

A Low-Cost Teaching Model of Inguinal Canal: A Useful Method to Teach Surgical Concepts in Hernia Repair

Luca Ansaloni^{1,*}, Fausto Catena², Federico Coccolini¹, Marco Ceresoli¹, Antonio Daniele Pinna³

¹Unit of General Surgery I, Papa Giovanni XXIII Hospital, Bergamo, Italy

²Emergency Surgery, Maggiore Hospital, Parma, Italy

³Unit of General and Transplant Surgery, St.Orsola-Malpighi University Hospital, Bologna, Italy

*Corresponding Author: lansaloni@hpg23.it

Copyright © 2014 Horizon Research Publishing All rights reserved.

Abstract Objectives: Inguinal canal anatomy and hernia repair is difficult for medical students and surgical residents to comprehend. Methods: Using low-cost material, a 3-dimensional inexpensive model of the inguinal canal was created to allow students to learn anatomical details and landmarks and to perform their own simulated hernia repair. In order to test the efficacy of this model a trial with volunteer medical students of the University of Bologna randomly assigned either to a frontal classical academic lesson with a simple slide support or to construct the 3-dimensional inguinal canal model was performed. At the end of each lesson the same multiple choice test was submitted to students of the two groups with the aim of evaluating differences in performances. Results: All students belonging to the experimental group succeeded in building the 3-dimensional model appropriately under teacher supervision in less than 15 minutes and performed significantly better than the control group at the multiple choice test. Conclusions: This teaching model for inguinal canal anatomy was effective, inexpensive, simple to set up and well received by medical students. Further studies are needed to evaluate the applicability of the teachings into the clinic/surgical activity.

Keywords Hernioplasty, Inguinal canal, Model, Training, Educational

1. Introduction

Inguinal hernia repair represents one of the commonest and relatively simple surgical procedure in the world. However the anatomy of the inguinal canal remains extremely difficult to comprehend and explain to medical students and surgical residents due to the complexity of its anatomical structure [1-6]. Moreover, the majority of surgical textbooks and atlas often are full of complicated anatomical details which are not essential for learning the anatomy of inguinal canal in order to perform hernioplasty

procedures [7]. Some attempts have already been done in order to show didactical methods useful to make easier the comprehension, for example, by using a bi-dimensional model of inguinal canal [8].

Aim of this work is to show the feasibility in constructing a low-cost three-dimensional model of a inguinal canal and to test its efficacy in teaching the anatomy and the hernioplasty procedures.

2. Materials and Methods

The three-dimensional simulator of inguinal canal has been created to make easier the learning of the anatomy of the inguinal region and the comprehension of hernioplasty procedures. It could be used by medical students and surgical residents and can be built by the students themselves starting from low-cost materials (approximately 3 euros) extremely easy to find in any hospital. These materials are the following (Fig. 1): a cardboard box of parallelepipedal shape (for example an empty box of disposable scalpels) which stands for the 4 walls of the inguinal canal (i.e. inferior: inguinal ligament, superior: conjoined tendon, posterior: fascia transversalis, anterior: external oblique aponeurosis); a gastric tube representing the ductus deferens; two strings, one red for the superficial epigastric artery and another blue for the superficial epigastric vein; three yellow strings for the nervous structures (i.e. the genital branch of genito-femoral nerve, the ilio-inguinal nerve and the ilio-hypogastric nerve); one Penrose drain to represent the spermatic cord. The Figures 2 and 3 show the completed inguinal canal model.

In order to test the efficacy of this model in teaching the anatomy of the inguinal canal, we planned to enroll 66 volunteer medical students belonging to the last two years of the Faculty of Medicine of the University of Bologna and we randomly assigned them to two different groups of 33 students each. In the control group students received a frontal academic lesson with a slide support. While in the experimental group all the above mentioned materials to construct the three dimensional inguinal canal model were

supplied to students who built it under teacher supervision. At the end of each lesson the same multiple choice test, composed of 13 questions relative to inguinal canal anatomy and hernioplasty procedures (Tab. 1), was submitted to the students of both groups. It was planned to perform the test in three blocks of 22 medical students (11 for the experimental and 11 for the control group) with an interim analysis after each block. A sample size of 33 medical students for each group was needed to reach a confidence level of 95% with a power of 80% ($\alpha=0.05$ and $\beta=0.2$) on the assumption that, like in a previous medical students' group 67% of them committed at least one mistake in the multiple choice test and that the use of three-dimensional model would reduce this percentage to 30%. Data are expressed as numbers (%) and means (SD). The results were analysed using the Chi-Square Test and Fisher Exact Test, as appropriate, for proportions. For means we used the Independent Samples T Test. A p-value of <0.05 was considered to be statistically significant. The analyses were done with SPSS version 13.0 (SPSS, Chicago, IL, USA).



Figure 1. Material for construction of low-cost inguinal canal model

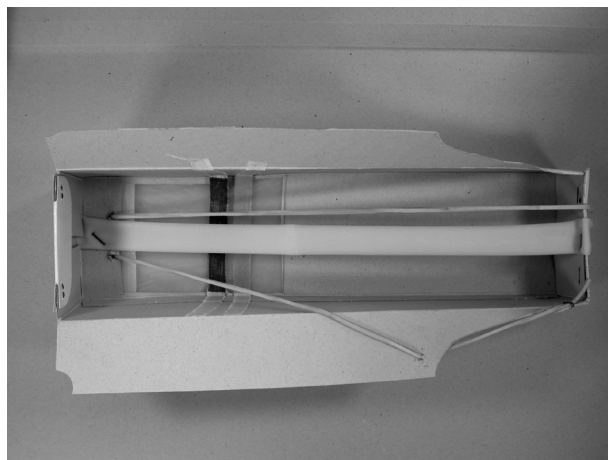


Figure 2. The anterior aspect of the inguinal canal model.

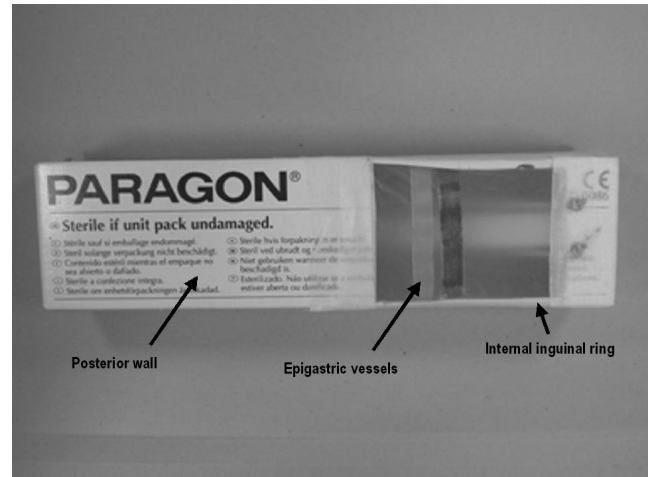


Figure 3. The posterior aspect of the inguinal canal model.

Table 1. Student quiz

Questions	Answers
Which structures run within the inguinal canal?	Vessels, nerves, spermatic cord Spermatic cord, epididimus Vessels, nerves
Which is the anterior wall of the inguinal canal?	Conjoint tendon Pritoneum and fascia transversalis External obliquum fascia
The superficial inguinal ring is	Lateral Medial
Which is the inferior wall of the inguinal canal?	Conjoint tendon Inguinal ligament Cremaster muscel
Which is the superior wall of the inguinal canal?	Poupart ligament Peritoneum and fascia transversalis Conjoint tendon
Which is the non-tension-free technique?	Bassini Shouldice Lichtenstein
The spermatic cord is enveloped in peritoneum?	Yes No Only in children
Which is the more frequent congenital inguinal hernia?	Internal oblique hernia External oblique hernia Direct hernia
An hernia palpable at the superficial inguinal ring: is this an indirect inguinal hernia?	Yes No Impossible to tell
Which is the position of the deep inguinal ring?	Above the anterior superior iliac spine Above the midpoint of the inguinal ligament Above the pubic tubercle
An hernia entering into the scrotum, it is most likely a(n):	Direct inguinal hernia Indirect inguinal hernia Femoral hernia
Which is the nerve to spare in inguinal incision	Ileo-hypogastric nerve Ileo-inguinal nerve Femoral nerve
In which technique prosthesis must be used	Tension-free Non-tension-free Both

3. Results

After the first interim analysis of the first block (22 medical students), in the control group the total number of mistakes was 17 (12%) against 1 (0.7%) in the experimental one ($p=0.0075$). Students who had committed at least one mistake were 8 in the control group (73%) and 1 (9%) in the experimental group ($p=0.035$) with a mean of errors of 1.5 (SD 1.5, range=0-5) and 0,09 (SD 0.3, range=0-1) respectively ($p=0.005$). All students belonging to the experimental group succeeded in building the three dimensional model appropriately under teacher supervision in less than 15 minutes. Being already statistically significant the results after the first interim analysis the trial was considered concluded.

4. Discussion

The traditional model of surgical apprenticeship hinges upon "learning by doing". Over the course of many years, a trainee surgeon encounters a wide range of clinical conditions, gradually building up the necessary skills for independent practice by fusing together factual knowledge, clinical judgment and operative skill. Of course, surgical skills are not only needed by specialist surgeons, because less complex skills are required by a wide variety of students and health care practitioners. But human anatomy and surgical procedures are surely, in a lot of circumstances, very difficult to comprehend, explain and perform because of their complexity. The only way to teach and learn about them is represented by simulator-models on which it is possible to practice. The human model would be the best, but it could present moral problems and even dead bodies, in a lot of cases, are difficult to trace and even they could present problems of legal and economic nature.

So exists the necessity to build experimental and computer simulator-models. The most used devices are model-based [9], computer-based [10, 11], hybrid or integrated simulation procedures [12]. Key advantages of using simulation in teaching anatomy and surgery include the following: the training agenda can be determined by the needs of the learner, not of the patient; learners can focus on whole procedures or specific components, practicing these as often as necessary; moreover learners have "permission to fail" and to learn from such failure in a way that would be unthinkable in a clinical setting; simulators can provide objective evidence of performance, using their inbuilt taking functions to map a learner's trajectory in detail; lastly the capacity of simulators to provide immediate feedback in digital form offers potential for collaborative as well as individual learning [13-15]. The main disadvantages of some simulators are their cost. Even regarding inguinal canal anatomy and hernioplasty procedures 'model-based simulator' can be useful [8]. We developed a three-dimensional low-cost simulator in order to teach to medical students and surgical residents the anatomy of the inguinal canal and the basic

anatomical details useful to perform hernioplasties. Our model has shown to be effective in reaching this aim at a very low-cost.

This teaching model for inguinal canal anatomy is effective, inexpensive, simple to set up and easily understood by medical students. However further studies are needed to evaluate the applicability of the teachings into the clinic/surgical activity.

Acknowledgments

The only source of funding was the Department of Surgery, University of Bologna, Italy. No benefits in any form have been received or will be received from any commercial party related directly or indirectly to the subject of this article.

Conflict of Interest

No conflict of interest that might bias the outcomes of ours has to be declared.

REFERENCES

- [1] Thorlakson RH. (1966) Surgical anatomy of the inguinal region. *Manit Med Rev* 46:589-592.
- [2] Skandalakis JE, Gray SW, Skandalakis LJ et al. (1989) Surgical anatomy of the inguinal area. *World J Surg* 13:490-498.
- [3] Skandalakis JE, Colborn GL, Androulakis JA et al. (1993) Embryologic and anatomic basis of inguinal herniorrhaphy. *Surg Clin North Am* 73:799-836.
- [4] Stoppa R, Van Hee R. (1998) Surgical anatomy of the groin region. *Acta Chir Belg* 98:124-126.
- [5] Fagan SP, Awad SS. (2004) Abdominal wall anatomy: the key to a successful inguinal hernia repair. *Am J Surg* 188(6A Suppl):3S-8S.
- [6] Perrott CA (2004). Inguinal hernias: room for a better understanding. *Am J Emerg Med* 22:48-50.
- [7] Ahluwalia HS, Burger JP, Quinn TH. (2004) Anatomy of the Anterior Abdominal Wall. *Operative Techniques in General Surgery*, 6:147-155.
- [8] Mann BD, Seidman A, Haley T et al. (1997) Teaching three-dimensional surgical concepts of inguinal hernia in a time-effective manner using a two-dimensional paper cut. *Am J Surg* 173:542-545.
- [9] Dent J. (2001) Current trends and future implications in the developing role of clinical skills centers. *Med teacher* 23: 483-489.
- [10] National Center for Simulation. <http://www.simulationinformation.com> (accessed March

- 2008).
- [11] Institute for Simulation and Training. <http://www.ist.ucf.edu/> (accessed March 2008).
- [12] Gaba DM, Howard SK, Flanagan SK et al. (1998) Assessment of clinical performance during simulated crises using both technical and behavioral ratings. *Anesthesiology* 89:8-18.
- [13] Woodrum DT, Andreatta PB, Yellamanchilli RK et al. (2006) Construct validity of the LapSim laparoscopic surgical simulator. *Am J Surg* 191:28-32.
- [14] Hutton IA, Kenealy H, Wong C. (2008) Using simulation models to teach junior doctors how to insert chest tubes: a brief and effective teaching module. *Internal Med J* Feb 14 [Epub ahead of print].
- [15] Kirby TO, Numnum TM, Kilgore LC et al. (2008) A prospective evaluation of a simulator-based laparoscopic training program for gynecology residents. *J Am Coll Surg* 206:343-348.