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Title: Increasing the efficiency of laparoscopic surgical training: assessing the effectiveness of training interventions
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10a. Summary

This dissertation describes research investigating ways of improving efficiency of laparoscopic motor skill training. Performing laparoscopic surgery is a complex task that involves using a small camera (laparoscope), a visual monitor and a set of long instruments to perform surgery in the abdomen. The laparoscope and instruments are inserted via small incisions to make the procedure less invasive and create smaller scars compared to traditional open surgery (laparotomy).

In the Introduction (chapter 1), I describe how the increase of minimally invasive procedure such as laparoscopy has led to the demand for an alternative approach to surgical education. Traditionally, surgery is taught in a mentor-apprenticeship model, where a surgical resident first observes and assists an experienced surgeon and gradually starts to perform more challenging tasks in the operating room. Due to the complexity of laparoscopic surgery, this was no longer a viable option. This led to an increase in the development of surgical simulators, where a trainee can practice difficult surgical skills in a safe environment.

It also led to a stronger emphasis on standardized evidence-based medical education. In chapter 2, the results of a cognitive task analysis is reported, specifically describing all the essential action steps and decision points of an advanced laparoscopic procedure (resection of the sigmoid colon in the case of a tumor). It also lists what skills and knowledge ought to be included in a curriculum for laparoscopic residents with an estimate of their importance by a panel of experienced laparoscopic surgeons.

In chapter 3, the focus of the dissertation narrows down to simulation training of laparoscopic motor and perceptual skills. In this chapter, relevant literature is reviewed to provide a set of nine recommendations that trainers can use to enhance laparoscopy training. It suggests trainers use training models that have construct and preferably predictive validity with benchmarked proficiency levels by expert surgeons, that can serve as goals for trainees. Trainees should engage in adaptive training on a spaced practice schedule. Mental imagery can be utilized in surgical skill acquisition to reduce the amount of time and materials required for training. Trainers can use part-task training to reduce cognitive load, although care should be taken, since there are not a lot of studies that have tested this concept in medical training. Also, it is important to provide for a form of skill integration at a later stage in training. Dual-task training conditions can be used to measure the degree of automatization of motor skills, and to provide adequate integration of all the different tasks present in the operating room. The curriculum should actively endorse an attitude of deliberate practice and life-long learning, so residents continue towards surgical mastery after they have reached proficiency at the end of training.
Trainers can increase the variability of different task parameters at a later stage of training, as this is commonly found to correlate with better long-term retention of skill. In chapter 6, we found that increased variability of the angle of the laparoscope in the simulator hampered skill acquisition and retention in novice trainees, so we recommended lower amounts of task variability for novices. Differences in training task switching was not associated with worse or better performance.

Chapter 4 comprises a short commentary on a study on self-directed feedback touching on the theme of feedback dependency. Feedback is helpful tool to increase a trainee’s pace of learning and also has a motivational function. When feedback is omnipresent, a trainee’s performance (or confidence) can become too dependent on it and this can become problematic if no one is aware of how of a trainee’s performance is reliant on the presence of (instructor) feedback.

In chapter 5, the subject of feedback continues, namely visual force feedback. In previous studies, the presentation of visual force feedback on the simulator monitor facilitated the acquisition of safe tissue manipulation skills as compared to a control group without visual force feedback. In the current chapter, the aim was to find the optimal dosage for the presentation of visual force feedback. The different feedback conditions consisted of: (1) continuous, (2) gradually fading in as time-on-task accumulates or (3) only when a trainee exceeds a certain force threshold. All conditions significantly reduced the amount of exerted force on the tissues, but no significant differences were found between groups.

In chapter 7, we compared a massed training group with a spaced training group. The massed group received all their laparoscopy training on a single day, whereas the spaced group had three training seasons spread across three consecutive weeks. Participants on the spaced group performed significantly better on the laparoscopic tasks at the end of training, two weeks after training and approximately a year after training. In chapter 8, the spacing effect was further studied with a larger sample and four different training groups. The first group was a massed condition, which has all of the training sessions on a single day without any major breaks in between. The second group also received training on a single day, but with two 45-minute breaks in between three training sessions. The third group was identical to the second, except that they were allowed two 30-minute powernap opportunities on an inflatable mattress in dark room with muted sensory input. The fourth group had three training sessions spaced over three consecutive days. In the results, we found that the third and fourth group outperformed the first and second group at the end of training and two months after training, but the margins and effect sizes were not as large (and not statistically significant for every task comparison) as the study described in chapter 7, in spite of larger sample sizes per group.

In chapter 9, the results of the training interventions tested in this dissertation are integrated with the recommendations from the literature review. I briefly mention the
results of the prospective analyses (in regard to factors such as age, sex, sport, gaming, music activity, etc.) done on the data presented in this dissertation as well as two studies that did not make it as a full chapter into the final dissertation due to the lack of meaningful results and the absence of retention data.