	MPI (ClinRozn=3, ULM (PerfO, n=1), Not clear (n=2)
Bone structure/position/healing			16	4	Not clear (n=4)
Muscle mass				4	Not clear(n=4) 🖁
Nervous system outcome subdomains				(	
General sensory recovery including proprioception		9		8	Sensory BM幕C (第=5), Modified Sensory BMRC (n= 2), Highe classificatio聲(n曇), Not clear (n=8)
Discriminative touch (light touch, two point discrimination, vibration, object recognition)	1	14			MHQ (n=1), ot on wool (n=3), Semmes Weinstein Monofilaments (n=4), Two point discrimination( n=2), Tuni fork (n=4), Not of fined (ClinRo, n=1)
Protective touch (pain, temperature, deep pressure)		3		7	Blunt pin (n=3), Not clear (n=7)
Structure of peripheral nervous system		1			MRI (n=1)
Reinnervation (level of reinnervation, time to innervation)		54			Two point scale on EMG(n=1) Four point scale on EMG (n=4 Not clear EMG (n=49)
Progression of regeneration		5			Tinel sign (n=5)

### Supplementary file 7. Measurement instruments mapped to domains

Speed of motor and sensory conduction		9			136/bm Page Page Page Page Page Page Page Page
General outcomes / symptoms					
Pain intensity/ relief	81			3	DASH (n=27) ASt S (n=1), TAPES (n=1), VAS(n=20),
					NRS(n=12), MHC (n=1) WBFRS(n=1), BPI (n= 4), UNWNS (n=1) McGill Pain westionnaire SF (n=2), McGill pain questionnaire (n= 2), MPI (n=1) CONSTANT-MURLEY (n=2), 4 point scale (n=
					Author deversion questionnaire(n=1), Not Clear (n=3), QuickDash (h=1) EQ5D 3L (n=1)
Pain duration or frequency	18	0	0	0	SST (n=1), S 5 5 5 8 8 9 8), MHQ (n=1), TAPES(n=1), NPSI (n=1), BPI (n=4), UCLA 3 8 9 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
Pain quality	8	0			TAPES (n= 1 最
Pain when arm exposed to cold	1	- RL			NPSI (n=1) 📅 🖥
Paraesthesia	28				DASH (n=27磺 QdckDash(n=1)
Sensitivity to touch, pressure, vibration etc	3				NPSI (n=1) 🖄 NNS (n=1), NRS (n=1)
Location of pain	4				BPI (n=4) 📅 💆
Pain medication use	4				BPI (n=4) 📑 🙀
Stiffness	27		1		DASH (n=27) _
Physical functioning					ind mi
Physical function non-specific	3				PSFS (n=2), <b>É</b> APÉS (n=1)
Lower limb and non-upper limb function	14			1	SF36 (n=8), = APES (n= 1), BPI (n=4)
(walking, running, climbing stairs etc)					Non described PBO (n=1), EQ5D-3L (n=1)
Reaching, pulling, pushing, carrying, throwing , lifting	41		4		DASH (n=28 UぞI (n=2), MHQ(n=1), ASES(n=1), SST (n=1), SF36(n=8), 条A式n=2), AMULA ( n=1) UNBtP ( n=1)
Turning twisting, gripping and releasing with	33		6	1	DASH (n=28; UBI (n=2), MHQ (n=1), ARAT(n=2), SHAP(n=2),
the arm	55		0	T	JHFT (n=1), XMBA (n=1), UNBtP (n=1), Not clear (n=1),
Fine hand movement include writing	32		7		QuickDash (n=1 DASH (n=28), U II (n=2), MHQ (n=1), ARAT(n=2), SHAP(n=2),
	52		/		JHFT (n=1) Purdue Peg test (n=1),AMULA (n=1), UNBtP (n=1)
Role Functioning					

Supplementary file 7. Measurement instruments mapped to domains 명 및 명 및 명 및 명 및 명 및 명 및 명 및 명 및 명 및 명									
Impact on return to work	46				5 DASH (n =2월, UEFI (n=2),MHQ (n=1), ASES (n=1), SST (n= SF36 (n=8), 5AP的 (n=1), MPI (n=1) No description 略O (n=1), Questionnaire no data ( n=1),				
					QuickDash $(\vec{p}=1)$				
Role function patient specific	2				PSFS(n=2)				
Carrying out daily routine, (including food preparation, housework, garden, plants)	43	1	5		DASH (n=28) UET (n=2), MHQ (n=1), TAPES(n=1), BPI (n= UCLA (n=1), GAB (n=2), Jebsen (n=1), ULM (n=1) Questionna (End defined (n=2), No description PRO (n=2) Unclear CLine (n=1), AMULA (n=1), UNBtP (n=1), QuickDash (n=2) EQ5D 3L (n=1)				
Maintaining personal hygiene	41	20	2		DASH (n=28				
Maintaining personal appearance	3	10,	1		UEFI (n=2), ASES (n= 1), AMULA (n=1)				
Dressing	33		2		DASH (n =2), UFFI (n=2), MHQ (n=1), ASES (n= 1), SST (n= AMULA (n=2) SHAP(n=2)				
Transport needs	29				DASH (n =2 $\frac{1}{3}$ , UEFI (n=2),				
Impact on recreational activities and sport	36			0,	DASH (n =29, UFFI (n=2), ASES (n= 1), TAPES(n=1), CONS MURLEY (n=2), Not described PRO (n=1), QuickDash(n=1)				
Social functioning									
Effect on relationship with family, friends, neighbours and groups	43				DASH (n =24, SB36 (n=8), TAPES (n=1), MHQ (n=1), QuickDash(#1), BPI (n=4)				
Effect on intimate relationships	28				DASH (n = $2\frac{3}{2}$				
Emotional Functioning									
Emotional distress/ mood	18				SF36 (n=8), SAP (n=1), BPI(n=4), UWNS(n=1), Self-rated anxiety scale (n-3), Self-rated depression scale (n=1), MF (n=1), EQ5D 3L (H=1)				
Thoughts and beliefs ( acceptance and adjustment)	1				TAPES (n=1)				
Self-esteem and self confidence	29				DASH (n=28), TAPES(n= 1)				
Body image	3				MHQ (n= 2), Noted described (n=1)				
Sleep and overall health					nt GEZ-LTA				

				BMJ Open		136/DB Page 78 Page 78 Page 78
	Supplementary file 7. Measurement instrum	ents mapped t	to domains			open-20; yright, ir
-	Impact on sleep	41				DASH (n=28 U段I (n=3), ASES(n= 1), MHQ (n=1), SST (n=1),
						BPI(n=4), CGNSANT- MURLEY(n=2),Not described PRO (n=1)
	General Quality of life	1				Not described Page (n=1)
	Perceived Health Status	10				SF36 (n=8), <b>J</b> AP <b>B</b> S (n=1), Eq5D 3L (n=1)
	Delivery of Care					es c
	Patient satisfaction	10				TAPES (n=1) $HCEA$ (n=1), MHQ (n=1), 10-point scale (n=1)
	~					4 point scale ( 3 3), 3 point likert scale (n=1), Questionnaire not
		8				described (ॡ් ඞ්) Mot defined PRO(n=2)
	Patient preference for treatment	1				Not describor (명구)
	Accessibility, quality and adequacy of	Jh			1	4 point scale (
	intervention					nd dat
	Hospital					da o o d
	Operation time				1	Not described (rational)
RESOURCE				5		ining, Al
				CVic		http://bmjopen.l
	Adverse Events				N,	
	Donor site motor morbidity to include		18		19	BMRC (n=7) BMRC modified(n=2), Dynanometry (n=8),
	weakness					EMG(n=1),Not clear (n=19)
	Donor site sensory morbidity	1	3		4	10-point scare PBO (n=1),Not defined (n=4),2PD (n=2),
	, ,					Monofilamegits =1)
		3				Not defined RCC(n=3)
	Donor site morbidity -pain	3				
212	Donor site morbidity -pain General complications	3			3	Unclear (n= 🕄 💫
	General complications		5			Unclear (n=) C 4 point scale PRO (n=1), x-ray (n=2), FEV (n=1), TLC(n=1), MVV
1		1	5		3 4	4 point scale PRo (n=1), x-ray (n=2), FEV (n=1), TLC(n=1), MVV
	General complications Respiratory complications				4	4 point scale PR 2 (n=1), x-ray (n=2), FEV (n=1), TLC(n=1), MVV (n-1), Not defin 4 (n=4),
VERSE EVENTS	General complications Respiratory complications Vascular complications		5 2 2		4 13	4 point scale PR (n=1), x-ray (n=2), FEV (n=1), TLC(n=1), MVV (n-1), Not defined (n=4), Not defined (n=3), Visual assessment (n=1), USS (n=1)
ADVENSE EVEN IS	General complications Respiratory complications		2		4	4 point scale PR 2 (n=1), x-ray (n=2), FEV (n=1), TLC(n=1), MVV (n-1), Not defin 4 (n=4),

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 Supplementary file 7. Measurement instruments mapped to domains
 Image: Comparison of the arm shoulder and hand, UEFI Upper Extremity Functional Index, MHQ Michigan Hand Questionnaire, BMRC Britisle Medical Research Council, ULM Upper Limb

 DASH Disabilities of the arm shoulder and hand, UEFI Upper Extremity Functional Index, MHQ Michigan Hand Questionnaire, BMRC Britisle Medical Research Council, ULM Upper Limb

 ual In. Jider Test, M. G Outcome, ASES Am. Scale, WBFRS Wong Baker Fa. J Brief Pain Inventory, PSFS Pain Specu. J Lebsen Hand Function Test, FEV Forced Expu. d dtot mining. At training, and similar. d dtot mining. At training, and similar. Module, SHAP Southampton Hand Assessment Procedure, SST Simple Shoulder Test, MPI Mayo clinic Performance Index for the elbow, A to research Arm Test, ClinRO Clinician Reported Outcome, PerfO Performance Outcome, PRO Patient Reported Outcome, ASES American Shoulder and Elbow Surgeons Index, 700 ES the Trinity Amputation and Prosthesis Experience Scales, VAS Visual Analogue Scale, NRS Numerical Rating Scale, WBFRS Wong Baker Faces Rating Scale, UNWNS University of Weshington Neuropathic pain Score, SF36 Short Form 36 health survey, NPSI Neuropathic Pain Symptom Inventory, BPI Brief Pain Inventory, PSFS Pain Specific Functional Scale, AMULA America Measures for Upper Limb Amputees, UNBPT University of New Brunswick test of Prosthetics function, JHFT Jebsen Hand Function Test, FEV Forced Expiratory Volume, TLC Tidal Lung C Brac R, MVV maximal voluntary ventilation, USS July 2021. Downloaded from http://bmjopen.bmj.com/ on May 12, 2025 at Department GEZ-LTA Erasmushogeschool . related to text and data mining, AI training, and similar technologies. Ultrasound Scan.

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			BMJ Open Ed 3	Page 80 of 80
1 2 3	PRISMA 20	)09	Checklist	
4 5 6	Section/topic	#	Checklist item	Reported on page #
7	TITLE		9 fo	
8 9	Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
10	ABSTRACT			
12 12 13 14	Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sour study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limetions; conclusions and implications of key findings; systematic review registration number.	3
15				
16 17	Rationale	3	Describe the rationale for the review in the context of what is already known.	5-6
18 19	Objectives	4	Provide an explicit statement of questions being addressed with reference to participants interventions, comparisons, outcomes, and study design (PICOS).	7
20 21	METHODS			
22 23		5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and a available, provide registration information including registration number.	7
24 25 26	Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics ze.ge years considered, language, publication status) used as criteria for eligibility, giving rationale.	8
27 28	8	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	8
29 30 31	Search	8	Present full electronic search strategy for at least one database, including any limits used sugh that it could be repeated.	Supplementary 2
32 33		9	State the process for selecting studies (i.e., screening, eligibility, included in systematic revieve, and, if applicable, included in the meta-analysis).	9
34 35 36	Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	9-10
37 38	Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and argy assumptions and simplifications made.	9-10
39 40 41	Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data somethesis.	9
42	2 Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	N/A
43 44 45	Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (erg, erg, for jeach metacanalysis) open.bmj.com/site/about/guidelines.xhtml	11
46	) )			

cted by copyright, in 0.1136/bmjopen-2020 Page 81 of 80 **BMJ Open** PRISMA 2009 Checklist Page 1 of 2 lud Reported Section/topic # Checklist item on page # Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective Risk of bias across studies 15 9 reporting within studies). ဗဓ Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regiression), if done, indicating 16 Additional analyses N/A which were pre-specified. RESULTS Study selection 17 Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at 13 ( Fig each stage, ideally with a flow diagram. 1) For each study, present characteristics for which data were extracted (e.g., study size, Picos, follow-up period) and Study characteristics 18 14-16 provide the citations. Risk of bias within studies 19 Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12). n/a For all outcomes considered (benefits or harms), present, for each study: (a) simple surfmation data for each Results of individual studies 20 n/a intervention group (b) effect estimates and confidence intervals, ideally with a forest plot≥ 22 Synthesis of results 21 Present results of each meta-analysis done, including confidence intervals and measures of consistency. n/a Risk of bias across studies 22 Present results of any assessment of risk of bias across studies (see Item 15). 23-24 Additional analysis 23 Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-degression [see Item 16]). n/a DISCUSSION Summarize the main findings including the strength of evidence for each main outcome; 2 on sider their relevance to Summary of evidence 24 24-25 key groups (e.g., healthcare providers, users, and policy makers). Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of Limitations 25 26 33 identified research, reporting bias). Provide a general interpretation of the results in the context of other evidence, and implication is for future research. 27 Conclusions 26 **FUNDING** 38 Funding 27 Describe sources of funding for the systematic review and other support (e.g., supply of dat $\mathbf{a}$ ; role of funders for the 30 systematic review. 39 From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The RISMA Statement. PLoS Med 6(7): e1000097. 42 doi:10.1371/journal.pmed1000097 F For more information, visit: www.prisma-statement.org. 43 44 For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml 45

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