Development of a Low-Cost Simulator for Training in Hemorrhoidal Ligation

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Abstract

Introduction Rubber band ligation is a minimally invasive outpatient hemorrhoid treatment with low cost, low complication rates, and rapid realization. It is performed with the aid of an anoscope and uses a rubber ring that surrounds the hemorrhoidal nipple, causing compression of the vascular structures of the tissue, leading to necrosis and remission of the hemorrhoid. No device for training this essential procedure for treating this pathology has been identified in the literature. Therefore, we aim to develop a low-cost simulator for training hemorrhoidal rubber ligation.

Methods The model was constructed using PVC pipe wrapped in neoprene fabric. Hemorrhoidal nipples and the pectineal line were also simulated using fabric and sewing threads. The procedure is performed with conventional anoscope and ligature forceps.

Conclusion The device in question is a low-cost simulation model designed to train the skills required to perform a rubber band ligation and review the basic anatomy of the anal canal during anoscopy. Given these qualities, the model can be used for academic training due to its low cost and simplicity of application.

Keywords
- medical education
- simulation
- low-cost technology
- rubber band ligation
- hemorrhoids

Introduction

Rubber band ligation is a minimally invasive method for treating grade I or II internal hemorrhoidal diseases and for selected grade III cases.[1,2] First described in 1954, it consists of wrapping hemorrhoids with a rubber ring and stands out for its ease of technical execution, low cost, the possibility of being performed on an outpatient basis, and may dispense with anesthetics.[3,4] However, as with any procedure, there are complications. The most common include pain, rectorrhagia, vagal symptoms, anal fissure, anal fistula, and perianal abscess. Pain is the most frequent, although usually of low intensity.[2]

Given these advantages, training to perform rubber band ligation is essential due to the high incidence of hemorrhoidal disease in outpatient coloproctology centers and the risk of complications.[3] However, obtaining industrialized simulators requires a high cost, making their acquisition often unviable for many educational institutions, especially those with low economic investment.[5,6]

Therefore, the development of low-cost models has emerged as an advantageous alternative, enabling and

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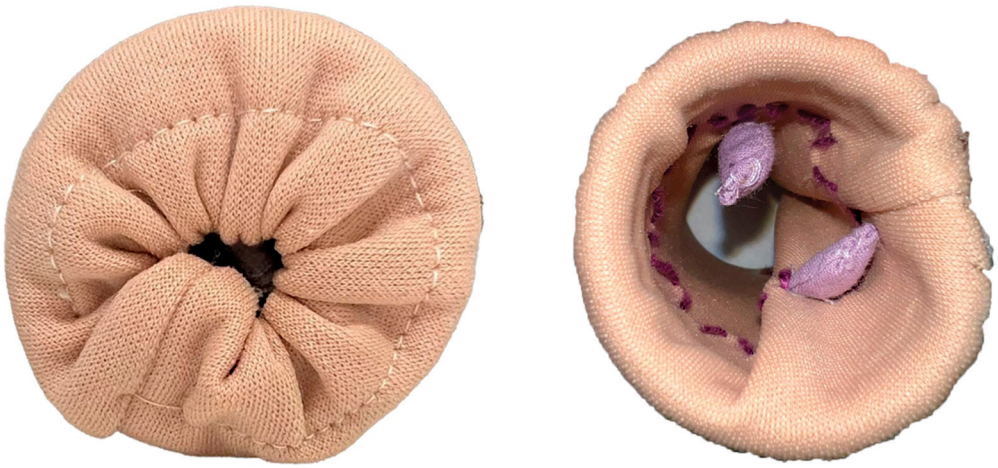

Fig. 1 Rubber band model. On the left, the complete model is ready for use. On the right, the model without the final tissue cover, for demonstration of the anatomy overview.

expanding the use of this resource by the academic community by making simulation models more accessible.[5–7]

Given this panorama, we aimed to describe the assembly of a low-cost simulator for training hemorrhoidal rubber band ligation.

Presentation of Device

A low-cost model was developed with the following materials: PVC pipe (10 cm long and 3.5 cm in diameter), fabric (neoprene), cotton thread for sewing, and sewing rubber band, having a total cost of approximately R$10 reais/model.

The PVC pipe was coated and glued with neoprene. This fabric was previously sewn 2 cm from the beginning with purple cotton thread to simulate the pectineal line. Fusiform structures were created in purple fabric, simulating hemorrhoidal nipples positioned before and after the pectineal line. To finish, an extra coating for the barrel is made with neoprene, and a rubber band embedded in its distal end.

After this last step, the model is ready for use, and the rubber band can be adjusted according to the need and use of the model. (►**Figs. 1** and **2**)

Discussion

The first simulation was described in the 18th century by Georg Heinrich, who described a model called the "Phantom" for training and teaching obstetric maneuvers. In the same period, Giovanni Antonio Galli, a surgeon, developed a glass uterus with a fetus model to train midwives and surgeons for childbirth.[5–7]

Since these milestones, the use of simulators has grown over the years. This trend is due to the need to achieve a high technical level in performing these procedures while avoiding potential iatrogenic events during supervised in vivo procedures and ethical issues that permeate animal training.[7–9]

New simulation techniques are being developed that use 3D printers and virtual reality devices to increase the fidelity

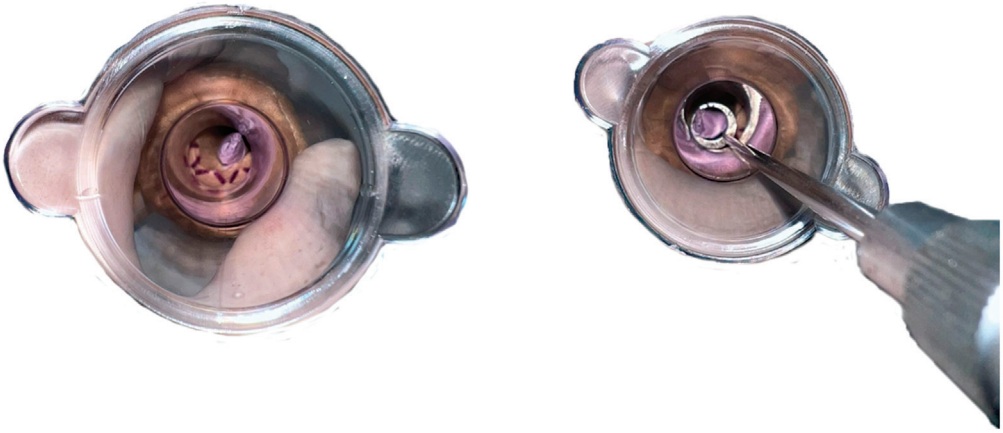

Fig. 2 Performing hemorrhoidal rubber band ligation on the low-cost model.

of surgical models. With this, their financial cost increases, making their acquisition and consequent application more difficult. In contrast, low-cost simulators tend to have less realistic fidelity but are educational tools that stimulate and develop skills, technical knowledge, and professional safety concerning a given procedure. It is crucial to emphasize that this tool facilitates learning and training for students and is affordable due to its low cost, bringing medical practice closer to reality. Therefore, medical education institutions must encourage and promote its use.[10–13]

Furthermore, simulation goes beyond the individual improvement of the person performing the procedure, as the safe environment provided allows for the training of the entire multidisciplinary team involved. This creates a work routine that aims to make healthcare delivery safer and more efficient, resulting in an ideal working environment to achieve the highest quality standards in healthcare.[14,15]

Considering the benefits mentioned above, an innovative and accessible simulator for training hemorrhoidal ligation was developed to expand access to the practice of this technique. It is noteworthy that, through this simulator, it is possible to train not only the rubber band ligation but also the performance of anoscopy and the review of anatomical and pathological aspects, such as the pectineal line and internal and external hemorrhoids. This set of skills improved on the simulator contributes to the more complete and comprehensive training of medical professionals.

Conflict of Interest
None.

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