Preclinical Training Strategies

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We believe that the use of simulation will shorten surgical training times and helps to reduce surgical complications for the patients.

Take-Home Messages

- Arthroscopic simulator training by surgical trainees improves technical performance in the operating theater.
- Interval practice is a more effective training schedule than massed practice.
- Residents can successfully teach in the skills laboratory, and their teaching skills are acceptable compared with those of faculty instructors.

10.1 Introduction

With innovations in the surgical training program, the need for alternative surgical skills training methods becomes more and more important. Over 80 % of orthopedic residents and orthopedic program directors in the USA agreed that surgical simulation should become a required part of orthopedic resident training. (Karam et al. 2013). However, surgical skills facilities were not available in almost 25 % of training sites. The main obstruction to create formal surgical skills programs was a lack of money (Karam et al. 2013). Karam and coworkers (Karam et al. 2013) therefore concluded that orthopedic educators should find cost-effective solutions to improve surgical skills training. This chapter describes different kinds of preclinical training strategies for orthopedic residents in arthroscopic surgery.

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10.2 Simulators

The simulators used for training arthroscopic surgery can be classified into physical simulators, virtual reality simulators, and hybrid simulators (Fig. 10.1). Physical simulators include human or animal cadavers or artificial models. Virtual reality simulators are video based or computer based. Whenever virtual reality simulators are combined with physical components for real tactile feedback, these are named hybrid simulators (Madan and Pai 2014). All different types of stimulators are discussed in Chaps. 5, 6 and 7.

10.3 Factors Affecting Preclinical Skills Acquisition

10.3.1 Level of Experience

Several studies evaluated the ability of simulators to differentiate between novice and expert arthroscopic surgeons (Andersen et al. 2011; Pedowitz et al. 2002;

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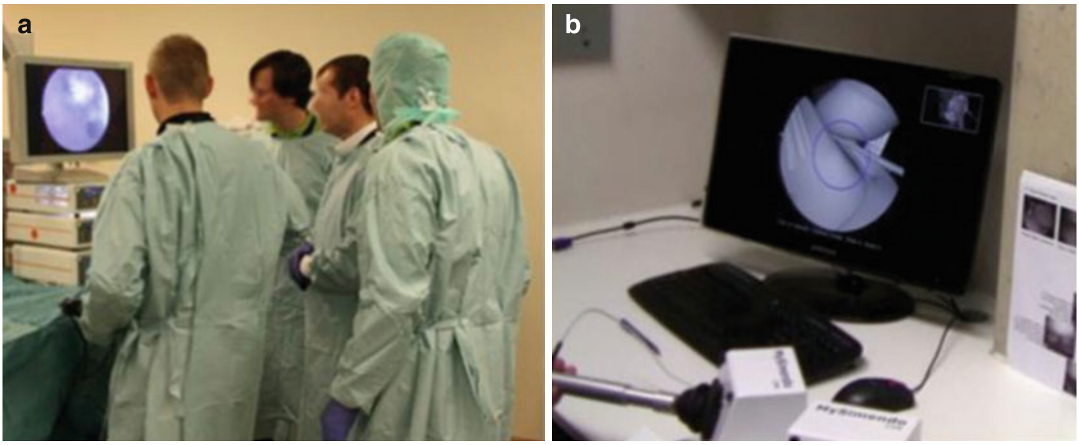

Fig. 10.1 Arthroscopic simulation training in practice (© I.F. Kodde, 2014. Reprinted with permission)

Tuijthof et al. 2010). All studies found good construct validity for virtual reality simulators, with experienced surgeons performing tasks faster and with more efficiency compared to residents and interns.

Interestingly, a 5-h training for inexperienced trainees on a virtual reality simulator was sufficient to perform better than the experienced surgeons in a second test (Andersen et al. 2011). So it is suggested that simulators provide the greatest performance gain for novice trainees (Madan and Pai 2014). The abovementioned results indicate that the simulator does show deviations from real arthroscopic surgery. However, the fact that experienced surgeons outperformed the inexperienced colleagues on a virtual reality simulator indicates that these skills are somewhat transferable. Furthermore, one RCT compared two groups of orthopedic trainees to investigate the transfer validity of arthroscopic skills from simulator to the operating theater. One group received a fixed protocol of simulator training before performance in the operating theater was assessed. The control group did not have simulator training before practice in the operating theater (such as in the traditional training schemes). The simulator-trained group significantly outscored the untrained group in terms of both the Orthopedic Competence Assessment Project and global rating scores (Appendix 13.A). Thus, arthroscopic simulator training by surgical trainees improves technical performance in the operating theater (Howells et al. 2008).

10.3.2 Video Games

Rosenthal and coworkers compared virtual reality task performance of children with different levels of experience in video games and residents. They concluded that the use of computer games may contribute to the development of skills relevant for adequate performance in laparoscopic virtual reality tasks (Rosenthal et al. 2011). However, others contradicted this theory (Harper et al. 2007; Thorson et al. 2011).

10.3.3 Innate Skills

The acquisition of a new surgical skill is characterized by a learning curve and the progress of an individual on the curve might be influenced by the innate ability of the individual to acquire a skill. It has been questioned whether variations in arthroscopic skills of trainees are caused by the training provided or rather by innate skills. Alvand and coworkers observed considerable variability in the arthroscopic ability of medical students and hypothesized that this was due to innate arthroscopic ability since none of the study subjects had any previous exposure to the tasks in question (Alvand et al. 2011). However, it has also been suggested that self-reported interest in surgery is a better predictor than innate skills for learning simulated arthroscopic surgery tasks (Madan and Pai 2014; Thorson et al. 2011).

10.3.4 Gender

Sex differences have been found to exist in the acquisition of skills (Strandbygaard et al. 2013). Thorson et al. evaluated laparoscopic skills among medical students and found that female students performed worse on the laparoscopic trainer than males after adjusting for age, choice of medical specialty, and video game use. They concluded that female medical students differ in their innate abilities on the laparoscopic trainer which might be related to a different psychomotor skill acquisition and behavior of females compared to males (Thorson et al. 2011).

10.3.5 Timing of Simulator Training

The acquisition of motor skills may be influenced by the time of day. Bonrath and coworkers evaluated whether results of laparoscopic training were different based on the time of day (morning, afternoon, or evening) the training was provided. There were no differences observed between the groups with training during working hours (morning and afternoon) and after working hours (evening). All participants significantly improved in laparoscopic skills (Bonrath et al. 2013). Rest appears to be an important adjunct to effective practice; more than four hours of practice per day causes the quality of practice to deteriorate and leads to fatigue. Also, an adequate amount of sleep seems to be a predictor of success on a laparoscopic surgery simulator (Wanzel et al. 2002). The acquisition of skills is also dependent on the training schedules. Practice sessions can be either a single long session (massed practice) or multiple short sessions (interval practice). It has been shown that interval practice is a more effective training schedule than massed practice. This has probably to do with the theory that the skills being learned have more time to be cognitively consolidated between practices (Gallagher et al. 2005).

10.3.6 Instructors

Strandbygaard and coworkers (Strandbygaard et al. 2013) performed a RCT to evaluate the feedback of an instructor during a virtual reality simulator course. Feedback was defined as the provision or return of performance-related information to the performer. Instructor feedback increased efficiency when training a complex operational task on a virtual reality simulator; time and repetitions used to achieve a predefined proficiency level were significantly reduced in the group that received instructor feedback compared with the control group. In addition, they found that the feedback influenced the females' performance more than that of males (Strandbygaard et al. 2013). However, in more basic tasks, such as coordination and instrument navigation, no specific advantages of instructor feedback have been found (Snyder et al. 2009). Also, it has been shown that residents can successfully teach in the skills laboratory and that their teaching skills are acceptable compared with faculty instructors (Pernar et al. 2012).

Conclusion

Simulation is being used more and more in arthroscopic training for the acquisition of both basic and advanced arthroscopic surgical skills. The impact of virtual reality training is currently more established in the field of laparoscopy rather than arthroscopy. While there are no comparative studies that evaluated whether the results of virtual reality in laparoscopy also account for arthroscopy, it is generally believed that the acquisition of basic skills such as coordination and instrument navigation will be comparable for the two. Although the consensus at the present still seems to be that simulators are useful in arthroscopic training but are adjuncts to real experience and cannot fully replace it, we believe that the use of simulation will shorten surgical training times and helps to reduce surgical complications for the patients. With the development of more sophisticated

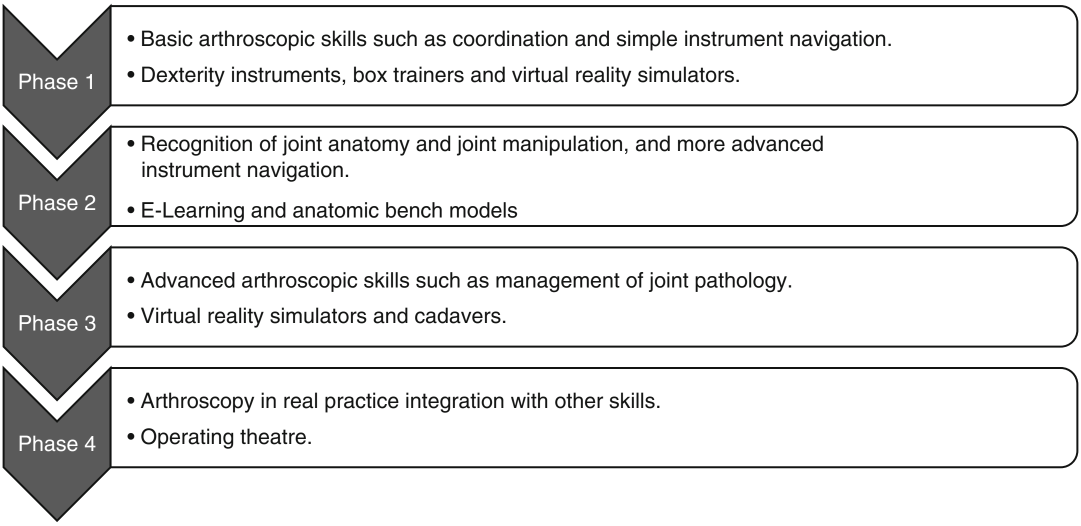

Fig. 10.2 Proposal for strategy to effectively train arthroscopic skills

simulators, it is likely that these will present an important part of future arthroscopic surgical training programs.

10.4 Approach for Arthroscopic Simulator Training

The success of preclinical simulator training depends on numerous factors. Based on the abovementioned factors, a 3-step approach for arthroscopic simulator training has been suggested by Madan and coworkers (Madan and Pai 2014). The first step would be to provide hand-eye coordination and simple manipulation training on box trainers. The second step would be to provide instrument navigations skills and recognition of joint anatomy. The third step would be to provide surgical skills to deal with joint pathology. The second and third steps could be done using cadavers and/or virtual reality simulators (Fig. 10.2).

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