

Surgical Training in Resource-Limited Settings: Cost-Effective, Portable and Reproducible Personal Laparoscopic Endotrainer

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ABSTRACT

Introduction

Minimal invasive surgery (MIS) is standard of approach for many surgical pathologies. The best way to enhance the psychomotor skills for MIS is through the disciplined and structured time with the Endotrainer. The cost and portability of available Endotrainer is the main reason for surgeons and residents allocating minimal time for training. Our goal was to create cost-effective and portable Endotrainer that enables skill development at home and classroom setting.

Methods

The framework of this Endotrainer was made-up of local plywood. The anterior surface was divided into nearly equal superior and inferior surface by horizontal plywood stick. A rectangular window was created at the anterior surface for mobile phone or tablet or iPad placement. Similarly, two 8 mm hole were drilled and padded with locally available rubber washer inferior and lateral to rectangular window as laparoscopic ports. For light commercially available mini dimmable LED was installed. The final trainer box was similar in shape and size of medium suitcase, which was portable and could house laparoscopic hand instruments and training pads.

Conclusion

The Endotrainer was easy and cost-effective to assemble. Embodying the essence of portability and reproducibility, this trainer box offers a personal practice tool that empowers trainee to sharpen their skills at their home or classroom.

Keywords

Endotrainer; laparoscopy; minimal invasive surgery

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INTRODUCTION

Minimal invasive surgery has become the standard of care for many surgical procedures. Learning curve is defined by 'the time taken and/or the number of procedures an average surgeon needs to be able to perform a procedure independently with a reasonable outcome'. Among the factors that influence the learning curve the training programme, the innate ability and discipline of the individual surgeon to learn are the main factors.¹ Thus, learning curve can be minimized by structured and dedicated practice using simulation tools like Endotrainer.²

There are few to none academic centers in Nepal that have dedicated minimal invasive training program with simulators or Endotrainers. Personal, cheap and portable Endotrainer is the solution to current scenario in MIS training program. The access to personal Endotrainer is commercially available box trainer, which are costlier and not locally available in Nepal.

This Endotrainer is cheap, made using local products, portable and most importantly reproducible.

METHODS

This Endotrainer was made using locally available and affordable materials. We divided our work into four phases.

First phase: Conceptualization and framework installation.

Since we wanted our Endotrainer to be portable,

we conceptualized the shape and size of our Endotrainer to be similar to that of medium suitcase. The graphical design including shape, size, possible future camera and port sites were done using PowerPoint for mac (version 16.53) (Figure 1).

Plywood was used as main material for framework as it was cheap and easily available. A rectangular box of dimension 38 cm * 30.5 cm * 10 cm was made. The Endotrainer consisted of two near equal halves of rectangular box connected at one end with two aluminum hinge joints and at other end with aluminum latch lock (Figure 2).

Phase 2: Ergonomic and practice floor adjustment

The adjustment for angle of visualisation and hand position during training is a major issue in laparoscopy. The angle is different for different person and varies according to the location of endotrainer and also with position of the trainee. To address the issue, we created multiangle adjustable roof of the box with the help of one cm thick and 16 cm long plywood at floor and two cm thick and 18 cm long with saw-tooth serrated slotted plywood at roof of the box. Similarly, 25 cm and 14 cm width slanted plywood was fixed at floor of the box for placement of different training modules (Figure 3).

Phase 3: Camera window and light installation

We gathered different types of smartphones and tablets from our residents. We evaluated best possible size and site for camera window compatible to most of the available smartphones and tablets. Thus, we created 8 cm long and 6 cm width window at lower mid portion of superior part of roof (Figure 4).

Thirty-five mm long and 8 mm width plywood was fixed horizontally at the lower end of the window to support phone and tablet. We fixed 6.5*6.5*2.5 cm mini dimmable LED video light at the inner surface of roof just superior to camera window (Figure 5).

Phase 4: Endotrainer port size and location allocation

We drilled multiple 8 mm holes at different places on the roof, inferior to camera window. (Figure 6)

We requested our colleagues and juniors to try practicing suturing from each created hole. Finally, the location of ports, two cm lateral to inferior angle

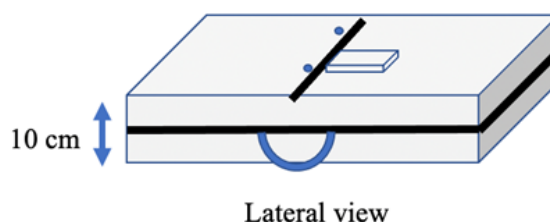
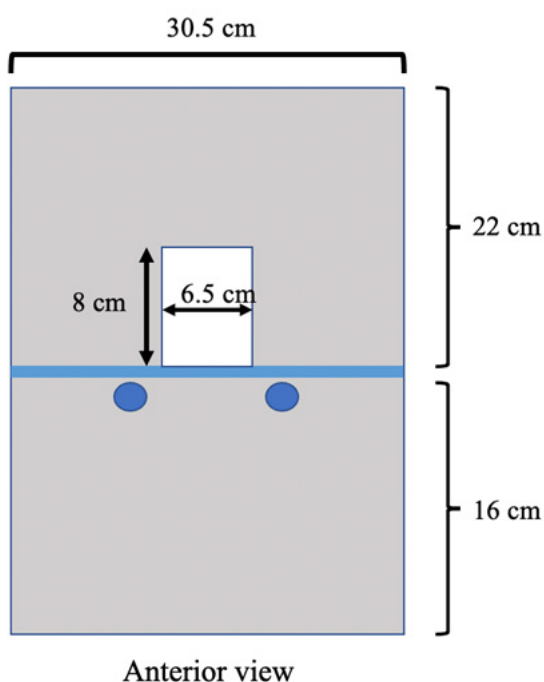


Figure 1. Graphical representation of framework of Endotrainer

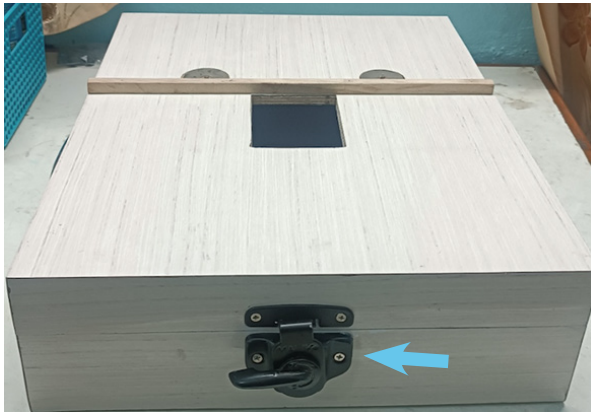


Figure 2. Two halves of box fixed at one end with Latch lock (blue arrow)



Figure 5. LED video light fixed at inner surface of roof (blue arrow head)



Figure 3. Roof and floor of Endotrainer with adjustable serrated and flat plywood (blue arrowhead) and slanted plywood at floor (purple arrow)

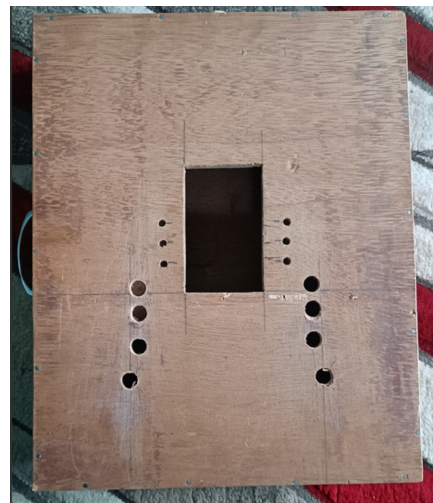


Figure 6. Multiple 8 mm holes in the anterior surface of roof.



Figure 4. Window for camera of smart phone and tablet (white arrow)

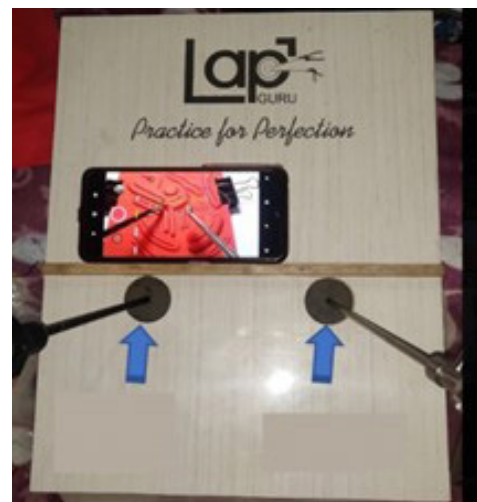


Figure 7. Front view of the Endotrainer showing washer (blue arrow)



Figure 8. Lateral view of the Endotrainer with hand instruments

of camera window was decided then created and was padded with 3.5 cm diameter rubber washer (Figure 7 and 8).

The approximate cost of the Endotrainer was US \$ 50. The cost of plywood and carpentering \$20, hinges and latch \$10, LED light \$10 and others \$10. Not only the cost but the Endotrainer is handy and portable (Figure 9).

DISCUSSION

There have been many developments in different aspects of minimal invasive surgery since its establishment in 1980s to become standard of care for many surgical pathologies.³ From first laparoscopic cholecystectomy to first laparoscopic liver transplantation, MIS has evolved from simple to more complex and advanced surgery.⁴ This giant leap in surgical approach has mandated current surgical young residents and practicing surgeons to be fully versed with both basic and advanced laparoscopic arts. The concept of learning curve in medicine and surgery was borrowed from its first use in aviation and manufacturing science.⁵ "Learning before doing" approach as a concept of learning curve has shown their significant impact on surgical outcomes in surgery including minimal invasive surgery.⁶

Focused practice and expert guidance are the main way to shorten the surgical learning curve. The knowledge of the surgical procedure can be improved by reading book, active participation and discussion with experts, watching surgical videos but the technical skills can be developed by rigorous, structured and disciplined training at hospital and home. Endotrainer is the best way to develop basic laparoscopic skills and has shown to shorten the learning curve in minimal invasive surgery.⁷ Cost-effective Endotrainer was studied and developed



Figure 9. Easy to handle and portable Endotrainer

by Uttam et. al. at around 2021 in Nepal. It was a great development by their team and encouraged us to create our version of Endotrainer which is even cheaper and portable than their version of Endotrainer.⁸

There are few to none minimal invasive skill development center in Nepal. There are no wet laboratory centers and very few centers with limited dry laboratory facilities like Endotrainer. The available Endotrainer in those centers are mostly donated, costlier, limited in number and not reproducible. Laparoscopic surgical training course was set up in Nepal in 2013 under the guidance of Royal College of Surgeons of Edinburgh at Dhulikhel hospital. It is basic laparoscopic training course with live laparoscopic surgery demonstration.⁹ These limited few days of minimal invasive courses every year are integral part of MIS training but are incomplete without continuation of structured and disciplined practice program to one's institute or at home. Portable Endotrainer are like surgical books that can be carried from training center or hospital to home. Trainee will not only refine their skills in hospital settings but also nurture their expertise in a serene and unhurried environment at home. Moreover, home training when compared to simulation lab center have more laparoscopic skill acquisition and retention.¹⁰

Nepal is developing country with poor economic status. We import most of our medicine and surgical instruments including Endotrainer from abroad. We do not have locally manufactured Endotrainer, thus, we have to import it at high cost from outside country. Our Endotrainer was made using locally available products like plywood. We utilized local carpenters for creating framework for our box. The shape and size of the box was similar to that of commonly available medium sized suitcase.

Trainee could keep their personal laparoscopic hand instruments and different training module inside the box and could secure it with a lock and key. Low cost and high-quality small LED video light were ordered from local market and installed in the box. The total cost of box including the light and wages of carpenter is around \$50.

This Endotrainer provides space for trainee own mobile phone or tablet for the purpose of digital visualization. The ultra-high-definition quality of recent smartphones and tablet camera provides an excellent visual platform for the Endotrainer. Trainee can record, pause, evaluate and retrain using their smart phones or tablets. This Endotrainer is cost effective, portable and easily reproducible. We advise our colleague and juniors to reproduce similar or even more efficient and reproducible Endotrainer, and share with surgical communities so that we can learn and grow together.

CONCLUSION

The Endotrainer was easy and cost-effective to assemble. Embodying the essence of portability, cost effectiveness and reproducibility, this trainer box captivates residents and surgeons alike, offering a personal practice tool that empowers them to hone their skills at the comfort of their own home or within the inspiring walls of a classroom.

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CONFLICT OF INTEREST

The author(s) declare that they do not have any conflicts of interest with respect to the research, authorship, and/or publication of this article.

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