

A porcine model for teaching surgical cricothyroidotomy

Modelo porcino no ensino da cricotiroidotomia cirúrgica

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A B S T R A C T

Objective: To evaluate the acceptability of an educational project using A porcine model of airway for teaching surgical cricothyroidotomy to medical students and medical residents at a university hospital in southern Brazil. **Methods:** we developed a teaching project using a porcine model for training in surgical cricothyroidotomy. Medical students and residents received lectures about this surgical technique and then held practical training with the model. After the procedure, all participants filled out a form about the importance of training in airway handling and the model used. **Results:** There were 63 participants. The overall quality of the porcine model was estimated at 8.8, while the anatomical correlation between the model and the human anatomy received a mean score of 8.5. The model was unanimously approved and considered useful in teaching the procedure. **Conclusion:** the training of surgical cricothyroidotomy with a porcine model showed good acceptance among medical students and residents of this institution.

Key words: Airway. Cricoid cartilage / surgery. Thyroid cartilage / surgery. Teaching / education.

INTRODUCTION

Medical skills training, particularly in early phases, are increasingly based on simulation¹. Simulation is an interactive and immersive method of teaching, recreating in whole or in part a clinical experience, without exposing patients to associated risks^{1, 2}. Simulation modalities may vary according to the type of technology used. Among the low technology simulators, there are the models based on animals and on human or animal cadavers³.

Airway management is key in emergency situations⁴. Patients requiring a surgical airway may represent 1% of procedures for obtaining a definitive airway in urgency settings. However, since this method is used when the other techniques are unsuccessful, failure in obtaining a surgical airway commonly will lead to death due to hypoxemia⁵. Among the surgical airways techniques, cricothyrotomy is preferred over tracheotomy in emergency situations due its simplicity and rapid execution⁴.

This article presents and analyzes the acceptability of a teaching project using an airway porcine model for surgical cricothyrotomy to medical students and residents in a university hospital in the south of Brazil.

METHODS

Since June 2013, in Universidade Estadual do Oeste do Paraná started a teaching project using porcine

models in resuscitation procedures training for residents and last-year medical students. As part of this teaching project, trainees filled a feedback questionnaire about the used model. We analyzed the questionnaires used to assess the airways the porcine arway model filled by the participants from the start of the project until August 2014. Project approval: CR 40119/2013.

This teaching project comprised three steps: a) trainees attended a class about cervical anatomy and the surgical cricothyrotomy, according to the Advanced Trauma Life Support® (ATLS) principles; b) they performed the surgical cricothyrotomy in the porcine model, supervised by an ATLS instructor; c) they filled out an assessment questionnaire about the model (optional).

We obtained segments of porcine airways by donation from animals used for human consumption, according to regulatory sanitary rules.

We used a porcine arway segment from above the thyroid cartilage to about 10cm below the cricoid cartilage and a segment of pig skin (Figure 1). A plastic bag was adapted to the trachea end and the specimen was placed over a rigid wood surface (Figure 2). The specimen was covered with a segment of pork skin. In the internal segment of the pork skin, a rubber glove was attached and tensioned (Figure 3), to simulate a "new" cricothyroid membrane after the first procedure. The pork skin was then fixed to the rigid surface, allowing the airway segment to be moved below the skin in order to use the same model for several trainees (average of 10 trainees /

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model – Figure 4). A surgical cloth was placed over the plastic bag to simulate the chest movement seen during the bag ventilation. The step by step construction of the model and its operation can be observed on the site (<http://youtu.be/18fDbost0O8>).

The questionnaire used inquired about epidemiological aspects, previous training in airway management and adequacy of the used model for training medical student and residents. Some of the answers from the questionnaire were not object of this study, but used to improve graduation teaching opportunities.

Specifically, we requested assessments about the general quality of the model (robustness, ease in handling, similarity with biological tissues) and anatomic correlation (similarity with human anatomy). Both varied from 0 to 10.

The questionnaire was elaborated by the senior author and was not previously validated. The questionnaire data was grouped and presented in absolute numbers and percentages.

During the development phase, three independent senior surgeons with experience in this procedure tested this model. They unanimously approved it as an educational tool and gave the average score of 8.7 to its general quality and 7.6 to the anatomical correlation.

The teaching group was composed by: a) medical students from emergency room internship (last year of our medical school); b) medical residents (first and second year) from general surgery and internal medicine who requested this training.

RESULTS

This project had 63 participants, 54 medical students and nine medical residents. There was no refusal in participate in the training or in filling the questionnaire. The average age was 26 ± 3.1 years old (22-39). Thirty-two were males, 29 females and two did not disclose this information. Among the tested trainees, 60 (95.2%) informed no previous training in the procedure.

All participants considered the proposed model as an important tool in teaching surgical cricothyrotomy to medical students. The average overall model quality was 8.8 (scores varied from 6-10). The anatomical correlation of the model was scored in average as 8.5 (scores varied from 6-10). All trainees evaluated approved the use of this model as a teaching adjunct for medical graduation.

DISCUSSION

Since cricothyrotomy is relatively infrequently required and the patients who need the procedure are usually in physiologic extremes, the development of experimental animals models for professional training are important to provide medical training^{6,7}. Using animal



Figure 1 - Porcine airway and skin specimens.



Figure 2 - Porcine airway on a rigid board with a plastic bag ("lung") adapted to its end.



Figure 3 - Porcine skin with glove fixed in the inner side. The glove simulates the cricothyroid membrane after the first procedure.



Figure 4 - Airway model ready to practice. The surgical cloth covers the "chest" and rises in each ventilation.

models in airway procedures training is frequent, since biological tissues have higher similarity with human ones, when compared with synthetic materials^{8,9}. Also, animal models using porcine airways have low cost and are frequently easy to obtain¹⁰.

Porcine models can present economical advantage when compared with mannequins¹⁰. In the current study, the porcine airway specimens were obtained as donation from trainees after these animals were abated for human consumption. Medical teaching based in passive techniques and knowledge acquisition verification based in written exams are not enough to assure competence, quality and safety when handling emergency situations¹¹. Most of incidents and serious adverse events that happen in hospitals are related to human factors^{12,13}. These figures are likely higher in emergency cases^{12,13,14}. Simulation tries to reduce these undesired outcomes, providing education based on active learning in low-risk environment, improving knowledge, the technique, and non-technical skills¹¹. Urgent surgical airway access is required when another technique is not feasible or failed⁴, and frequently is performed by emergency physicians¹⁵. Performing this procedure can be difficult in the absence of adequate training¹⁰. Some suggest minimal training of 5 attempts or performing this procedure in 40 seconds in mannequins⁹.

There are several teaching models used in airways management^{8,15}. Traditionally, cricothyrotomy teaching is performed in mannequins and animals due to ethical and economical reasons^{8,16}. Among the animal models, the use

of porcine airways is well-established¹⁷⁻¹⁹. Porcine airways and skin are relatively similar to human tissues^{8,18}. In a previous randomized study, the similarity of porcine models with human tissues and anatomy was considered greater than the one of mannequins¹⁰.

Medical training in airways management was uniformly considered important by trainees. This study presented an experimental airway porcine model based on low technology and cost for teaching surgical cricothyrotomy in medical graduation. The used model was approved for medical training among all study participants. The model used in this study was tested by three independent seasoned physicians, who corroborated the high correlation with human anatomy. Trainees also graded the model similarity with human anatomy to be medium to high. Other studies have shown similar results²⁰. Each porcine airway model allowed 10 trainees in average to practice per specimen, due to the practice of sliding the model under the skin and glove. Alive models or cadavers do not allow repetition^{6,8}. This possibility adds practicality and economical advantage to the model.

The model used was developed at our institution, using local conditions. However, there are other described porcine airway models¹⁷⁻¹⁹. Also, it does not recreate all anatomical characteristics present in real situations, such as protuberant jaw, cervical immobilization, hematomas, urgency, obesity, etc. However, performing this procedure in a real situation without previous training or simulation may incur in ethical inadequacy, and may increase failure rates.

There are few physicians seasoned in surgical cricothyrotomy in the region. In consequence, only three tested the model. Nevertheless, other studies used similar animal models for training^{10,18,19,20}. The trainees opinion about anatomical correlation may not be as accurate, since they have relatively low knowledge of the anatomy and low experience in airway management. Also, trainees may tend to give higher scores to the models to please their teachers, even though they anonymously filled the questionnaires. Thus, due to such limitations, the presented model needs additional assessment and validation with specific methodology and/or by other institutions.

The proposed porcine airway model had good acceptability for surgical cricothyrotomy. Considering the low cost and easy preparation, it presents good potential for training medical professionals in developing countries. Further studies are necessary to validate this model as a teaching tool.

R E S U M O

Objetivo: avaliar a aceitabilidade de um projeto de ensino utilizando modelo porcino de vias aéreas no ensino da cricotirodostomia cirúrgica para estudantes de Medicina e médicos residentes em um hospital universitário no sul do Brasil. **Métodos:** foi desenvolvido um projeto de ensino usando modelo porcino para treinamento em cricotirodostomia cirúrgica. Estudantes de Medicina e residentes receberam aula teórica sobre esta técnica cirúrgica e, em seguida, realizaram no modelo o treinamento prático. Após o procedimento, todos os participantes preencheram um formulário acerca da importância do treinamento em manuseio de vias aéreas e do modelo utilizado. **Resultados:** houve 63 participantes. A qualidade geral do modelo porcino foi estimada em 8,8, enquanto a correlação anatômica entre o modelo e a anatomia humana recebeu o escore médio de 8,5 entre os treinandos. O modelo foi unanimemente aprovado e considerado útil no ensino do procedimento. **Conclusão:** o treinamento de cricotirodostomia cirúrgica em modelo porcino apresentou boa aceitação entre os estudantes de Medicina e os residentes desta Instituição.

Descritores: Manuseio das Vias Aéreas. Cartilagem Cricoide/cirurgia. Cartilagem Tireoidea/cirurgia. Ensino/educação.

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