Acquiring minimally invasive surgical skills

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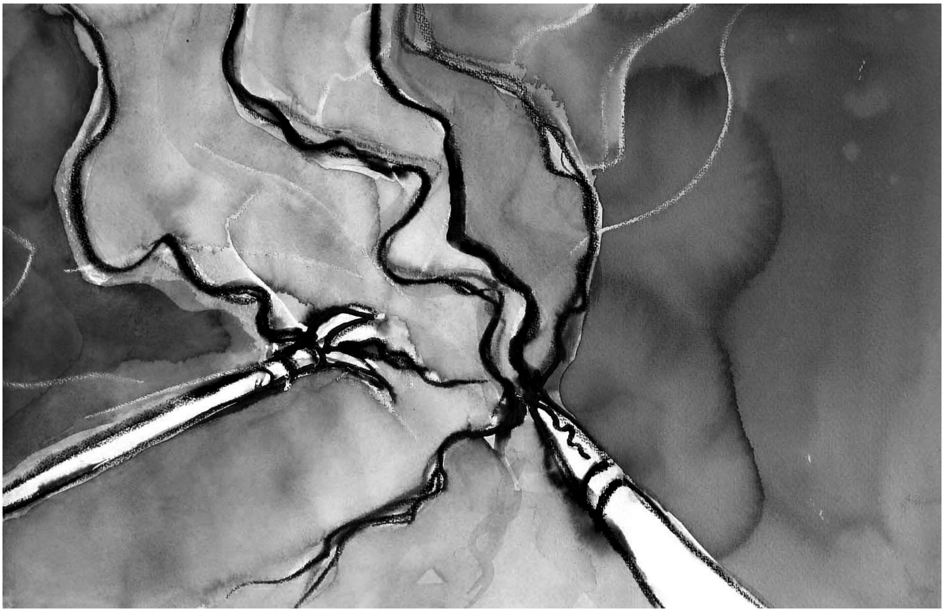
CHAPTER 11
GENERAL DISCUSSION



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Minimally invasive surgery (MIS) presents new technical challenges for the surgeon. In fact, the visualisation of the operative field is completely different and the surgical instruments have to be handled remotely. The need to benefit maximally from the learning moments in the OR whilst optimizing patient safety and the particular skills required for MIS have led to the development of simulators. Despite the compelling arguments to support the widespread use of these simulators as a core and mandatory part of MIS training, the implementation has been lagging behind.

In this thesis, a scientific basis is set for the organisation of MIS skills training. Hopefully, this will help to guide the demands of occupational groups of medical specialists and government for a more uniform and better implemented training regimen. Nowadays, this is important with the increasing pressure to assess the quality of health care. The ultimate goal is to enhance patient safety. When setting up a skills training program, the curriculum needs to be carefully considered in terms of specific and measurable learning outcomes. Validated training and assessment tools should be employed where available. Not only can simulation develop, consolidate and evaluate surgical skills, but it could also be used to identify a trainee's deficiencies and qualities. The latter will allow for the development of personalized training regiments. Finally, skills learned outside of the OR need to be integrated into the live situation. Findings and considerations related to the optimal organisation of skills training and assessment are discussed below.

Curriculum development

In the absence of a structured curriculum, a well-equipped skills laboratory does not guarantee success. Up until now, standards or guidelines of how the MIS skills training should be organized are lacking. Therefore, we developed an international and consensus based set of quality criteria for a skills laboratory. According to worldwide experts in MIS, the most important factor to motivate surgical trainees is mandatory training supervised by laparoscopic experts. **(chapter 7)** Training facilities remain unutilized if practice of MIS skills is considered voluntary.[Chang et al., 2007] It is not only essential that the training is mandatory, the performance of laparoscopic surgery in the OR should only be sanctioned once trainees have achieved a predefined skill level.[Stefanidis & Heniford, 2009a]

The most important criteria regarding curriculum development are the presence of a structured skills curriculum, dedicated time for skills training and a yearly evaluation of the progress and maintenance of laparoscopic skills of the resident. **(chapter 7)** In addition, the retention of acquired skills needs to be monitored. This is important, because obtaining a diploma for basic laparoscopic skills once, does not guarantee that the skills remain over time. Trainees Obstetrics and Gynaecology often encounter periods of non-exposure to the OR, given the rotation of residents around the variety of disciplines and hospitals. We showed that tissue handling skills diminish slightly in absence of training or patient exposure of one year, because a deterioration of time and precision was observed to perform a task that mainly required those skills. **(chapter 6)** Therefore, an annual evaluation seems appropriate. In accordance with that, a recent study confirmed that laparoscopic skills deteriorate between 6 and 18 months without training.[Maagaard et al., 2011] This additionally supports a re-examination after one year.

Appraising the organisation of MIS skills training in the Netherlands, it can be determined that the demands of the Dutch Health Inspectorate for uniformity in training and a predefined skills level are met by the mandatory nationwide basic surgical skills course. **(chapter 2)** However, the additional implementation of skills training in the curriculum is left to the individual clusters of teaching hospitals. Regarding the latter, the ranked list of quality criteria for MIS skills laboratories **(chapter 7)** can be used to verify the quality of an existing laboratory. From there, the focus for new developments can be chosen to upgrade the quality of the lab at specific levels. In general, the adage "See one, do one, teach one" needs to be changed to "See one, do multiple in a skills lab, do one for real" [Bashankaev et al., 2011]

Type of trainer model

Animal models most closely approximate operating on a live patient in terms of being the only models that can effectively simulate a bleeding and complications. However, they are expensive and are associated with infectious, moral and ethical concerns. [Hammoud et al., 2008] Furthermore, the anatomy of a human female genital tract is not equivalent to a pig's model. Regarding inanimate models, the two available trainer models are box and VR trainers. Although evidence is convincing that both models improve psychomotor surgical skills, they have different characteristics. For one, box trainers are much cheaper than VR trainers. During box training, surgeons can familiarize themselves with real laparoscopic instruments and natural haptic feedback (in terms of the feel of the instruments on the tissue surfaces and the pressure of opening and closing the instruments) is preserved. Haptic feedback is especially important during the early phase of psychomotor skill acquisition.[van der Meijden et al., 2009] The absence of haptic feedback during VR training is a disadvantage when trying to replicate traditional MIS, but it may be a truer representation of robotically assisted MIS in which haptic feedback of the tissue is lacking.[Hammoud et al., 2008] In VR trainers, entire procedures can be trained. A recent study showed that training laparoscopic salpingectomy in VR leads to an improvement of skills level during the real procedure.[Larsen et al., 2009] The authors suggested that procedure specific training improves cognitive skills in addition to psychomotor skills. Moreover, most VR trainers give instant feedback on performance allowing solitary training and personal assessment. During box training, this is only possible if the box is equipped with a tracking device that generates instant feedback. However, verbal expert feedback turned out to be superior to computer generated feedback in terms of economy of movement, especially with respect to retention of skills. [Porte et al., 2007] In addition to provision of individualized feedback, expert feedback allows for the opportunity to exchange tips and tricks for daily clinical practice. Finally, portable box trainers with fixed video cameras can also provide the opportunity for practice 'at home'. In summary, the superiority of one of both simulators has been disputed in multiple studies, often with poorly comparable training setups with varying outcomes. We found that box training models are superior to traditional VR systems for an exercise in which tissue handling is important. However, additional kinematic interaction between instruments and objects can be a promising surrogate for haptic feedback in VR systems. **(chapter 3)**

Based on their different characteristics and varying advantages, we conclude that it is ideal to use box and VR trainer in tandem. Future evidence should be sought to ascertain how they should ideally be combined within training programs. However, it has to be considered that the box trainer is the authority based standard, derived from the higher priority that worldwide experts in MIS training gave a to the presence of a box trainer than to the presence of a VR trainer. **(chapter 7)**

Exercises

It is of the utmost importance that the construct validity of the exercises used, is confirmed. Preferably, an expert standard has been established to allow goal oriented training, and thereby fuelling the motivation of participants.[Stefanidis & Heniford, 2009a] When making a choice of the available validated exercises, the learning objective of different exercises needs to be taken into consideration. Some tasks focus, for example, predominantly on hand-eye coordination, while tissue handling is more important in others. Unfortunately, the effectiveness of different exercises has not been compared yet, in spite of some reports of participants' preferences. Also, the transferability of exercises to the real laparoscopic situation is relevant for selecting exercises. Cutting, suturing and knot tying are directly transferable to a real laparoscopic procedure. For that reason we showed the validity of the clinically relevant knot tying task. (**chapter 5**) In addition, future research should be undertaken to categorize the various training exercises and examine their effectiveness.

Metrics

A simple and feasible measure of assessment is the time needed to complete a task. Although in general time is able to discriminate between surgeons of different skill levels, a measure of precision should be added from a clinical point of view. Additionally, it was revealed that it takes longer to achieve precision than speed. [Smith et al., 2002] Therefore, Kolkman et al developed a composite score rewarding speed and precision for the five validated exercises used in this thesis.[Kolkman et al., 2008] Despite the superiority of time as a measure of assessment, trainees benefit from feedback on performance in the form of motion analysis parameters. [Stefanidis et al., 2009b] Also, motion analysis parameters discriminate between surgeons of various skill levels during real laparoscopic procedures.[Smith et al., 2002] We proved the construct validity has for time, path length, motion in depth, and motion smoothness of the laparoscopic suturing task using a box trainer. The addition of economy of movement as a measure of assessment to time to complete the task has the potential to refine acquisition of skills.**(chapter 5)**

Time taken to complete the task, precision and economy of movement parameters may suffice for many exercises. However, these outcome measures are less appropriate in the case of a task during which tissue handling is predominantly required. Force imparted by the operator on the tissue is likely to be of greater importance and attempts have been made to measure forces used during the performance of certain exercises.[Horeman et al., 2010] Research needs to be done on how force application should be integrated into laparoscopic skills training.

Selecting trainees

Ex vivo training and assessment has the potential to contribute to the selection of appropriate candidates for surgical residency positions. Stefanidis et al. were able to predict the rapidity of skills acquisition based on simple psychomotor tests.[Stefanidis et al., 2006a] A recent study also found a correlation between innate psychomotor and visuospatial abilities and skill level at the end of a training session.[Van Herzeele et al., 2010] Certainly, identification of residents' particular strengths and weaknesses may allow for a more tailored, individualized approach to training, but whether tests of baseline and rudimentary performance on laparoscopic simulators can find a valid role in candidate selection remains a subject for debate. No doubt, skilfulness is a prerequisite for a surgeon. However, there is no guarantee that the medical student with the best results in a psychomotor test, like a finger taps test, will also become the best surgeon during residency. In fact, master surgeons recognize cognitive factors and personality (decision making ability, insight, team spirit, and emotional stability) as being of equal importance for selection [Cuschieri et al., 2001] Currently, differentiating between better and less skilled trainees seems more important for tailoring training to individual needs, rather than for selection purposes.

Assessment in the OR

The organization of skills training outside of the OR, including its implementation into the residency curriculum, is an essential first step to warrant patient safety during MIS. After basic surgical skills have been acquired outside of the OR, residents should be trained, assessed and reassessed in the OR in order to achieve transparent skilfulness. This parallels the development that all medical specialties move towards more competency-based outcome measures rather than being solely based on the length of training or the number of procedures performed. In an attempt to overcome the subjectivity on which surgical skills assessment was traditionally based, the general global rating scale of the OSATS has been developed for testing in laboratory settings. Two findings indicate the construct validity of using the general global rating scale of the OSATS for intraoperative assessment. Firstly, surgeons who had performed more than 100 laparoscopic cholecystectomies were rated with a higher score than surgeons who had performed less than 10, based on video assessment.[Aggarwal et al., 2008] Secondly, the OSATS score, obtained by direct intraoperative observations, raises with increasing experience of individual residents **(chapter 8)**. Furthermore, the reliability of assessment with OSATS has been proven in laboratory settings.[Martin et al., 1997] In accordance, we confirmed substantial agreement between resident and supervisor if an OSATS is used for intraoperative assessment **(chapter 9)**. The ideal proof would be to schedule two independent supervisors during a series of procedures. However, this is a very costly method conflicting with the strive for efficient health care. Therefore, the present evidence for reliability is the best available. The large scale implementation of OSATS for intraoperative assessment is permitted with respect to its validity and reliability, although it already took place prior to manifestation of the results mentioned above.

Additionally, practical decisions have to be made about the intraoperative use of OSATS. The timing and frequency of assessment remains controversial [Pandey et al., 2006] The majority of questioned residents state they prefer every procedure to be assessed. (**chapter 9**) Although it is well established that feedback is indispensible during learning,[Mahmood et al., 2004] it remains questionable if residents who are assessed with OSATS will become better surgeons than those who are not. Furthermore, it is questionable whether consequences should be drawn from a residents OSATS score and what these consequences should be. We have made a first step to benchmark the OSATS, by establishment of the score at which a resident can perform a procedure autonomously (**chapter 9**). However, a thoughtless implementation of such assessment tools for authorization should be avoided. In the first place, authorization is a more complex and multifactor process which depends on more aspects than technical skills only, e.g. knowledge, decision making (before, during and after the operation), communication skills, and leadership skills.[Moorthy et al., 2003] In the second place, the objectivity of the OSATS is limited, as appeared from a survey among users (**chapter 9**) and the large range of median OSATS scores given by the supervisors (**chapter 8**).

An advantage of the fact that OSATS has proven to be valuable is that it fuels other clinical research regarding technical skills performed during actual surgery. For example, we can be reassured with the finding that basic MIS procedures do not seem harder to perform during residency than conventional surgical procedures.(**chapter 10**) This may have resulted from the incorporation of structured MIS training programs in residency. It is likely that the current generation of residents familiarizes quicker with new technologies due to an earlier introduction to computers and other audiovisual devices. This is illustrated by the findings of Rosser et al. that gaming surgeons operate quicker and with less errors.[Rosser, Jr. et al., 2007]

This thesis has focused on training and assessment of psychomotor technical surgical skills. Obviously, in an era of rapid technological innovations, a surgeon should also be well informed about instrumentation and OR set up (e.g. integrated operating rooms). However, the time has passed when medical education could be planned with a focus solely on the latest aspects of medical diagnosis and (surgical) treatment. The Royal College of Physicians and Surgeons of Canada (RCPSC) has developed the CanMEDs competency framework for the education of medical professionals. Seven roles have been defined that a physician should fulfil to meet the health care needs of the patients, communities and societies they serve. These roles are medical expert (central role), communicator, collaborator, manager, health advocate, scholar and professional.[Frank et al., 2007] As a result, residency programs are now restructured with more competency based training and outcome measures. Residents that excel in one area of competence but lack in other competencies may need to shift their priorities in their training curriculum. [Schijven et al., 2011] Examinations are indispensible in that process and may function to tailor the curriculum further to each individual.

Finally, acquiring surgical proficiency is an ever continuing process that does not end with completing residency training. The requirements in training and assessments for residents will also have implications for use in revalidating more experienced surgeons. In parallel, surgeons should also be prevented from implementing new technologies (e.g. laparoscopic endoscopic single site surgery and robotically assisted surgery) without proper training and transparent proficiency. Unfortunately, consensus regarding the latter still has to be achieved.