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Training of Young Medical Professionals: Implementation of Modern Training Concepts Under Consideration of Changing Conditions for Training - A Pilot Project for Surgical Subjects

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Abstract

Background: Operative novices complain about deficits in practical operative education. Simulated training offers perspectives for an effective education tool. In a former study we could show an improvement of knotting time from about 247 sec to 45 sec after 2 h of training. This study focuses on the acceptance of a simulator based education model.

Aim: Is a simulator based operative education accepted by operative novices and considered as equivalent to education on patients? Is it possible to increase basic knowledge of novices with no experience within two hours?

Material and Methods: 73 medical students of higher terms underwent endoscopic basic training on a box-trainer. According to a special basics-curriculum students learned single knots and continuous sutures within a two hours intensive course. Afterwards they evaluated the endoscopic basic-training.

Result: 93.6% (73/78) completed the evaluation. About 90% stated an improvement of instrument handling and operative competence. 93.2% would recommend on the simulated training, 85% stated an improvement of educative quality. Nevertheless students stayed realistic concerning their operative knowledge. About 65% saw a relevance of learning endoscopic basics for their favorite medical subject.

Discussion: Operative novices show a high acceptance of simulated operative education associated with a subjective as well as verifiable improvement of operative competence. A broader implementation of early operative education using simulators should be discussed.

Keywords: Laparoscopy simulation; Surgical training; Evaluation; Learning curve, Hands-on training

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Introduction

In the past few years, the framework conditions for surgical training have changed in many countries. The traditional training of surgical skills on the patients under the supervision of an experienced colleague can hardly be performed in everyday routine and had been abandoned. The specialization of surgical sub-areas, a consolidation of the work, scarce financial resources and also the change in social demands have led to the fact that the independent implementation of surgical interventions has a different status in specialist training compared with the situation 20 years ago. However, these changes are also accompanied with an increasing lack of offspring in operative disciplines [1,2].

It is well-known that surgical interventions are subject to learning curves, with the number of repetitions being necessary to achieve a qualitatively good surgical level fluctuating between 20 and 70 interventions depending on the complexity of the intervention [3,4].

The question arises as to how practical procedures, such as laparoscopic surgery, can be learned in a time of limited resources for training in everyday clinical practice. Besides, for ethical reasons,

it is also doubtful, whether surgical training has to be carried out on patients.

Similar to the pilot training that has been established for decades, there are now numerous different simulators for endoscopic operations demonstrating good successes in terms of learning curves [5-7]. This training on the simulator is usually offered on a subject-specific or partially operation-specific basis as part of charged courses. In contrast to pilot training, the course fees and travel expenses are usually borne by the course participants themselves. However, in medicine there is now the option of using simulators being available at every clinic or privately.

The study's goal is to present the concept and the evaluation results of a laparoscopy course for future doctors in order to motivate other medical faculties and clinics in other countries to consider simulated training as a basis for surgical training. The concept presented by us is awarded with the Rockstroh Award. It allows an ethically responsible training with an acceptable expenditure of time. With regard to the financial outlay, the system presented can be more economical for the clinics than the traditional training system, since the learning curve plateaus can be achieved without costly surgery time and the complication rates may also be positively influenced.

In our opinion it makes sense to organize the initial contact with such simulators in a later study phase, as this allows the students to explore the preferred subject. Ideally, this helps to counteract the shortage of skilled workers in surgical subjects.

Materials and Methods

Medical students who took part in the gynecological practical clerkship (9th semester) were offered the opportunity to participate in a laparoscopic simulation training over a period of two hours as part of the regular clerkship. As a maximum of ten students are usually assigned to each block, five workstations have been created.

A workplace comprised the following materials

- a classic box trainer with accessories (the accessories consisted of a bead plugging tool, a pipe cleaner tool, a suture pad, an endoscopic gripper, an integrated light source and a tablet/smart phone holder).
- an endoscopic needle holder for training purposes (can be purchased separately)
- a tablet/smart phone (as a camera replacement, provided by the students or by us)

We used an approximately 20 square meter room with a 1 × 2.40 m table. Alternatively (depending on the number of simulators) several small tables would be sufficient (Figure 1).

The students each practiced alone at a training station. If there were more than five participants, the students took turns at the vacant stations after the exercise.

The curriculum comprised the following steps

Short explanation of the instruments

Peg-transfer

Exercises at the pearl tool (10-15 min): Objective: Hand-eye coordination training and transition from one-handed to two-handed

- This exercise is done with one hand. Threading thick beads with a 6 mm hole diameter onto appropriate rods. Here the students are instructed to grab into the pearl with the grasping instrument and then to spread the instrument. Afterwards, it can be placed on the stick in a controlled manner.
- From now on, the operation will be done with two hands. In the second hand there is a needle holder with which the threaded pearl can be undermined and pushed up so far that the gripper of the other hand can grasp the pearl from above. This is then put back in the collecting bowl.
- Now the needle holder is passed through into the bead opening. With the gripper of the other hand, the bead is pushed up and fixed. Then it will be preceded in the same way with the other pearls until all pearls are threaded.

Figure 1: Exercises on the box trainer as part of the pilot project.

Exercise on the pipe cleaner tool (approximately 10-15 min): In this classic hand-eye coordination exercise, a pipe cleaner is pushed through an array of eyelets. The main difficulty is that the work is done in three dimensions, but is only transmitted in two dimensions on the monitor. In addition, the pipe cleaner must be pulled through sufficiently from the beginning so that all eyelets can be grasped. Besides, the dosage of lever and pulling forces is trained in this exercise.

Suture and knotting exercises (ca. 70-90 min): First, the students are instructed in the correct clamping technique of the needle. Afterwards, a demonstration of the correct stitch technique and the possibilities of knotting is performed.

Then, the students should initially perform the following exercises with vicryl 2-0 threads with a large needle on a straight strand of the suture pad:

1. Clamp the needle

2. Piercing

3. Double knot and single counter-rotating knot

4. Continuous seam with three stitches, whereby the thread is not pulled through completely with the last stitch

At this point, the students are shown the technique of the final knot in a continuous seam. You then do this.

5. Closing knot

6. Further rows of seam at other points on the seam pad with smaller needle sizes, thinner threads as well as PDS threads and additional knots.

Additional modules are available for colleagues who are already surgically more advanced, which simulate more complex interventions such as descensus operations, cyst enucleations or

appendectomies and can be operated on accordingly.

Evaluation of the simulation training by the students

Evaluation form: We used a standardized evaluation sheet to evaluate the course by the participants [8,9]. This comprised 15 statements. To assess these statements, the participating students could choose between the five categories "applies", "rather applies", "neutral", "rather does not apply" and "does not apply" (with a cross) (Table 1). The completion and submission of the evaluation questionnaire was done anonymously.

All data have been compiled in accordance with national law and the Helsinki Declaration of 1975 (in the current, revised version).

Results

Active part of the course

The skill exercises and the hand-eye coordination exercises can be carried out by the students in an adequate amount of time. Students who have problems with the first exercises compensate for this within the next exercises. After the 2-h course, over 90% of the students are able to clamp a needle and to perform knots laparoscopically. The first knots are not always correctly tightened ("air knots"), although this improves with the number of knots performed and is also critically realized by the students. The more continuous seams are performed, the tidier the seam rows will be. More than 90% of the students manage to sew three rows of seats with at least six to eight knots in the given period. The seam and knot times become progressively shorter (time saving of first versus last knot 80%, i.e. approximately 4 min).

Evaluation form analysis

A total of 78 medical students took part in the laparoscopy course during the practical clerkship in gynecology. Out of the 78 students, 73 (93.6%) completely filled out the evaluation sheet for the course. This means the evaluation form was not filled out by three participants. Individual answers were missing twice.

The conclusion of the students evaluating the course was consistently positive: 95.9% (70/73) requested more practical exercises like laparoscopy training in other subjects and in the practical year. 68 out of 73 participants (93.2%) would completely recommend the course with the laparoscopy simulator. 67 out of 73 students (91.8%) concluded that they enjoyed the course without restrictions. 66 out of 73 participants (90.4%) were fully motivated during the course. 65 medical students (89%) felt that the application of the models had unrestrictedly improved the ability to handle laparoscopic instruments. 64 students (87.7%) had the opinion that they had greatly benefited from the practical laparoscopic exercises on the models. 62 participants (84.9%) saw an improvement of the quality of their medical study due to the course with the laparoscopy simulator. 49 (67.1%) agreed with the statement that the course improved understanding and competence of a surgical procedure. 47 course participants (64.4%) stated that the course is relevant for the future medical profession, even more in the case of a prospective gynecological activity (52 and 71.2%). Finally, 32 students (43.8%) found that the laparoscopy simulation course had improved their understanding of the subject of gynecology and obstetrics, that the course gave them sufficient technical knowledge about the processes in the operating room and that they had learned to utilize team work.

The lowest degree of agreement could be observed for the statements that the participants in the course had gained enough self-confidence to work in the operating room (26 times full agreement or 35.6%) and that the course motivated the participants to work in gynecology and obstetrics in the future (23 students or 31.5% fully agreed).

The evaluation results of the laparoscopy course are summarized in Table 1.

Discussion

The pilot project presented shows that simulated laparoscopic short- training with a structured training program during study reveals good results in terms of laparoscopic basic abilities (skills, hand-eye coordination, suturing and knotting techniques) and that it is an accepted alternative for training at the patient.

The use of advanced box trainers in combination with modern tablet cameras enables an affordable supply of a sufficient number of simulator units so that a larger number of trainees can be taught simultaneously. This allows an economic teaching activity - both in terms of time and money.

PEG transfer and suture/knotting exercises are an effective tool for hand-eye coordination, manual dexterity and laparoscopic basic training [10-13]. By using tablet cameras as optics, modern box trainers allow self-sufficient practice without the inevitable need for expensive endoscopic optics and surgical assistance, but still allow this option as an alternative. A wide availability of inexpensive simulators with the possibility of structured training up to junior status could favor their use as a recognized training instrument and allows also an evaluation of the individual status [12-14].

Numerous studies have shown that basic laparoscopic skills on simulators allow an impressive improvement in the learning curve [13,15-17]. This correlates to the findings of our educative program with an improvement of knotting time of more than 80% from an average of 247 sec (range 45 to 1290 s) to 45 sec (range 7 to 280 s) after our 2-h training [15].

From a behavioral point of view, repetition is an important factor in implementing what has been learned. It could be shown that a first learning plateau is reached after ten knots [7,18,19]. Ideally, there is at least one night between two training sessions. Unfortunately, this often cannot be set up in everyday clinical practice for teaching. Nonetheless, it has been shown that the trainees start at a higher level when resuming simulator training and improve their learning curves more quickly than it was initially the case [17,20,21].

Only a few studies examined long term skill retention after short training in young residents or students. A high skill retention even after one year was reported [20,21]. Laparoscopic training at an early stage of education is thus not wasted time, but offers more time to extend skills and broaden medical mind also for surgical subjects. We could demonstrate that students show a high acceptance for participation in a simulated program- not only to get in touch with laparoscopy at all but also for ethical aspects and sense of responsibility to their future patients.

In the USA, numerous clinics now require primary training on simulators (FLS) before procedures can be carried out on humans. There are a plenty of simulation centers owning interdisciplinary simulators to reach this goal. University centers in particular often have their own or connected simulation centers. The availability of training opportunities without great effort is known to increase their use. Conversely, it is hardly to be expected that trainees will use simulators and equipment if they do not work technically, if the

Table 1: Evaluation results of the laparoscopy course by the students (n=73).

Category	1 (doesapply)	2 (doesratherapply)	3 (partiallyapplies)	4 (doesrather not apply)	5 (does not apply)
Using the models in the laparoscopy course has improved my manual skills	66 (90.4 %)	6 (8.2 %)	1 (1.4 %)	0	0
Using the models has improved my ability to utilize laparoscopic instruments.	65 (89%)	7 (9.6%)	1 (1.4%)	0	0
The application of the laparoscopic models helped me to become aware of the algorithm for a minimally invasive gynaecological procedure.	51 (69.9%)	15 (20.5%)	6 (8.2%)	0	1 (1.4%)
I benefited greatly from the practical laparoscopic exercises on the models.	64 (87.7%)	9 (12.3%)	0	0	0
As part of my general experience, the practical laparoscopic exercises on the models haveimproved the quality of my medical studies.	62 (84.9%)	9 (12.3%)	2 (2.7%)	0	0
I would like to do more practical laparoscopic exercises with laparoscopic models in the practical year.	70 (95.9%)	3 (4.1%)	0	0	0
I would like to do more practical exercises with laparoscopy trainers in other subjects.	70 (95.9%)	2 (2.7%)	1 (1.4%)	0	0
The laparoscopic models have improved my understanding of the subject gynaecology and obstetrics.	32 (43.8%)	19 (26%)	18 (24.7%)	2 (2.7%)	2 (2.7%)
The practical laparoscopic exercises improved my understanding and competence of a surgical procedure.	49 (67.1%)	23 (31.5%)	1 (1.4%)	0	0
I received sufficient technical knowledge about the processes in the operating room.	32 (43.8%)	22 (30.1%)	16 (21.9%)	3 (4.1%)	0
I have gained enough self-confidence to work in the operating room.	26 (35.6%)	17 (23.3%)	22 (30.1%)	5 (6.8%)	3 (4.1%)
During the semester, I was motivated during the practical exercises on the laparoscopic models.	66 (90.4%)	7 (9.6%)	0	0	0
The practical laparoscopic exercises motivated me to work in gynaecology and obstetrics in the future.	23 (31.5%)	20 (27.4%)	8 (11%)	12 (16.4%)	10 (13.7%)
I enjoyed the practical exercises with the models.	67 (91.8%)	6 (8.2%)	0	0	0
I learned to work in a team.	32 (43.8%)	16 (21.9%)	20 (27.4%)	1 (1.4%)	4 (5.5%)
The practical exercises with the laparoscopic models are relevant for my later medical profession.	47 (64.4%)	15 (20.5%)	6 (8.2%)	5 (6.8%)	0
The practical exercises with the laparoscopic models would be relevant for mylater medical profession if I would work in the field of gynaecology and obstetrics.	52 (71.2%)	13 (17.8%)	6 (8.2%)	1 (1.4%)	1 (1.4%)
I would recommend the event to others.	68 (93.2%)	5 (6.8%)	0	0	0

setup involves great effort or if the optics only provide good images with great effort. Our students have the option of continuing to use the existing university simulators so that the level of learning can be gradually increased. Training videos of the teaching content can be viewed free of charge on the Internet, so that not only repetition, but also a further development of skills basing on the short training is possible. For students in higher semesters, such practical procedures can also provide an insight into the respective subject area and thus counteract the shortage of specialists in surgical subjects.

Conclusion

Surgical training on suitable simulators is well received by prospective surgeons and improves surgical skills subjectively, but also measurably. With structured curricula, the relevant training can be conveyed effectively and inexpensively. The lack of young people in surgical medical subjects is multifactorial, but good training concepts can make surgical subjects more attractive, at least from the practical side. Therefore in our eyes, a permanent establishment of basic operation training on the simulator with basic training already at an early stage appears to make sense.

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