OPEN ACCESS

Pathological fracture non-union of medial clavicle after radiotherapy

Chun Lok Chow, Chun Man Ma, Tun Hing Lui

Department of Orthopaedics and Traumatology, North District Hospital, Hong Kong, People's Republic of China

Correspondence to
Dr Chun Lok Chow;
drlionelchow@gmail.com

Accepted 15 April 2025

SUMMARY

The medial end of the clavicle is a relatively uncommon site of fracture. It is often associated with high-energy injury if it is traumatic in cause. Medial clavicle fracture arising from minor injury raises the suspicion of possible pathological causes. We present a case of pathological fracture non-union of the medial end of the clavicle in a patient who previously received radiotherapy for papillary thyroid carcinoma. The diagnostic challenge involved in identifying the causes of her condition is highlighted.

BACKGROUND

The medial clavicle is the least common site of clavicular fracture, accounting for around 2% of its incidence.[1] It is often associated with high-energy trauma and related to possible injury to other body systems, for example, the cardiorespiratory system.[2] Apart from physical trauma, there are other possible aetiologies accountable for medial clavicular fracture, including but not limited to neoplasm, metabolic disease and infection.[3] We describe a patient who was referred to us for medial clavicular fracture, which was subsequently diagnosed to be pathological in cause. The diagnosis of osteoradionecrosis from previous radiotherapy causing fracture was made a few months after its initial presentation. We aim to discuss the diagnostic difficulty and the possible delay in diagnosing the pathological cause of medial clavicle fracture. A high index of suspicion is necessary to avoid such delay and allow timely management.

CASE PRESENTATION

A woman in her 70s was referred to us by the emergency department for persistent symptoms after fracture of her left clavicle at its medial end. She had an oncological history of papillary carcinoma of the thyroid, which was treated with total thyroidectomy more than 20 years ago. During her total thyroidectomy, incomplete excision of the tumour tissue was performed as the tumour was found to be in close proximity to her trachea with dense surrounding adhesion. She was later referred to oncologists for adjuvant therapy. Radioactive iodine therapy and external radiation therapy (60 Gy/30 fr/39 days) were arranged and completed. She was on lifelong thyroxine replacement since then, with no relapses noted at her subsequent follow-up. Apart from her oncological history, she was diagnosed with hypertension and hyperlipidaemia, with her condition regularly monitored by medical physicians. She was not a smoker or a drinker.

Figure 1 Clinical photo showing patient's postradiation skin status and prominence over left clavicle over its medial end.

She suffered from a minor left shoulder contusion after running into a passer-by in the street. Instead of seeking medical advice immediately, she consulted at the emergency department 9 months after injury due to persistent pain and symptoms. X-ray of her left clavicle was performed, which found a fracture at the medial end of her clavicle. She was subsequently referred to our orthopaedic specialist out-patient clinic for further management.

During our first assessment, she complained of pain over the medial end of her left clavicle just next to the sternoclavicular joint. There were no other associated symptoms like fever, night sweats or constitutional symptoms. She still enjoyed good function with independent activities of daily living. She experienced mild shoulder stiffness in cross-arm movement and weakness limited by medial clavicular pain. During the physical examination, she was noted to have hyperpigmentation over her anterior neck and upper chest, possibly due to postradiotherapy skin changes (figure 1). There was prominence noted over the medial end of her left clavicle without skin impingement. Palpation found tenderness over the clavicular prominence. Her left shoulder range of motion was 160° in forward

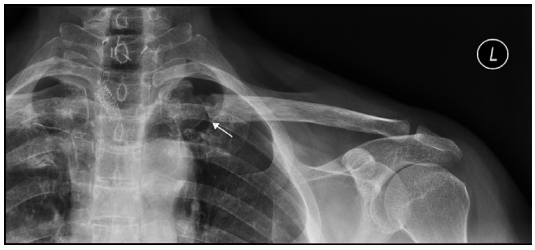

Figure 2 X-ray of the patient's left clavicle showing cortical incontinuity with cystic and sclerotic change at fracture end (arrow).

To cite: Chow CL, Ma CM, Lui TH. *BMJ Case Rep* 2025;**18**:e260961. doi:10.1136/bcr-2024-260961

Figure 3 MRI both clavicles (T1 weighted in coronal view) showing the lack of marrow signal and absence of extraosseous soft tissue expansion (arrow).

flexion and abduction. Cross-body adduction test showed tenderness in her left sternoclavicular joint. Shoulder power in forward flexion, abduction and rotation was reduced to grade 4 according to the Medical Research Council (MRC) scale.

INVESTIGATIONS

Blood tests of the patient were unremarkable. There was no elevation of her inflammatory and tumour markers. The calcium profile, albumin/globulin ratio, parathyroid hormone level as well as alkaline phosphatase were all within normal range.

X-ray was repeated for more recent assessment of her fracture status, which found fracture non-union of the medial end of her left clavicle. There was gapping between fracture fragments with associated cystic changes and well-defined sclerotic borders at the fracture ends (figure 2).

The lack of significant physical trauma raised our suspicion of possible pathological causes accountable for her condition. MRI of the left clavicle and bone scan were arranged for her with the aim to identify the possible aetiological cause.

Figure 4 MRI of both clavicles (T1 weighted in coronal view) showing the lack of marrow signal and absence of extraosseous soft tissue expansion (arrow).

Figure 5 MRI of both clavicles in axial view showing the absence of marrow signal (arrow).

The MRI of her left clavicle showed a reduced marrow signal in the T1 weighted (T1W) image. Fluid signal was noted around the fracture end of the left medial clavicle signifying fracture non-union. There was no discrete extraosseous soft tissue component. Bilateral sternoclavicular joints were unremarkable (figures 3–5).

The bone scan showed slight tracer uptake around fracture ends without convincing evidence of local infection, malignant lesion or bony metastases (figure 6).

TREATMENT

The patient was treated conservatively with physiotherapy as well as analgesics for symptomatic relief of pain. She was given COX-2 inhibitor (oral Celebrex 200 mg two times per day), which showed good response in giving adequate pain control. She was referred to physiotherapy for shoulder mobilisation exercises. Our physiotherapists arranged training sessions two times per week with passive stretching and strengthening of muscles around the shoulder girdle as well as the pectoralis muscles. Pulsed electromagnetic field therapy was also given during interval episodes of pain exacerbation.

OUTCOME AND FOLLOW-UP

Follow-up was arranged 3 months after her initial consultation. On her subsequent follow-up, her symptoms resolved significantly and were well-controlled by the occasional use of analgesics. She was noted to have reduced frequency of analgesic usage.

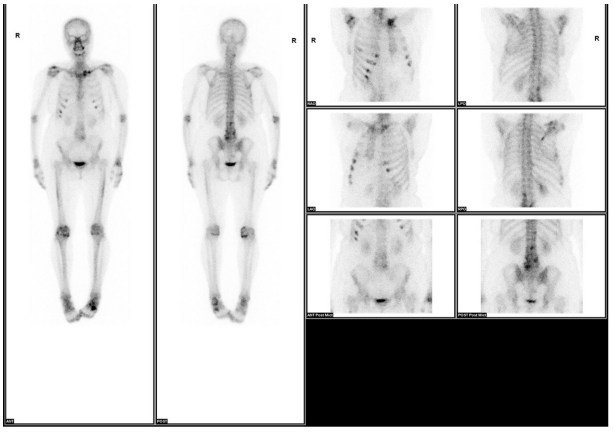

Figure 6 Bone scan of the patient showing trace metabolic activity at the left medial clavicle.

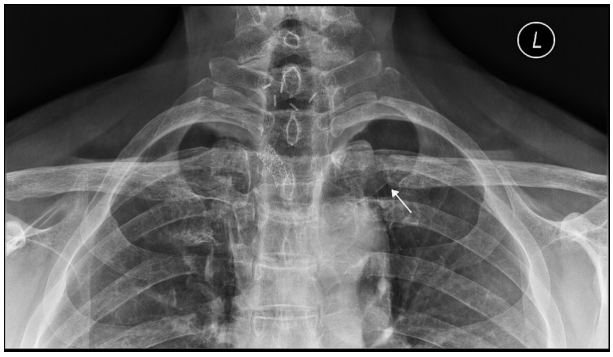

Figure 7 Follow-up X-ray of the patient's left medial clavicle showing radiological evidence of fracture non-union (arrow).

Her left shoulder muscle power and range were noted to have improved after treatment. Shoulder muscles power charting showed full power (ie, MRC grade 5) in forward flexion, abduction, internal and external rotations. She was able to perform cross-body adduction without any pain. Shoulder active range of movement, including forward flexion and abduction, was restored to 180° as compared with the pretreatment range of movement of 160°. Subsequent follow-up showed no recurrence of symptoms.

Progress X-ray imaging of her left clavicle showed similar non-union of fracture with no interval change (figures 7 and 8). A follow-up MRI scan was arranged from which a comparison was made with her previous MRI findings. The later MRI showed fracture non-union of her left medial clavicular head. There was no internal change or bony destruction to suggest neoplastic or infective causes. Increased T2W hyperintense fluid signal surrounding the previous fracture was found, which could be due to pseudoarthrosis formation (figures 9 and 10). Mild osteoarthritic changes were noted over the left sternoclavicular joint.

DISCUSSION

Pathological fractures of the clavicle are most commonly found at its medial end.[4] The presence of fracture at this location is frequently masked by the superimposed bony or soft tissue shadow. Failure to recognise its presence and inability to acknowledge its possible underlying pathology may lead to delay in diagnosis and treatment. It is not uncommon for patients and medical practitioners to fail to recognise its significance. As shown in this case, the patient was referred to our specialist clinic for further work-up and investigation 9 months after symptom onset. If more sinister causes were to be accountable for her condition, it might end up with delayed management, leading to irreversible disease progression affecting treatment outcome. In fact, there was a case report describing such a delay in the diagnosis of pathological fracture of medial clavicle from metastasis of the renal cell carcinoma.[5] A high index of suspicion was needed in managing atraumatic medial clavicular fracture.

Pathological fracture from osteonecrosis after irradiation should be a diagnosis by exclusion. One needs to rule out other possible causes before committing to its diagnosis. Malignancy, both bony primary and secondary metastases from other organs, needs to be ruled out. Irradiated bony tissue was

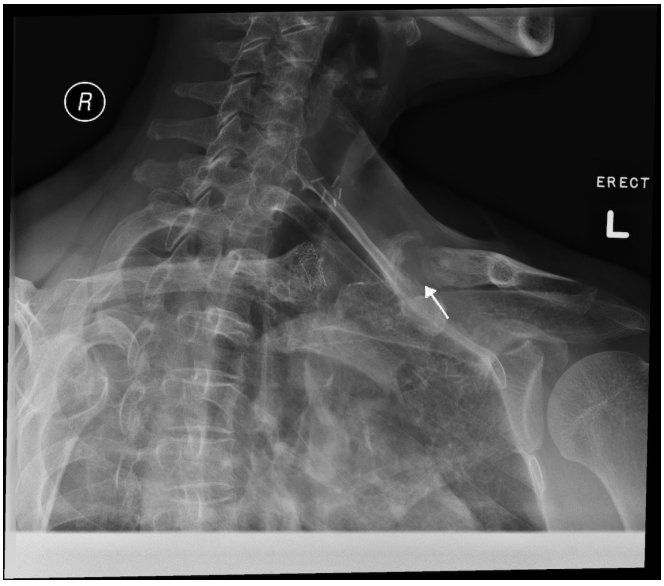

Figure 8 Follow-up X-ray of the patient's left medial clavicle showing radiological evidence of fracture non-union (arrow).

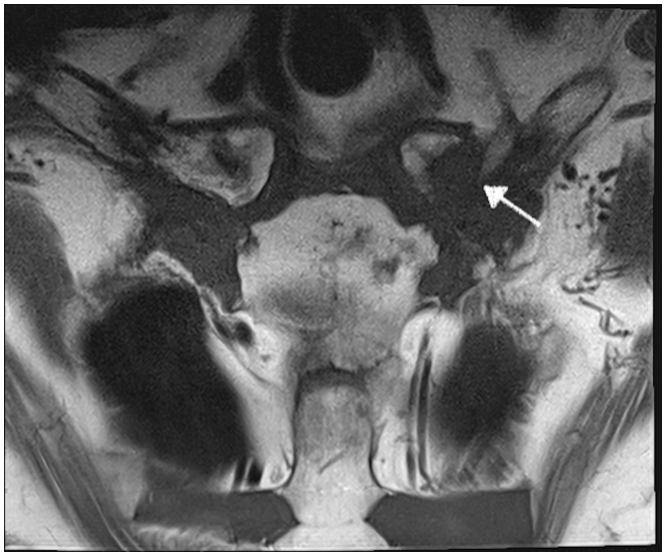

Figure 9 Follow-up MRI of both the clavicles of the patient showing fracture non-union with formation of pseudoarthrosis in coronal view (arrow).

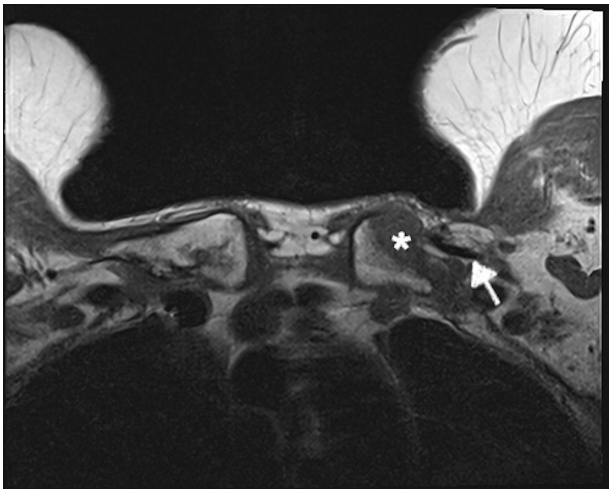

Figure 10 Follow-up MRI of both the clavicles of the patient showing fracture non-union (star) with the formation of pseudoarthrosis (arrow) in axial view.

Table 1 Summary of case reports regarding pathological fracture clavicle

Author, year	Presentation	Diagnostic modality	Time to reach diagnosis	Management	Outcome
Malik, 2009[5]	Pain after lifting a flowerpot	X-ray CT of thorax, abdomen and pelvis with contrast for primary cancer Bone scan Open biopsy	At least 4 months	Referral to oncologist	Not mentioned
To, 2012[7]	Shoulder drooping 5 year after radiotherapy for nasopharyngeal carcinoma	X-ray Bone scan	1 year	Conservative	Remained asymptomatic
Strauss, 1982[8]	Pain after putting on trousers 15 months after submandibular gland excision and radical neck dissection	X-ray Bone scan Needle biopsy	At least 7 weeks	Surgical claviculectomy and flap coverage	Minimal functional limitation
Pellard, 2005[9]	Pain 5 months after radiotherapy for laryngeal carcinoma	X-ray Bone scan Open biopsy	Not mentioned	Conservative	Remained asymptomatic
Niikura, 2012[10]	Atraumatic fracture diagnosed 8 years after radiotherapy for nasopharyngeal carcinoma	X-ray Bone scan MRI	1 year	Initial conservative failed Followed by open reduction internal fixation with plate and screws	Asymptomatic and full range of shoulder motion

associated with increased risk of developing osteosarcoma, and its occurrence at the clavicle had been reported.[6] Given this woman's oncological history of incomplete tumour excision, there was a possibility of metastases from incompletely treated thyroid cancer as well as primary cancer from other sites. Other possible aetiologies include infective osteitis and metabolic diseases, for example, Paget's disease.

Few studies have described cases that presented with pathological fracture of the clavicle with or without radiation therapy, and some also experienced delayed complications and difficulty in reaching a diagnosis.[5 7–10] Their presentations, management and outcomes vary, which are summarised in table 1.

In this patient, the possible aetiological causes of pathological fracture include infection, tumorous lesion of benign or malignant causes, metabolic bone disease and osteonecrosis. Normal serum levels of inflammatory markers made infection a less likely diagnosis. The presence of a normal serum level of metabolic markers and insignificant osteoblastic activity in bone scan ruled out metabolic causes. MRI of the clavicle showed the absence of tumorous lesions with reduced marrow signal in the T1W image, suggesting possible underlying bony necrosis. Reduced fracture healing ability, as shown by the development of pseudoarthrosis, further increases its likelihood. Differential aetiological diagnosis and the corresponding investigation findings are summarised in table 2.

Alteration of the bone quality and possibly osteonecrosis after radiation therapy has been known for decades.[11] On irradiation beyond a certain dose level, bone cells are noted to be microscopically killed directly by the radiation and indirectly through a vascular-related mechanism, leaving hypocellular and hypovascular fibrotic tissues.[12] Given the recent developments in radiotherapy, for instance, intensity-modulated radiation therapy, the frequency of such complications has diminished significantly.[13] Difficulty in recognising and diagnosing bony necrosis after radiotherapy has been described. The average time to diagnosis of osteoradionecrosis is 1–2 years, but delayed diagnosis of up to nearly 20 years has also been reported.[14] Patients suffering from this condition are often asymptomatic but may present with pain if complicated by fracture. Patients may also suffer from skin complications such as infection, ulcer, sinus and fistula tract formation. Osteonecrosis from radiotherapy targeted on head and neck cancer is common in mandibles with a reported incidence of up to 18%, but it is regarded as rare in structures around the sternoclavicular joint.[15,16] There is no consensus concerning the causal relationship between radiation dosage and radiation-induced osteonecrosis. Some studies identified radiation dosage as a risk factor,[17 18] while some found no association in between.[19 20]

Mainstay of treatment of medial clavicular fracture after ruling out sinister pathologies should be conservative management.[21] It is found to have a high rate of non-union up to 95%. Despite the high non-union rate, good functional outcome is reported after conservative management of the condition.[22] Main indications for surgery, as suggested by literature include significantly displaced fracture, fracture with skin impingement, open fracture and segmental fracture.[23] Various implants have been described in the literature for the fixation of medial clavicle fractures, yet none of them were specifically designed for medial clavicle.[22] The lack of availability of a designated implant increases the surgical difficulties in stabilising such fractures.[24] There was also a lack of controlled studies for conclusive comparison of operative and non-operative treatment

Table 2 Summary of differential aetiological diagnosis and corresponding investigation findings

Differential aetiological diagnosis	Investigation findings
Infection	► Normal inflammatory markers ► Insignificant activity in bone scan
Tumour	► Absence of tumorous lesion and discrete mass in MRI ► Normal level of tumour markers
Metabolic bone disease	► Normal level of bone turnover markers ► Normal calcium profile and hormonal level ► Insignificant activity in bone scan
Osteoradionecrosis	► Compatible history and physical exam findings ► Reduced lack of marrow signal in T1 weighted image in MRI ► Reduced fracture healing potential

in the case of medial clavicular fracture. For complicated osteonecrosis with infection, surgical excisional debridement of necrotic tissue combined with an extended course of systemic antibiotics remains the gold standard.[14] We adopted the strategy of conservative management after considering various factors, including the location of the condition (ie, medial clavicle, with a relatively low load-bearing structure), tolerable symptoms and well-preserved shoulder function. Interval follow-up also showed a good response to treatment from the patient. Management of radiotherapy-induced osteonecrosis should be tailored to patients, including the patients' premorbid functional status and the area being affected. In areas where high physical load or weight bearing is anticipated, for example the femur, surgical treatment may be a more appropriate choice in physically fit patients.[25 26]

We acknowledge certain limitations of this case study, including the retrospective nature of the diagnosis and challenges in attributing causation to radiotherapy in a definite manner.

Learning points

- Medial clavicle fractures are the least common clavicle fractures.
- Atraumatic medial clavicle fractures raise suspicion of a pathological cause.
- Osteonecrosis of the clavicle after irradiation should be a diagnosis of exclusion in the case of medial clavicle pathological fracture after ruling out sinister causes.
- Early investigation should be considered in patients with a history of local radiation therapy complaining of clavicular pain in order to avoid delay in diagnosis and treatment.

Contributors The following authors were responsible for drafting of the text, sourcing and editing of clinical images, investigating results, drawing original diagrams and algorithms, and critical revision for important intellectual content: CLC, CMM and THL. The following authors gave final approval of the manuscript: CLC, CMM and THL. The guarantor is CLC.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Patient consent for publication Consent obtained directly from patient(s).

Provenance and peer review Not commissioned; externally peer reviewed.

Case reports provide a valuable learning resource for the scientific community and can indicate areas of interest for future research. They should not be used in isolation to guide treatment choices or public health policy.

ORCID iD

Chun Lok Chow http://orcid.org/0000-0003-1438-5856

REFERENCES

1 Postacchini F, Gumina S, De Santis P, *et al*. Epidemiology of clavicle fractures. *J Shoulder Elbow Surg* 2002;11:452–6.
2 Robinson CM. Fractures of the clavicle in the adult. *J Bone Joint Surg Br* 1998;80-B:476–84.
3 Lazarus MD, Seon C. Fractures of the clavicle. In: *Rockwood and green's fractures in adults*. 6. . Philadelphia, PA: Lippincott Williams & Wilkins, 2006: 1211–56.
4 Kim W, McKee MD. Management of acute clavicle fractures. *Orthop Clin North Am* 2008;39:491–505, .
5 Malik SS, Azad S, Malik S, *et al*. Difficulty in diagnosing the pathological nature of an acute fracture of the clavicle: a case report. *J Orthop Surg Res* 2009;4:21.
6 Tobin HE, Miles PA. Radiation induced osteosarcoma of the clavicle: a case report and literature review. *Mil Med* 1987;152:89–92.
7 To EW, Pang PC, Tsang WS, *et al*. Pathologic fracture of clavicle after radiotherapy. *AJR Am J Roentgenol* 2001;176:264–5.
8 Strauss M, Bushey MJ, Chung C, *et al*. Fracture of the clavicle following radical neck dissection and postoperative radiotherapy: a case report and review of the literature. *Laryngoscope* 1982;92:1304–7.
9 Pellard S, Moss L, Boyce JM, *et al*. Diagnostic dilemma of an atraumatic clavicle fracture following radical treatment for laryngeal carcinoma. *J Laryngol Otol* 2005;119:1013–4.
10 Niikura T, Lee SY, Sakai Y, *et al*. Radiation-associated fracture nonunion of the clavicle treated with locking plate fixation and autologous bone grafting. *Case Rep Med* 2012;2012:407349.
11 Mandair GS, Oest ME, Mann KA, *et al*. Radiation-induced changes to bone composition extend beyond periosteal bone. *Bone Rep* 2020;12:100262.
12 Curi MM, Cardoso CL, de Lima HG, *et al*. Histopathologic and Histomorphometric Analysis of Irradiation Injury in Bone and the Surrounding Soft Tissues of the Jaws. *J Oral Maxillofac Surg* 2016;74:190–9.
13 Pointon RC. The management of oral cancer. Radiotherapeutic aspects. *J Laryngol Otol* 1977;91:929–33.
14 Hao SP, Chen HC, Wei FC, *et al*. Systematic management of osteoradionecrosis in the head and neck. *Laryngoscope* 1999;109:1324–7; .
15 Gehani N, Ludin A, Baskin JZ. Sternoclavicular osteoradionecrosis following treatment for head and neck cancer. *Am J Otolaryngol* 2013;34:731–4.
16 Stenson KM, Kunnavakkam R, Cohen EEW, *et al*. Chemoradiation for patients with advanced oral cavity cancer. *Laryngoscope* 2010;120:93–9.
17 Gortzak Y, Lockwood GA, Mahendra A, *et al*. Prediction of pathologic fracture risk of the femur after combined modality treatment of soft tissue sarcoma of the thigh. *Cancer* 2010;116:1553–9.
18 Holt GE, Griffin AM, Pintilie M, *et al*. Fractures following radiotherapy and limb-salvage surgery for lower extremity soft-tissue sarcomas. A comparison of high-dose and low-dose radiotherapy. *J Bone Joint Surg Am* 2005;87:315–9.
19 Blaes AH, Lindgren B, Mulrooney DA, *et al*. Pathologic femur fractures after limb-sparing treatment of soft-tissue sarcomas. *J Cancer Surviv* 2010;4:399–404.
20 Lin PP, Schupak KD, Boland PJ, *et al*. Pathologic femoral fracture after periosteal excision and radiation for the treatment of soft tissue sarcoma. *Cancer* 1998;82:2356–65.
21 Kang LX, Faulkner HJ, Howard WH, *et al*. Displaced medial clavicle fractures: a systematic review of outcomes after nonoperative and operative management. *JSES Int* 2023;7:79–85.
22 Asadollahi S, Bucknill A. Acute medial clavicle fracture in adults: a systematic review of demographics, clinical features and treatment outcomes in 220 patients. *J Orthop Traumatol* 2019;20:24.
23 Sidhu VS, Hermans D, Duckworth DG. The operative outcomes of displaced medial-end clavicle fractures. *J Shoulder Elbow Surg* 2015;24:1728–34.
24 Brunner A, Wedi E, Hoffmann A, *et al*. Bilateral fracture of the medial clavicles treated by open reduction and internal fixation using angle stable locking T-plates. *Injury Extra* 2008;39:276–8.
25 Kim HJ, Healey JH, Morris CD, *et al*. Site-dependent replacement or internal fixation for postradiation femur fractures after soft tissue sarcoma resection. *Clin Orthop Relat Res* 2010;468:3035–40.
26 Duffy GP, Wood MB, Rock MG, *et al*. Vascularized free fibular transfer combined with autografting for the management of fracture nonunions associated with radiation therapy. *J Bone Joint Surg Am* 2000;82:544–54.