Construction of a Low Cost Homemade Laparoscopic Simulator for Use in a Caribbean Setting
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ABSTRACT

Introduction: To the modern surgeon in training, the acquisition of laparoscopic skills is essential. Laparoscopic simulators are effective but in the often resource poor setting of the Caribbean, the cost of these simulators is often prohibitive. We describe the construction of a simulator which is cheap, easy to assemble and effective. It is also relatively easy to mass produce for use in training programs across the region.

Materials and methods: The simulator is constructed using a semi-transparent plastic box. Realistic access ports are fashioned using gel type shoe inserts and excellent vision is achieved by mounting a high definition camera on the inside of the box. As the box readily transmits light, a light source is not a necessity. The total cost of this unit is US$48 and construction time is approximately 30 minutes.

Results: This trainer was easy to construct and offered a realistic laparoscopic experience. We believe construction is easily reproducible.

Conclusion: This simulator is effective and is easy to construct. It may have applications in surgical training programs within the Caribbean region and beyond.

Keywords: Homemade laparoscopic simulator, surgical training, Trinidad and Tobago

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INTRODUCTION

The acquisition of laparoscopic skills is now considered an essential part of surgical training. Gaining proficiency requires significant practice and simulators are currently considered standard part of surgical training. In the Caribbean we face significant challenges in the procurement of laparoscopic simulators, particularly as it relates to cost. We describe the construction of a cheap, easy to assemble and effective simulator which we hope to eventually reproduce in different surgical training units across the region.

Materials

All materials required to construct this box are easily available locally. Required items include a semi-opaque box (we utilized a Sterilite 32Q Clearview ® box with dimensions of 60cm × 41.6cm × 16.5cm), one pair of gel type heel cushions/shoe inserts (our chosen brand was Dr Scholl’s®) and a high definition webcam with USB cable (fig. 1).

Because the box is “clear” it readily allows the penetration of light and may be used as is in a well lit room. One may however add a light source. For this one will require a light socket (the variety which has a built in plug), a drop cord and a 20 watt energy saving light bulb which emits white light.

For the construction of this box one will require an electric drill with a step bit, glue (eg. Krazyglue®), a pair of scissors, as well as a ruler and marking pen.

Construction

Construction time 30 minutes
1) Mark out the location of the instrument ports on the lid of the box (fig. 2); the port should measure about 2.5cm in diameter. A smaller port will also be required for the passage of the USB cable and this may be drilled on the right or left side of the box. If a light source is being added, then another port will be required at the opposite end of the box or along one of the sides; in our case we have chosen the latter (fig. 3).

2) Cut circular pads from the shoe inserts to use as a covering for the instrument ports (fig. 2). This gives the user a very realistic feel, not dissimilar to commercial ports. Use glue to secure these pads in place, covering the ports. Make small cruciate incisions in the centre of the ports to facilitate passage of the instruments or a trocar.

3) Using glue, secure the webcam on the inside of the box as shown. The USB cable is brought out via the previously described port. For a sturdier placement, screws may be used to secure the webcam to the inside of the box.

4) If a light source is required, one may secure a light socket into the port described earlier. Configure the socket and the drop cord as shown in figure 3. Complete the light source with the insertion of a light bulb (care should be taken to ensure that the bulb does not abut the lid or make contact with the side of the box as heat generated may damage the box). If a light bulb is used one or two ventilation holes should be drilled in the lid above the bulb to allow for dissipation of heat.

5) The box is ready to be used and a laptop computer is then connected (fig. 4). A variety of endoscopic toys may be placed in the box depending on the nature of the training exercise and proficiency of the user. These need not be expensive and may even include ex vivo animal tissue as the plastic nature of the box lends itself to easy cleaning.
6) The approximate cost in United States (US) dollars is $48. The cost of the basic raw materials is as follows: Box - $15, webcam - $25, shoe inserts - $8. The optional light bulb, drop cord and socket add an additional $12 to the overall cost.

DISCUSSION
All surgeons in training are now required to be competent to some degree in minimally invasive surgery. Gaining proficiency in laparoscopic surgery requires a good deal of training and practice (1). It has been noted that dedicated training improves skill, even in experienced operators (2).
While commercial simulators are available, these are typically expensive (3) and most hospitals in the Caribbean are not currently equipped with laparoscopic training facilities. If a skills lab is set up, ensuring sufficient resident training requires an adequate number of trainers as well as strategic allocation of lab time. In our hospital, dozens of residents currently have shared access to two laparoscopic simulators. This, in a teaching hospital in which laparoscopic surgery is routine, is inadequate. By describing a homemade simulator, it is hoped that with construction of enough units laparoscopic training may be undertaken both in a structured supervised setting as well as on the residents’ own “down time”.

Several authors have described do-it-yourself laparoscopic simulators. Chung described a cardboard trainer also utilizing a webcam (4). Beatty also reported on a home-made simulator, the clear box in this author’s description ensured that a light source or lamp was not needed once the room was adequately lit (5). Similarly, Moreiro-Pinto and colleagues described a simulator built, like ours, of a plastic box. This simulator also had no light source as the authors felt it added expense. In addition, the ports were created via a large rubber sheath covering the top (lid) of the box (3). Not only is this more difficult to configure, but compared to the shoe inserts which we utilize as ports, a suitably sized rubber sheet is more difficult to procure. Our choice of material also supplies a very realistic feel and to the best of our knowledge, it is the first time that this material has been utilized for such an application. These gel pads are also very easily replaced in the event of wear and tear. Two 5mm trocars may be placed through the gel ports which may minimize damage to the port. We feel that while the construction of similar trainers has been described in the past, our model adds to the existing literature in that it provides an additional design option using materials which are easily procured, more so in Caribbean territories. Additionally, the final product is durable with excellent tactile feedback.
Effective endoscopic exercises need not be expensive, and a number of cheap endoscopic toys may be devised – for example, one simple exercise involves removing a candy from its wrapper. Ex vivo animal tissue, such as chicken breast, may also be utilized. A single set of instruments is required for each trainer and may, as in the authors’ case, consist simply of used laparoscopic graspers, a needle holder and scissors, all retired from the operating theatre.

We also feel that a light source may be added at very little additional cost although, as mentioned earlier, in a well lit room visualization is excellent.

With our construction, a laptop computer may be mounted onto the unit. This compares to another similarly described unit utilizing a mirror (6). We feel the performance of our current configuration is superior to this as it mimics an actual endoscopy setup. Vision may also be improved by using a better quality camera albeit at an increased cost.

It is our hope to report on the reproducibility and performance of our box in a residency training unit in the future. It is also our hope that others may improve upon our design.

**CONCLUSION**

We describe an easily built, cheap laparoscopic simulator using materials easily acquired in a Caribbean setting. It is hoped that construction of this trainer will be easily reproducible and will allow residents and even surgeons to quantitatively and qualitatively improve their laparoscopic training and skills.
REFERENCES


Constructing a Low Cost Laparoscopic Simulator

Figure 1: Basic items required for construction of the box - shoe inserts (top left), webcam (top right) and plastic box (bottom)

Figure 2: Holes for the ports are marked out (top left) and drilled (top right). The webcam has been secured and brought out (bottom left). The "gel ports" have been secured in place (bottom right).
Figure 3: Configuration of light source

Figure 4: The box is now ready for use!