Simulators for Laparoscopic Surgery: A Coming of Age

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A competent surgeon is required to possess knowledge, sound clinical judgement, and excellent technical skills. We have traditionally taught knowledge through a programme of lectures, suggested reading materials, and direct teaching around the patient. Clinical judgement is developed through graded clinical experience centred on clinical teaching units. In this manner, the surgeon-in-training is exposed to clinical material and an opportunity to discuss issues that arise in the care of patients in a collegial situation. In both of these domains, we have developed an evaluation process that essentially verifies that learning has occurred. It includes an examination in which the candidate is required to demonstrate a knowledge of the clinical material through answering either multiple choice or essay questions. Surgical judgement is usually evaluated by clinical scenarios, usually in an oral format.

However, we have not developed any appropriately validated methods to either train or evaluate the technical skills component of surgery. Because of this, the opportunity for a surgeon-in-training to learn surgical skills is dependant on many factors and may vary widely between training programmes. Surgical experience during training depends, to a great extent, on the opportunities provided by the institution in which they are working, i.e. on what comes through the doors.

Basic technical skills are generally acquired in the operating room. They are learned by observing other surgeons at work and by trying to mimic these actions. It is assumed that more junior surgeons-in-training will recognize and reproduce the good habits they observe but avoid learning "bad techniques". After a period of training, there is no good verification that learning has actually occurred. Traditionally, evaluation is carried out through subjective in-training assessments by attending surgeons at the completion of a clinical rotation. This global assessment of technical competence is based on the observation of a trainee's supervisors while he/she performs a select but random series of procedures.

Since technical skill is one of the most important things that distinguish surgeons from other medical specialists, it is important that this aspect of education and evaluation is studied in more depth. We should question the role of the operating room as the ideal learning environment for the acquisition of basic technical skills. Resources in the operating room are very expensive and somewhat limited. Furthermore, the opportunity to learn specific skills may vary according to the case mix. It is for this reason that many academic medical centres are developing skills laboratories to train and evaluate their surgeons-in-training in fundamental technical skills. This is an environment where learning can occur in a structured fashion, and at a time when it is most convenient for the trainee to learn.

A curriculum can be developed to teach optimal technical skills that do not depend on the opportunities provided in the operating room. In addition, an evaluation tool can be included in this curriculum to provide an objective and detailed formative assessment that is essential in providing constructive feedback. This feedback should also include recommendations regarding customized remedial programmes that can be developed to enhance those areas of technical skills where the candidate is somewhat deficient. Ultimately, a summative assessment can be made that will provide reliable and valid measurements of technical skills. This will ensure that the surgeon-in-training has achieved the requisite level of skill before applying those skills in the operating room.

The introduction of laparoscopy in the late 1980s and early 1990s has emphasized the importance of formalized training in surgical skills. Laparoscopy was essentially a new technology that required a large group of surgeons, both in training and in practice, to develop competence in novel technical skills

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that were not required in their previous (open) surgical work. Many surgeons introduced laparoscopic procedures in the care of their patients before they had acquired the fundamental skills essential in the provision of safe care. As a result, a large number of complications occurred that may have detracted from the ability to introduce this new technology to their patients' benefit.

After observing the disorder associated with the introduction of laparoscopic cholecystectomy, several academic medical centres developed curricula to teach these technical skills and to verify learning through an evaluation process. An example of this is the McGill Inanimate System for Training and Evaluation of Laparoscopic Skills (MISTELS) that was developed at McGill University in Canada.[1] A panel of expert laparoscopic surgeons reviewed a series of videotapes of laparoscopic procedures and identified seven basic skills that were required in these operations. These were then modelled in the laboratory in order to produce an educational curriculum that was easily reproducible, inexpensive, portable, and associated with metrics that would provide objective measurements of the efficiency and accuracy of completion of these tasks. The MISTELS programme has subsequently been introduced into a large number of academic medical centres across North America, and data have been acquired showing that the measurements were highly reliable, with inter-rater and test–retest reliability measurements that ranged between 0.89 and 0.97. The value of MISTELS as an educational tool was assessed by demonstrating that the skills acquired in this inanimate training box system could be transferred easily to procedures performed in a live animal model.[2] Furthermore, performance scores measured in the MISTELS inanimate simulator corresponded very well to the performance assessments of surgical trainees in the operating room. The measures of performance determined in the MISTELS system proved to be not only reliable but also highly valid. Further assessment showed that only five of these skills were truly necessary to provide a structured educational programme and an accurate evaluation.

The MISTELS programme simulates technical skills in a physical environment. It utilizes actual surgical instrumentation and laparoscopic optical systems for training. The tasks to be performed include bimanual transferring drills, cutting with precision, placement of and securing a ligating loop, and suturing using either intracorporeal or extracorporeal knot tying. These drills familiarize the surgeon-in-training with the issues of visual–spatial perception and eye–hand coordination required in laparoscopy. The trainee must use long instruments constrained by the fulcrum of the trocar, reproducing the conditions of the operating room. The haptics are maintained and the instrumentation is identical to that used in the operating room, thus giving the surgeon an opportunity to become familiar with the feel and rotational handling of the instrument and the blunted tactile feedback characteristic of laparoscopic surgery.

The Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) has recently developed a programme known as the Fundamentals of Laparoscopic Surgery (FLS). The curriculum includes knowledge, judgement, and technical skills fundamental to laparoscopic surgery. The goal of this multimedia programme is to provide surgeons near the end of their training, and practising surgeons, with a body of information specific to laparoscopic surgery. The candidates can learn at their leisure and this can be supplemented through continuing education courses based on the curriculum. When the candidates feel that they have attained the requisite knowledge, judgement, and skills, they can be certified at a test centre where verification of learning can be achieved through a combination of a computer-based multiple choice examination and a technical skills assessment. This innovative programme is one of the early efforts to develop a method of surgical education based on a standard curriculum where knowledge, judgement, and technical skills are taught and appropriately evaluated.

A landmark paper recently published by Seymour and colleagues has shown that technical skills can also be taught with a virtual reality simulator, in this case the Minimally Invasive Surgical Trainer Virtual Reality (MIST VR) system (Mentice AB, Gothenburg, Sweden).[3] The authors required residents to practice using this virtual reality system until they attained a measured level of performance equivalent to a group of expert laparoscopic surgeons. The trainees were then asked to perform a laparoscopic cholecystectomy in the operating room. They were able to complete this operation with greater efficiency and far fewer technical errors than a similar group of trainees who did not have the opportunity to develop their skills using the virtual reality system. This important paper provides evidence that there is great value in a structured programme to teach technical skills. It also demonstrates the value of metrics to provide formative evaluation to ensure that competence is achieved before working on patients.

Trainees who develop their skills outside the operating room environment will function in the operating room with greater confidence and take better advantage of the opportunities afforded to them to hone their technical skills. The use of the very valuable resource of the operating room will be optimized, as procedures will be carried out more quickly and with fewer errors. Patients will benefit because better-trained surgeons will perform their operations more precisely and more efficiently. We have reached the time when it is essential that we reassess the way we educate the surgeons of the future. We need to strongly emphasize education in the technical domain. Measurement tools must provide specific information and feedback to our trainees that not only tells them whether they are doing well or not, but also tells them the specific domains in which their performance needs improvement. This should be supplemented by a specific curriculum to help them achieve competence. It is important that we, as professionals, take the initiative in this role before third-party agencies such as governments force them upon us.

References

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