How to self train in basic laparoscopic skills

Training in laparoscopic skills has a long learning curve and requires regular practise. It is vital that surgical trainees start training in basic laparoscopic skills early in their career. Time-restricted training and patient safety has lead to the development of training models to learn these skills outside the operating room. This article provides a framework for and practical solutions to home-based laparoscopic training.

Laparoscopic surgery requires a unique subset of skills such as working in indirect vision, performing a task in three dimensions while visualizing it in two dimensions, and working with altered tactile sense, visuospatial orientation, hand–eye coordination and magnification of image. In the present era of time-restricted training, the opportunities for surgical training are reduced. Self training is important for the fledgling laparoscopist to overcome the learning curve, compensate for the potential loss of training and prepare for complex skill acquisition.

Training technology can be divided into virtual trainers and physical trainers. The former are not accessible to all because of their high cost. Diesen et al (2011) in their recent randomized controlled trial concluded that box trainers are as effective as virtual reality simulators for teaching laparoscopic skills.

Good quality physical trainers have been developed. A portable box trainer can facilitate the development of psychomotor skills and dexterity required to perform basic laparoscopic surgery. Novices are likely to benefit from practising tasks as a part of structured curriculum. A validated structured curriculum, including a subset of tasks, is proposed by the Society of American Gastrointestinal and Endoscopic Surgeons and has been proven to make junior trainees proficient in basic laparoscopic skills (Ritter and Scott, 2007). Their recommended training packages can be bought for $150–1755, and the trainer box costs $2200 – these are available for individual purchase if desired. More details and order forms can be found at: www.flsprogram.org/wp-content/uploads/2011/02/FLS_order-form_2011.pdf

Mr Mitesh Sharma *is Research and Education Fellow in General Surgery and* **Mr Alan Horgan** *is Consultant Surgeon and Director, Newcastle Surgical Training Centre, Freeman Hospital NHS Trust, Newcastle Upon Tyne NE7 7DN*

Correspondence to: Mr M Sharma (dr_miteshsharma@yahoo.co.uk)

Commercially available portable box trainers (like Simulab Corporation, Seattle, USA) are useful but can be expensive. These usually include a set of accessories designed to simulate specific surgical tasks.

Another option can be a portable, collapsible box trainer from Ethicon Endo-surgery called TASKit (Train Anywhere Skill Kit) which enables practice of basic laparoscopic skills privately. Trainees can gain access to the TASKit by contacting their local Ethicon Endo-Surgery representative.

Studies have reported the steps involved in designing home box trainers using materials ranging from bonded steel baskets to desk drawers (Blacker, 2005; Ricchiuti et al, 2005; Al-Abed and Cooper, 2009; Jaber, 2010). Some have used complex techniques to construct a home box trainer which can be challenging. Ricchiuti et al (2005) designed a box trainer which was constructed with the help of a machinist using materials like Lexan, aluminium, Neoprene rubber and panhead Phillips machine screws. Neoprene rubber was sandwiched between aluminium and Lexan and holes were bored in for port entry. It cost about $275.

Jaber (2010) described construction of a portable box trainer using a metallic basket made of strong epoxy-bonded steel. An acrylic sheet was used as a base for the box. He used a drill and screw driver to install two hinges on both the basket and the acrylic sheet on one side. None have recommended a structured training regimen for basic laparoscopic skills training.

This article describes a method for making a homemade box trainer and a simple, cost-effective structured curriculum to practise basic laparoscopic tasks on a portable homemade or pre-formed box trainer, which would help trainees deprived of elaborate facilities to begin their laparoscopic training.

Steps to construct a portable home box trainer

Step 1: box assembly

Any box of a size that can accommodate laparoscopic instruments can be chosen (recommended height 7–10 inches). A smaller height would make it difficult to accommodate laparoscopic instruments appropriately, but if it is too high, the angles that the instruments form will be too near the perpendicular and will not mimic in-vivo practice. The box should not allow direct vision of the target.

The roof should be constructed of a material which allows easy creation of points of entry for instruments but is not transparent so that the trainee cannot directly see the inside of the box (e.g. cardboard, rubber sheet, vinyl) (*Figure 1*). The roof should be taped to the box to prevent unnecessary movement during laparoscopic training (*Figure 2*). The points of entry can be padded using foam pads to give a feeling of entering through ports (*Figure 3*) but this is not essential. A semi-trans-

Figure 1. Creating the roof of the box trainer using waste cardboard.

parent plastic storage box, which is easily available, can be used for the body of the box trainer as shown in *Figures 2* and *3*.

Figure 2. Securing the cardboard as the roof of the box trainer with adhesive tape.

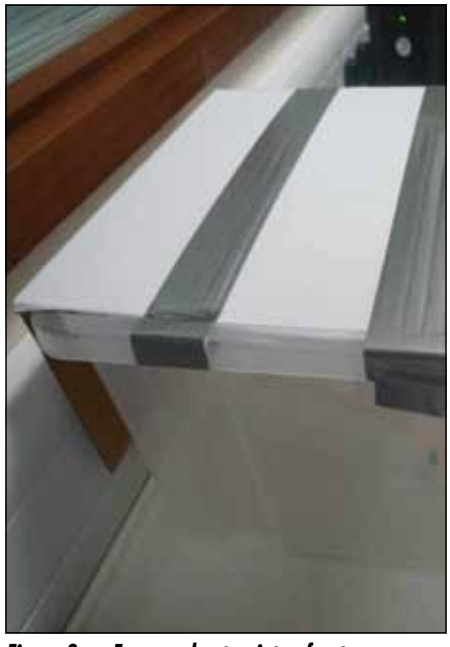
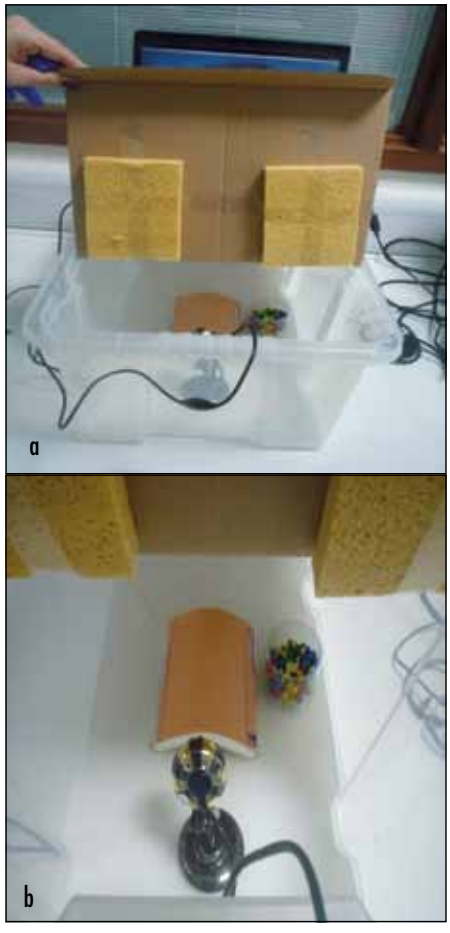


Figure 3. a. Foam pads at points of entry. b. Inside of box showing web cam and jigs.



Step 2: selection of web cam

If the box material does not allow light through, a web cam with good magnification, light source and stand should be chosen. This can be bought for £5–10. If the box material is transparent (e.g. transparent storage box), a web cam without a light source can suffice (*Figure 3*).

Step 3: connecting web cam to computer screen

This is required to transfer the three-dimensional image to two dimensions and allow the trainee to work under indirect vision. The laptop or PC screen will act as the monitor.

Step 4: gathering instruments and practise jigs

Laparoscopic instruments (needle holders, scissors, graspers) can usually be obtained by contacting local endo-surgery industry representatives. A suture pad can be bought for £10–15 from various online sites. The suture pad jig has rubber caps on the base which easily stick to the plastic base of the training box keeping it stable during practise.

Once this set up is complete, the trainee can start practising (*Figure 4*).

Principles of laparoscopic training

Supervised practice of technical skills ensures that the tasks are performed correctly. The next stage of skill acquisition is the autonomous stage (i.e. developing the learned skill so that it becomes automatic, involving little or no conscious thought or attention while performing the skill) and improving the speed of tasks. Repeated practise ensures that the psychomotor skill components (involving both mental and motor activities) are linked into a smooth action, with more likelihood of retention of the acquired skills to reach the stage where the skills have been internalized and can be performed without having to focus on them (Warburton's technological threshold).

Figure 4. Start practising.

Another important concept in psychomotor skills training is the benefit of 'distributed practise' over 'massed' training (Mackay et al, 2002; Moulton et al, 2006). In their randomized controlled trial, Mackay et al (2002) concluded that, during skills training, 20 minutes of distributed practise in 5-minute blocks with 2.5 minutes of rest between these blocks resulted in better retention of psychomotor skills than training comprising of 20 minutes of massed practise.

These principles are recommended to get the maximum benefit from any technical skills training exercise. Hence, greater benefit is expected by following the principles of 'learn and practise' and 'little and often' rather than 'all at once'.

Practise of skills

Recommended curriculum

The Fundamentals of Laparoscopic Surgery is a validated curriculum (by the Society of American Gastrointestinal and Endoscopic Surgeons) with a set of structured tasks that can be practised using a box trainer and are proven to enhance laparoscopic skills (Ritter and Scott, 2007). It includes five tasks which trainees can practise using the recommended benchmark to track their progress.

The trainee should practice each of the five tasks in order (task 1 until proficiency is achieved or number of maximum repetitions reached, then task 2, then task 3). The authors recommend that the initial attempt at these tasks should be supervised by an expert to ensure the correctness of action. If the trainee can not achieve the recommended proficiency for a task within the specified maximum repetitions, he/she should proceed to the next task but arrange to see the expert mentor to provide guidance to achieve the required proficiency. Trainees who do not have access to simulation facilities can either design a portable box trainer (as explained above) or buy one that is commercially available.

Ways in which these Fundamentals of Laparoscopic Surgery tasks can be easily replicated (with some improvisation) in a homemade box trainer are discussed below. Proficiency-based training should be conducted using the performance levels and the protocol (derived from the Fundamentals of Laparoscopic Surgery curriculum) listed below.

Task 1: peg transfer

Pick a coloured peg from one transparent pot using the non-dominant hand, transfer it in mid-air to the dominant hand and place into another transparent pot (*Figure 5*). Complete the task by returning the peg back to the first pot, this time by picking it up using the dominant hand and transferring them to the non-dominant hand in mid-air. This will enhance hand–eye coordination, ambidexterity and depth perception. This task should be practised until it can be performed in 48 seconds with no pegs dropped outside of the field of view; this level of performance should be achieved on two consecutive repetitions and then again on 10 more non-consecutive repetitions for reinforcement. If a trainee cannot achieve this level of performance in 80 repetitions, that trainee should proceed to task 2.

Task 2: pattern cut

Draw two concentric circles on a gauze circle 5 mm apart (*Figure 6*). Stick a suture pad to the base of the box trainer and pin the gauze to the suture pad. Cut between the circles without encroaching on the circle lines. This will enhance cutting skills required for dissection as well as two-handed movements. This task should be practised until it can be performed in 98 seconds with all cuts within the 5 mm section between the two lines of the training gauze; this level of performance should be achieved on two consecutive repetitions or for a maximum of 80 repetitions.

Task 3: endoloop

Inflate a surgical glove and pin it to the suture pad. Draw a circle around a glove finger. Introduce an endoloop through one port site while controlling the marked glove finger tip using grasping forceps through other. Clinch the loop precisely over the marked line. This task should be practised until it can be performed in 53 seconds with up to 1 mm accuracy errors (i.e. the loop should not miss the marked line by more than 1 mm); this level of performance should be achieved on two consecutive repetitions or for a maximum of 80 repetitions.

Task 4: extracorporeal suture

Make an incision on the suture pad. Put two dots on either edges of the incision exactly opposite to each other. Using 2-0 PDS or silk, put an extracorporeal knot to approximate the incision edges by passing the suture needle through the marked dots. This task should be practised until it can be performed in 136 seconds with up to 1 mm accuracy errors (i.e. needle passing not more than 1 mm from the marked dots); this level of performance should be achieved on two consecutive repetitions or for a maximum of 80 repetitions.

Task 5: intracorporeal suture

Perform the above mentioned exercise by using intracorporeal knot tying technique (*Figure 7*). This task should be practised until it can be performed in 112 seconds with up to 1 mm accuracy errors (i.e. needle passing not more than 1 mm from the marked dots); this level of performance should be achieved on two consecutive repetitions and then again on 10 more non-consecutive repetitions for reinforcement or for a maximum of 80 repetitions.

Fundamentals of Laparoscopic Surgery (2006) gives more details of how these proficiency scores were developed and the expected time period that the trainee might need to devote to reach those scores (Ritter and Scott, 2007).

It is difficult to supervise trainees during the entire learning process and trainees are likely to prefer to practise the correctly learned skills in their own time and space. However, the authors recommend that after sufficient practise, skills acquired should be reappraised by a skilled laparoscopist, preferably the same one who supervised the initial attempt. Any one of the above described portable box trainers can be used to practise these tasks.

The authors' experience with TASKit

The authors run a simulation and cadaver-based university accredited minimal access training curriculum and have used TASKit (Train Anywhere Skill Kit) to improve the speed of performance of basic laparoscopic tasks. It has an 'additional practice set' which is a basic kit that enables trainees to simulate skills similar to the Fundamentals of Laparoscopic Surgery curriculum.

The principles described above were applied in the training unit. Seven candidates who enrolled for the postgraduate

Figure 5. Peg transfer.

Figure 6. Pattern cut.

Figure 7. Intracorporeal suturing.

taught course practised a part of this structured curriculum on TASKit in their home environment. They also performed an additional task of stacking five sugar cubes to further enhance depth perception. There were no benchmark performance scores for this task. Before their home practise, the candidates received supervised practise on conventional pelvic trainers.

Once the techniques were confirmed to be correct, trainees were given a set of tasks mentioned above to be practised at home; each to be repeated at least 10 times over 2 weeks. The trainees were also given a demonstration DVD to refer to. All were asked to maintain a diary of their activity on TASKit and record the time taken for each repetition using a stopwatch.

The trainees' feedback, obtained via a questionnaire (using a Likert-type rating scale), revealed that it was well accepted by trainees and perceived as a good form of training. In addition, the candidates showed improvement in the speed of skill performance for relatively simpler tasks of peg transfer and stacking sugar cubes.

The limitations of these findings are the small numbers and the lack of a control group to compare the results with. However, they were still useful to assess trainees' satisfaction with home-based laparoscopic training and its potential to improve their speed outside face to face teaching.

Drawbacks

The main drawback with self practise using a portable home box trainer is the lack of objective feedback. It can be partly overcome by requesting the assistance of a supportive expert to ensure sound technique and thereafter to reappraise in order to consolidate this. The trainee can maintain a record of the performance scores (while practising these tasks at home) to ensure that he/she is improving with subsequent repetitions. Once a comfortable level of performance is reached, the tasks can then be reappraised by the same expert. Hence some degree of mentorship is recommended to ensure the quality of acquired skills. This form of training is useful for novices in laparoscopic surgery, but is less useful for training in advanced tasks both because of the difficulty in replicating the tasks and the need for increased levels of supervision.

Conclusions

Surgical trainees can initiate and accelerate their basic training in minimal access surgery early in their career by using portable box trainers. Practise in the trainee's own time in the home environment using a structured programme will improve basic laparoscopic skills and could help compensate for the loss of 'on-job' training time. BJHM

Conflict of interest: none.

Al-Abed Y, Cooper DG (2009) A novel home laparoscopic simulator. *J Surg Educ* **66:** 1–2

Blacker AJ (2005) How to build your own laparoscopic trainer. *J Endourol* **19:** 748–52

Diesen DL, Erhunmwunsee L, Bennett KM et al (2011) Effectiveness of laparoscopic computer simulator versus usage of box trainer for endoscopic surgery training of novices. *J Surg Educ* **68**(4): 282–9

Fundamentals of Laparoscopic Surgery (2006) *Technical Skills Proficiency-Based Training Curriculum.* www.flsprogram.org/wp-content/uploads/2010/08/Technical-Skills-Proficiency-Bases-Training-Curriculum.pdf (accessed 25 August 2011)

Jaber N (2010) The basket trainer: A homemade laparoscopic trainer attainable to every resident. *J Minim Access Surg* **6**(1): 3–5

Mackay S, Morgan P, Datta V, Chang A, Darzi A (2002) Practice distribution in procedural skills training; a randomized controlled trail. *Surg Endosc* **16:** 957–61

Moulton CA, Dubrowski A, Macrae H, Graham B, Grober E, Reznick R (2006) Teaching surgical skills: what kind of practice makes perfect?; a randomized controlled trial. *Ann Surg* **244:** 400–9

Ricchiuti D, Ralat DA, Evancho-Chapman M, Wyneski H, Cerone J, Wegryn JD (2005) A simple cost-effective design for construction of a laparoscopic trainer. *J Endourol* **19:** 1000–2

Ritter EM, Scott DJ (2007) Design of a Proficiency – Based Skills Training Curriculum for the Fundamentals of Laparoscopic Surgery. *Surg Innov* **14:** 107–12

KEY POINTS

- It is vital that surgical trainees start training in basic laparoscopic skills early in their career.
- A cost-effective homemade box trainer can be built easily.
- Fundamentals of Laparoscopic Surgery is a validated curriculum from the Society of American Gastrointestinal and Endoscopic Surgeons that can be practised on a box trainer.
- Regular practise on a portable box trainer using a structured programme can improve basic laparoscopic skills.
- Some mentorship is recommended to ensure the quality of acquired skills.