ORIGINAL ARTICLE

Construction of a Low-cost Homemade Laparoscopic Simulator for Use in a Caribbean Setting

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ABSTRACT

Background: *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 programmes across the region.*
Methods: *The simulator was constructed using a semi-transparent plastic box. Realistic access ports were fashioned using gel-type shoe inserts, and excellent vision was 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 was US$48, and construction time was approximately 30 minutes.*
Results: *This simulator was successfully tested and subsequently reproduced with satisfactory function.*
Conclusion: *This simulator was effective and easy to construct. It may have applications in surgical training programmes within the Caribbean region and beyond.*

Keywords: Homemade laparoscopic simulator

Construcción de un simulador laparoscópico casero de bajo costo para uso en un contexto caribeño

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RESUMEN

Antecedentes: *El desarrollo de habilidades laparoscópicas es esencial para el cirujano moderno en su etapa de entrenamiento. Los simuladores laparoscópicos son efectivos, pero en el contexto del Caribe – frecuentemente pobre en recursos – el costo de estos simuladores es a menudo prohibitivo. Describimos la construcción de un simulador de bajo costo, eficaz, y de fácil montaje. También es relativamente fácil su producción masiva para uso en los programas de entrenamiento en toda la región.*
Métodos: *El simulador fue construido usando una caja plástica semitransparente. Puertos de acceso realistas fueron modelados usando plantillas de gel ortopédicas, y se logró una excelente visión montando un cámara de alta definición en el interior de la caja. Como la caja*

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transmite fácilmente la luz, no se necesita una fuente luminosa. El costo total de esta unidad fue de 48 USD, y el tiempo de construcción fue aproximadamente 30 minutos.

Resultados: *Este simulador fue probado con éxito y posteriormente reproducido con función satisfactoria.*

Conclusión: *El simulador fue eficaz y fácil de construir. Puede tener aplicaciones en los programas de entrenamiento quirúrgico en el Caribe y otras regiones.*

Palabras clave: Simulador laparoscópico casero

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INTRODUCTION

The acquisition of laparoscopic skills is considered an essential part of surgical training. Gaining proficiency requires significant practice, and simulators are currently considered a 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 will be reproduced eventually in different surgical training units across the region.

MATERIALS AND METHODS

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 60 cm × 41.6 cm × 16.5 cm), one pair of gel-type heel cushions/shoe inserts (our chosen brand was Dr Scholl's®) and a high-definition webcam with a USB cable (Fig. 1).

Fig. 1: Basic items required for construction of the box – shoe inserts (top left), a webcam (top right) and a plastic box (bottom).

Because the box is 'clear', it readily allows the penetration of light and may be used as is in a well-lit room. However, one may add a source of light. For this, one will require a light socket (the type 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, a ruler and a marking pen.

The construction time was 30 minutes.

- Mark out the location of the instrument ports on the lid of the box (Fig. 2). The port should measure about 2.5 cm 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 source of light is to be added, then another port will be required at the opposite end of the box or along

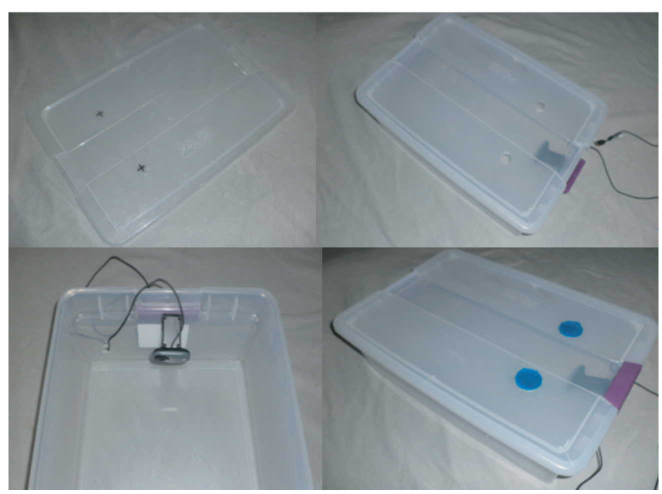

Fig. 2: Holes for the ports were marked out (top left) and drilled (top right). The webcam had been secured and brought out (bottom left). The 'gel ports' were secured in place (bottom right).

one of the sides; in our case, we chose the latter (Fig. 3).

- 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.
- 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.
- If a source of light is required, one may secure a light socket in the port described earlier. Configure the socket and the drop cord as shown in Fig. 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.
- 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.
- The approximate cost was US$48. The costs of the basic raw materials were as follows: box (US$15), webcam (US$25) and shoe inserts (US$8). The optional light bulb, drop cord and socket would add an additional US$12 to the overall cost.

RESULTS

This laparoscopic trainer was tested extensively and found to be quite adequate for laparoscopic simulation. It was subsequently modelled by several members of our team who reported satisfactory use. Additionally, it has been reproduced successfully in Barbados. We intend to reproduce this simulator for use in a formal training setting with more objective testing in the near future.

Fig. 3: Configuration of source of light.

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, they are typically expensive (3), and most hospitals in the Caribbean are not equipped with laparoscopic training facilities. If a skills laboratory is set up, ensuring sufficient resident training requires an adequate number of trainers as well as strategic allocation of laboratory time. In San Fernando General Hospital, the residents (approximately 25) currently have shared access to two laparoscopic simulators. This is inadequate in a teaching hospital in which laparoscopic surgery is routine. By describing a homemade simulator, it is hoped that with construction of enough units, laparoscopic training may

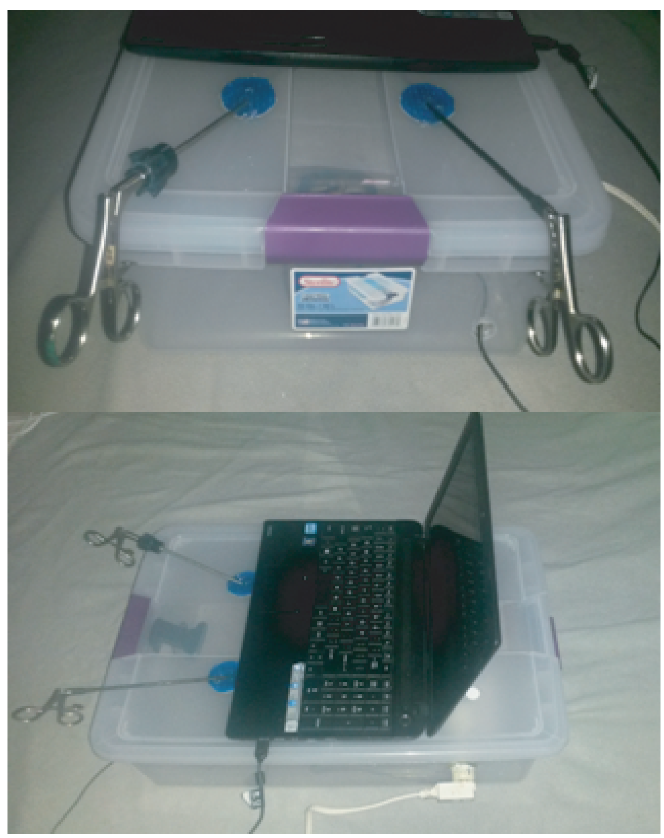

Fig. 4: The box is now ready for use.

be undertaken both in a structured supervised setting as well as on the resident's own 'down time'.

Several authors have described do-it-yourself laparoscopic simulators. Chung *et al* described a cardboard trainer also utilizing a webcam (4). Beatty also reported on a homemade simulator: the clear box in this author's description ensured that a source of light or a lamp was not needed once the room was adequately lit (5). Similarly, Moreira-Pinto *et al* described a simulator built, like ours, of a plastic box. This simulator also had no source of light as the authors felt that it would add to the 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 provided a very realistic feel and to the best of our knowledge, it was the first time that this material had been utilized for such an application. These gel pads are also very easily replaced in the event of wear-and-tear. Two 5 mm trocars may be placed through the gel ports which may minimize damage to the port. While the construction of similar trainers had been described in the past, our model added to the existing literature in that it provided an additional design option using materials which are easily procured, more so in Caribbean territories. Additionally, the final product was durable with excellent tactile feedback.

Effective endoscopic exercises need not be expensive. A number of cheap endoscopic toys may be devised, *eg* one simple exercise involves removing a sweet 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, as in the authors' case, may consist simply of used laparoscopic graspers, a needle holder and scissors, all retired from the operating theatre.

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

With our construction, a laptop computer may be mounted onto the unit. This compares to another similarly described unit utilizing a mirror (6). However, we believe that the performance of our current configuration is superior to this as it mimics an actual endoscopy set-up. 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 on our design.

CONCLUSION

We described 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 improve their laparoscopic training and skills quantitatively and qualitatively.

REFERENCES

1. Gallagher AG, Smith CD, Bowers SP, Seymour NE, Pearson A, McNatt S et al. Psychomotor skills assessment in practicing surgeons experienced in performing advanced laparoscopic procedures. J Am Coll Surg 2003; **197:** 479–88.
2. Seymour NE. VR to OR: a review of the evidence that virtual reality simulation improves operating room performance. World J Surg 2008; **32:** 182–8.
3. Moreira-Pinto J, Silva JG, Ribeiro de Castro JL, Correia-Pinto J. Five really easy steps to build a homemade low-cost simulator. Surg Innov 2013; **20:** 95–9.
4. Chung SY, Landsittel D, Chon CH, Ng CS, Fuchs GJ. Laparoscopic skills training using a webcam trainer. J Urol 2005; **173:** 180–3.
5. Beatty JD. How to build an inexpensive laparoscopic webcam-based trainer. BJU Int 2005; **96:** 679–82.
6. Robinson JK, Kushner DM. Development and validation of a home-based, mirrored, gynaecologic laparoscopy trainer. J Minim Invasive Gynecol 2006; **13:** 102–7.