

Chest tube simulation: experience report and brief review

Simulação de drenagem torácica: relato de experiência e breve revisão

Simulación de tubo torácico: informe de experiencia y breve revisión

Received: 07/07/2022 | Reviewed: 07/18/2022 | Accept: 07/19/2022 | Published: 07/26/2022

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Abstract

Chest tube insertion is one of the most performed surgical procedures in medical practice, being performed in Brazil by both general practitioners and experienced surgeons. This study aimed to report an experience with the application of an animal model to simulate chest drainage, as well as review the scientific literature available on the subject. In our experience, pork rib pieces were used to simulate the human rib cage, where medical students trained the procedure with the help of a thoracic surgeon. The porcine model used proved to be satisfactory, allowing the study of anatomical correlations and surgical technique among the students. In our review, we found 5 other experiences reported, 3 in a synthetic anatomical model, 1 in a porcine model and 1 comparative study between a synthetic model and a cadaver model. All models proved to be efficient for training students, but they present differences in terms of cost and durability, with the synthetic model being the most cost-effective alternative.

Keywords: Chest tube; Simulation; Medical education, Surgery; Emergency medicine.

Resumo

Drenagem torácica é um dos procedimentos cirúrgicos mais realizados na prática médica, sendo realizado no Brasil tanto por médicos generalistas quanto por cirurgiões experientes. Esse estudo objetivou relatar uma experiência com a aplicação de um modelo animal de simulação de drenagem torácica, assim como revisar a literatura científica disponível sobre o tema. Em nossa experiência, foram utilizadas peças de costela de porco para simular a caixa torácica humana, onde estudantes de Medicina treinaram o procedimento com auxílio de um cirurgião torácico. O

modelo porcino utilizado se provou satisfatório, permitindo estudo das correlações anatômicas e da técnica cirúrgica entre os estudantes. Em nossa revisão, encontramos outras 5 experiências relatadas, sendo 3 em modelo anatômico sintético, 1 em modelo porcino e 1 estudo comparativo entre modelo sintético e modelo em cadáver. Todos os modelos se mostraram eficientes para treinamento de estudantes, porém apresentam diferenças em relação a custo e durabilidade, sendo o modelo sintético a alternativa de maior custo-benefício.

Palavras-chave: Drenagem torácica; Simulação; Educação médica, Cirurgia; Medicina de emergência.

Resumen

El drenaje torácico es uno de los procedimientos quirúrgicos más realizados en la práctica médica, siendo realizado en Brasil tanto por médicos generales como por cirujanos experimentados. Este estudio tuvo como objetivo relatar una experiencia con la aplicación de un modelo animal para simular drenaje torácico, así como revisar la literatura científica disponible sobre el tema. En nuestra experiencia, se utilizaron piezas de costillas de cerdo para simular la caja torácica humana, donde los estudiantes de medicina entrenaron el procedimiento con la ayuda de un cirujano torácico. El modelo porcino utilizado demostró ser satisfactorio, permitiendo el estudio de correlaciones anatómicas y técnica quirúrgica entre los estudiantes. En nuestra revisión encontramos otras 5 experiencias reportadas, 3 en un modelo anatómico sintético, 1 en un modelo porcino y 1 estudio comparativo entre un modelo sintético y un modelo de cadáver. Todos los modelos demostraron ser eficientes para capacitar a los estudiantes, pero presentan diferencias en cuanto a costo y durabilidad, siendo el modelo sintético la alternativa más rentable.

Palabras clave: Drenaje torácico; Simulación; Educación médica, Cirugía; Medicina de emergencia.

1. Introduction

Chest tube insertion is one of the most commonly performed surgical procedures in medical practice, being performed at the bedside, in the operating room or in the emergency room. (Filosso et al, 2016) Its extensive use was only consolidated in 1917, but evidence suggests that the procedure was carried out by Hippocrates, in Ancient Greece, for the treatment of empyemas. (Venuta et al, 2017)

The drain is responsible for evacuating air, blood and fluids retained in the pleural cavity, improving lung re-expansion and respiratory function. As a result, it is indicated in cases of pneumothorax, hemothorax, pleural effusion, chylothorax and in the postoperative period of surgeries that access the chest. (de Azambuja et al, 2021)

However, with inadequate technique, chest tube insertion can generate serious complications, such as perforation of the right or left ventricle, main pulmonary artery or esophagus. (Gilbert et al, 1993, Anderson et al, 2021) In Brazil, despite being performed by specialists in many cases, a large part of the procedures are performed by general practitioners in emergency rooms. (Cipriano & Dessote, 2011)

Studies show that learning based on passive techniques, such as lectures and written tests, are not efficient in retaining knowledge and applicability of it. (Flato et al, 2011, and Khan et al, 2011) In this sense, the use of simulations becomes an effective and safe alternative to medical training. (Gaba et al, 2004) Therefore, the present study aims to report an experience with the use of an animal model for chest drainage training, as well as to review the literature on the subject.

2. Methodology

This is an experience report associated with a narrative review of the literature, conducted from searches in the Pubmed and Scielo databases. For this, we followed the recommendation of Gasparyan et al, 2011, in the elaboration of the literature review. Searches were performed according to the following descriptors: “Chest tube”, “Simulation” and “Medical education”. Full articles published in English, Portuguese and Spanish dealing with simulation models of chest drainage for educational purposes were included in the study.

3. Experience Report

In June 2022, a training in surgical skills was held at the University of Pernambuco, in Recife, by members of the

Academic League of Pulmonology and Thoracic Surgery of the same institution. At that meeting, the focus was on suturing and chest tube insertion training in a porcine model, object of study of this article.

For this, pieces of pork ribs and chest tube kits were ordered, the list of materials can be found in Table 1. The training took place in two stages: the first, theoretical, where a Thoracic Surgeon coordinated a discussion about the technique, indications and complications of the procedure, in the second stage, each student performed the procedure in the porcine model with the help of the same surgeon. Figure 1 shows the pork rib piece before and after the procedure.

Table 1. Materials used in the simulation.

| |
|----------------------|
| Flexible chest tube |
| Sterile gloves |
| Scalpel handle |
| Scalpel blade n. 10 |
| Curved Kelly clamps |
| Metzenbauer scissors |
| Nylon 3.0 thread |
| Pork rib piece |

Source: Authors (2022).

Figura 1. On the left, two pieces of pork ribs before the simulation was performed. On the right, a part after simulation.



Source: Authors (2022).

4. Results and Discussion

Mastering the chest tube involves multiple skills, such as handling sterile fields, knowledge of the different types of tube and instruments used, knowledge of the different techniques for inserting the tube, tube management and post-procedure monitoring. (Carluci et al, 2019, Venuta et al, ,2017) In this sense, poor or inadequate training can lengthen the technique's learning curve.

A major difficulty in teaching the technique is the lack of practice during medical school. Barr et al, 2016, applied a questionnaire about surgical experiences in 644 4th year medical students, where 89% had never performed a chest tube. This

deficit is observed in newly admitted residents, who need to master the technique later. Kuper et al, 2019, simulated the procedure with 49 resident physicians from different specialties. Of this sample, 30% of residents positioned the tube outside the pleural cavity, with no significant differences between residents of surgical and non-surgical areas.

In another study, Ball et al, 2007, analyzed 61 chest tube insertions performed by residents in a trauma service, where a 22.4% rate of complications per procedure was observed. In contrast to Kuper et al, residents of surgical areas had a lower probability of complications compared to others (hazard ratio 0.4, 95% confidence interval [CI] 0.16–0.96). In this way, the insertion of simulations in the medical school is a safe and effective alternative for training the technique.

Table 2 summarizes the experiences gained through our review. 2 different types of chest drainage simulation were reported, synthetic anatomical model and ex vivo model, being porcine or cadaver

Table 2. List of included studies.

| Study | Description |
|---------------------------|-----------------------------------------------------------------------------------------------------|
| Betega <i>et al.</i> 2019 | Experimental, randomized and controlled study using a 3D printing model for chest drainage training |
| Tatli <i>et al.</i> 2017 | Study using a dummy for chest drainage training |
| Yong <i>et al.</i> 2019 | Study using a low-cost anatomical model for chest drainage training |
| Tube <i>et al.</i> 2016 | Study using an ex vivo porcine model for chest drainage training |
| Tan <i>et al.</i> 2018 | Comparative study in anatomical model and cadaver model for chest drainage training |

Source: Authors (2022).

As in our experience, Tube et al, 2016, an ex vivo porcine model was used for chest drainage training, obtaining satisfactory results when analyzing the acceptance of the model, the study of anatomical correlations, and skills acquired by the participants. Pigs share some morphological characteristics with humans that make them an efficient animal model for surgical training. (Lada et al, 2020) In thoracic surgery, the use of live pigs for training in videothoroscopic surgery has already been reported (Tedde et al, 2015).

Another organic model alternative is cadaver training. Tan et al, 2018, compared this simulation model with a synthetic model through application by 16 residents of General Surgery and Emergency Medicine. In this study, both groups showed satisfactory results in terms of the residents' learning and confidence, with no differences between the models. However, this model has a low cost-benefit ratio, due to the material that is difficult to access and the low durability because it is organic material.

Of the models present in this study, the synthetic one has the best cost benefit, having high durability and produced specifically for didactic purposes. Tatli et al, 2017, and Yong et al, 2019, developed low-cost models for training medical students and residents, obtaining satisfactory results in the effectiveness of training and increased student comfort with the technique. Another synthetic model reported is the model developed through 3D printing, with technology and anatomical correlations superior to the others. However, due to the need for higher technology material, its cost-benefit is lower. (Betega et al, 2019)

The prospects for the future of simulations in medical education, however, are in the expanded reality. Recent studies have reported positive experiences with the use of this technology in Medicine, whether for educational purposes, with the use of virtual training models, or for operational purposes, with its application in preoperative planning. This model, despite initially having a high added technology, has the potential to revolutionize the teaching of surgical procedures. (Izard et al, 2018)

5. Final Considerations

The present experience proved to be satisfactory in teaching and training the technique of chest drainage by medical students, however, as it is an animal model, its low durability makes its cost-effectiveness low. The use of simulations in medical education guarantees greater safety for the student and allows for a reduction in the learning curve, making it a necessity, especially in Brazil, where most of these procedures are performed by general practitioners without training in General Surgery or Medicine. Emergency. Therefore, it is necessary to invest in new research projects in order to develop new synthetic models with greater cost-benefit, adding to the country's medical education.

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