



## Endoscopic surgery: talent or training?

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### Abstract

**Purpose** There are two groups of undergraduate students involved in endoscopic surgery with different degrees of experience: average and more experience. This study proves whether the subjective impression of the laparoscopic trainer is verifiable and which factors influence extreme talent.

**Methods** 21 medical students of the eighth term of the University of Witten-Herdecke participated in the study. On their first course day, students got instructed in suturing and knot technique. They were then required to tie a maximum of five knots within 2 h. After a week, students repeated this procedure. Time used for tying knots was stopped.

**Results** Regarding the time students used for their first knots, great differences were provable (7–8 min, average 23 min). However, an adaption of the knotting time was noticed at the end of the first course day. This was confirmed during the second course day. Neither acquired factors (music, sport, etc.) nor individual factors (visual acuity, handedness, etc.) had any impact on the time used for knotting. Merely, one advantage was seen with the first knots with the factors of playing the guitar and having a more than 10-h surgical previous experience. Knotting times leveled off at 95% to less than 10 min, though.

**Discussion** Neither normally talented nor extremely talented junior surgeons could be noticed, and so could not the co-factors providing an advantage or disadvantage for surgery, respectively. All prospective surgeons can learn defined tasks (knots) by short interval training, and thus show similarly good results after a few repetitions.

**Keywords** Junior surgeons · Simulated training · Endoscopy · Talent · Student teaching

### Purpose

During the past decades, laparoscopic surgery has become an integral surgical method for many standard operations in various specialties [1]. The success of a laparoscopic surgery does depend not only on the surgical equipment, but also on the training level of surgeons [2].

Gallager and Satava classified surgeon's training status into novices, juniors, and experts. Novices performed less

than 10, juniors 10–100 and experts more than 100 surgical procedures, respectively [3]. Experienced surgeons trained novices and juniors mainly on patients and increasingly on simulators. The use of simulators is not part of the surgical training curricula, and therefore has not been standardized yet [4].

Training programs for novices and juniors focus on performing different skills. Novices are trained to perform suturing and knotting. Juniors training includes practicing suturing and knotting, e.g., in more difficult areas of surgery, and train on more complex operation. Furthermore, with increasing level of training, juniors practice complication management and refreshment of anatomical knowledge with regard to difficult surgical sites. Using simulators, dangerous training on humans can be replaced by simulation to train novices and juniors. Both approaches show learning curves. With regard to surgery times, acceptable surgical result and low complication rate, learning less and more complicated surgeries required 10–30 and 50–70 repetitions, respectively [5].

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Despite these objective learning curves, trainers frequently get the subjective impression that a couple of prospective surgeons seem to be “more gifted” than their contemporaries.

The current study determines factors distinguishing a potentially “talented” from an “average” junior surgeon. Thus, prospective surgeons can be offered customized training programs based on their talent.

## Methods

21 undergraduate medical students took part in the endoscopic suture teaching program (ESTP). The training consisted of two 2-h sessions using one traditional inorganic simulators (box trainers) for each student. The aim of the first session was to teach candidates to tie a maximum of five knots in a given period of time. We introduced each trainee to knot and suture techniques. We then asked them to perform three knots ideally followed by a continuous suture starting and ending with a knot. Every complete knot consisted of a double knot in one direction and contrary. It was essential that the knots were tight. This was simplified by the use of Vicryl sutures and tissue imitations. We recorded knotting time. Knotting was defined as beginning to the end of the double-threaded knot. We limited the training duration to 2 h, even if the candidates did not perform all five knots. One week later, we invited the candidates to training simulation. We required to tie one single knot and two continuous sutures, each starting and ending with a knot.

The course schedule is demonstrated by a flowchart (Fig. 1). The time required to tie the knots was a parameter for student surgical skill. Individual factors such as physical size, body weight, height, gender, age, myopia, or right-/left-handedness were collected in a questionnaire and

evaluated. Furthermore, the questionnaire included previous experience like prior laparoscopic assistance in hours, artistic activities, or other co-factors (e.g., sport, playing a musical instrument).

For statistical analysis, we performed an explorative data analysis using SPSS Version 24 (IBM, Armonk, New York, USA) to determine average times of knotting. A positive ethics committee vote has been received for this study from the local Institutional Review Board (93/2009).

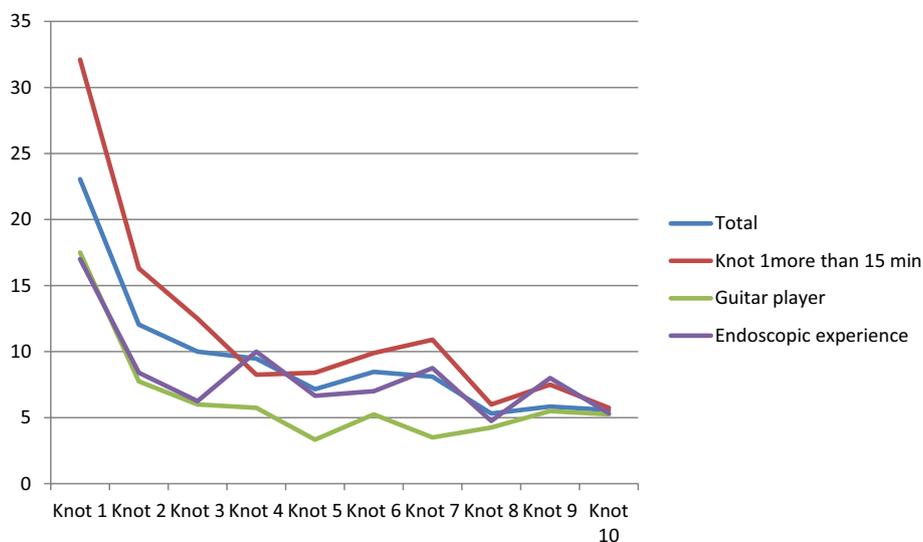
## Results

81% (17/21) of the students attended both course days. Therefore, their data and complete questionnaires were used. 2/21 (9.5%) trainees took part in only one of the sessions. Three of them (14.3%) did not complete the questionnaire. The time needed to perform the first knot averaged 23 min (median 20 min, 7–45 min), while tying the last knot in the second required only 6.2 min (median 5.5 min, 2–13 min). Whereas 90% (17/19) of the participants needed more than 10 min for their first knot in the first session, only one participant (5%) required more than 10 min (19 min) tying his last knot in the second session.

After a 1-week training, all 17 participants, who already took part in the first session, started with lower- or at the same low-level knotting times (on average 6.7 min quicker) compared to their very first knot. 53% (9/17) of the trainees were faster than with their last knot of the previous session.

In the subgroup analysis, female participants were slightly faster with their first and last knots than their male colleagues (21.9 min vs. 22.11 min; 5.375 min vs. 6.81 min). Surgeons who initially required longer knotting times showed within the first five knots a steeper learning curve.

**Fig. 1** Graphic scheme of the median nodding time-whole collective vs. subgroups endoscopic experience, guitar and long first nodding times



Female candidates, who were able to play a musical instrument ( $n = 10$ ), needed for their first knot 22.9 min (7–38 min) versus 20.9 min (16–43 min) for those not playing a musical instrument. For their last knot, the average time was 6.27 min (2 min–9 min) versus 6.22 min (2–6 min).

The knotting of guitar-playing candidates ( $n = 4$ ) was lower in knotting 17.5 min (10–28 min) for the first knot and 5.25 min (2–8 min) versus 5.69 min (2–6 min) for the last knot.

Female candidates with surgical experience  $> 10$  h ( $n = 5$ ) needed for their first knot 17 min (7 min–43 min) versus 25.2 min (10 min–45 min) in non-experienced females and for their last knot 5.3 min (3–7 min) versus 5.6 min (3–13 min).

Female candidates desiring surgery as their profession ( $n = 17$ ) required for the first knot 21.3 min (7–45 min) versus 32.3 min (29–38 min) and for the last knot 4.6 min (2–8 min) versus 8.7 min (4–13 min) in the rest of the trainees. Further co-factors which were investigated can be reviewed in Table 1.

There was no significant difference between right- and left-handed participants. By contrast, the times for the first three knots tied by students with laparoscopic assistance experience of at least 10 h were 4.6 min faster (6 min vs. 10.6 min) if compared with students having less than 10 h or no previous laparoscopic assistance experience (see Fig. 1). Manual previous experience, e.g., playing a musical instrument and knitting do not have a positive effect on the pace of tying knots. However, the subgroup of guitar-playing

candidates was continuously showing shorter knotting times than the other subgroups. After having tied approximately ten knots, we observed a leveling. Guitar-playing students were performing their knots 3.5 min (35.4%) faster than the average. This is for the criterion of the duration of surgery 6.4 min versus 10.6 min.

## Discussion

Our study proves that a simple, defined task (knots) practiced on simulators shows a time improvement after two training sessions with an interval of 1 week. 95% of the participants managed the task within 10 min. The outcome justifies classifying novices and juniors. However, the difference between the two groups even when the juniors' level (more than 10 knots) has been reached by all candidates.

Leveling is also watched with further factors like “playing musical instruments”, particularly the guitar, “visual sight” or “surgery as a career goal”.

According to our study, other factors, e.g., handedness, gender and the like did not primarily affect knotting times.

Our study does not prove a clear “talent factor” at least for novices and juniors. When doing the first steps in surgery, several factors seem to influence knotting times to a certain degree. With repetitive training, the “talent factor” disappears rendering all trainees equal. After having tied ten knots, these factors do not play a role. Our study reveals that everybody can learn basic surgical steps like endoscopic knotting irrespective of the duration of performing the first knot.

Test persons who required a very long time for tying their first knots showed clearly a steeper learning curve than test people with moderate knotting times (Fig. 1).

From behavioral point of view, the learning aim “nodding” is just a partial factor of the operative success. To reach the expert level, superior operative learning goal overview can be defined. This includes that all simple partial steps work as an automatism and therefore, cognitive valences can stay free which makes it possible to react on unsuspected happenings in an adequate way [6–9]. Here, the correct, target-aimed reaction is part of the (expert) learn effect resulting from repetitive training. The extent of the talent factor on reaching the expert level can not be assessed with the existing data; indeed, the basics and, therefore, also the automatisms seem to be well communicable to everybody with repetitive training independent of co-factors.

In our study, a time limit of 2 h was set; the results show that one reason for not reaching 5 nodes was long nodding times in the first nodes performed. Surprisingly, these candidates achieved similar nodding times like candidates who could perform all nodes at the first training day within an interval of 1 week and they could perform all five nodes on

**Table 1** Median nodding time of single subcollectives

Examined factor	Nodding time first node (min)	Nodding time last node (min)
Surgical experience $> 10$ h ( $n = 5$ )	17	5.33
Less than 10 h ( $n = 14$ )	25.21	5.64
Surgical profession goal ( $n = 17$ )	21.31	4.62
Conservative profession goal ( $n = 2$ )	32.33	8.75
Handcraft experience ( $n = 11$ )	24.7	5.11
No handcraft experience (8)	20.11	6.125
Glasses or contact lense ( $n = 6$ )	26.17	5.2
No seeing aids ( $n = 13$ )	21.62	5.58
Sportive active ( $n = 18$ )	24.47	3.92
Sportive not active ( $n = 1$ )	18	7
Men ( $n = 10$ )	22.11	6.81
Women ( $n = 10$ )	21.9	5.375
Music instrument ( $n = 10$ )	22.9	6.27
No music instrument ( $n = 9$ )	20.9	6.22
Subgroup guitar ( $n = 4$ )	17.5	5.25
Knitting ( $n = 6$ )	23.83	5.5
No knitting ( $n = 13$ )	22.69	6.5

the second course day. This affirms studies favoring short training units with repetitive interval training, also from the behavioral point of view [10]. Learned steps are internalized and processed mentally in the training-free interval (known as processing). Therefore, it is best to plan courses with interval times. Unfortunately, due to organizational reasons, training programs occur on 1 day or 2 days with a shortened (night) interval. Therefore, it would be desirable to create possibilities of repetition in the clinics of origin. Whereas box trainers are available at most clinics, often there is a lack of infrastructure (e.g., missing practicing instruments, laparoscopes with self lock for autarkic training, fix practicing station without long assembly time).

A limitation of our study is the low number of participants (21 students). Nevertheless, the resulting data are relatively uniform; a similar leveling of nodding times on a first plateau can be expected on a larger collective. This assumption is supported by other studies showing that operation times of complex surgeries as well as of surgical partial steps approach to an appropriate plateau after 10–70 repetitions according to the degree of difficulty [7–9]. It is not possible to state a statistical significance level for all subgroups, so tendencies could be established. Finally, the data show very homogenous nodding times at the end of the second course day in contrast to the very first nodes. Basically, the current study shows that nodding times can be improved in all candidates after a short period of time with the help of repetitive interval training independent of eventual initial influencing factors.

Our study examined different factors as well as disturbances influencing each other. It can be supposed that, for example, students wanting to become surgeons already possess surgical pre-experience (e.g., from medical clerkships). To avoid these disturbances/confounders as well as overlaps, a multivariate regression analysis is required. Since it has a small impact on our study aim, we have refrained from doing such an analysis. After consulting the local institute for medical statistics, the subgroups should have included much larger sample sizes in such a case (see Table 1). Especially, for individual factors supporting the ambidexterity, we would have expected an advantage for endoscopic surgery. In contrast, our results are showing a disadvantage. So, the nodding times for trainees participating in mechanic activity, playing an instrument and being able to knit tend to be higher. Solely in the subgroup of guitar players, continuous shorter nodding times in the first node are observed. Indeed, very homogenous nodding times are found after two course days, so that a “talent factor” in guitar players can not be hypothesized.

Our study shows that learning of endoscopic suture and nodding techniques in first line seems to be promoted by practicing and is not dependent of talent or co-factors. Simulators build an adequate instrument for instructors to realize

the learning goal according to the individual level of education in a low-risk surrounding. Creating an objective and transparent certificate for acquiring these skills is possible using simulators. Medical doctors first practicing the implementation of an operation with its single steps on a model have a significant shorter surgery time and lower complication rate [11–13]. The implementation of such training models could also be an argument for patients to decide for a certain hospital. From the ethical point of view, practicing on a training model before doing the first operation on a patient seems to be an urgent requirement. A limiting factor for the wide-spread use of simulators or even the implementation into the surgical curriculum is cost. While institutions employing other professionals, e.g. pilots, finance the necessary training of their employees to guarantee the quality of their performance, surgeons have to finance their own training in many instances.

Finally, our study can help to establish similar education schemes using simulators for surgeons, comparable to pilot training.

## Conclusions

Our retrospective study shows that endoscopic knotting is primarily influenced by training and is not determined by surgeon’s talent. All prospective surgeons can learn defined tasks (knots) by short interval training, and thus show similarly good results after a few repetitions.

**Authors’ contributions** SF, JCR-preparation of the manuscript, data analysis, literature review, ES-statistics, PS-layout, AH-language editing, EFS-counseling, proof of content, MB-figure, CS-tables, data collection, study design.

## Compliance with ethical standards

**Conflict of interest** The authors declare that they have no conflict of interest.

**Ethical approval** The study was conducted in concordance to the ethical standards of the institution.

**Informed consent** All 21 candidates signed an informed consent due to ethical standards before initiation of the study.

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