Chapter 2

Open knotting skills

Resident skill assessed

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Abstract

Background: Open knot tying- and suturing skills are fundamental surgical skills, founding many alternative knot tying techniques. It is therefore mandatory for residents to possess adequate basic open knot tying skills. The aim of this study was to compare an objective assessment of open knot tying skills by residents to a residents own estimation of his or her knot tying skills, before and after a knot tying course.

Method: A prospective observational cohort study was performed. At baseline level, after one training day in the Advanced Suturing Course (ASC) in The Netherlands and Belgium and after six weeks of autonomous practice (i.e., self practice), ninety-nine residents' open knot tying skills were objectively evaluated using the Objective Structured Assessment of Technical Skills (OSATS), as was a resident's own confidence in these skills evaluated.

Results: The ASC substantially significantly improved residents' knot tying skills according to the OSATS between baseline and post measurement. The observed improvement after one training day decreased after six weeks of autonomous practice. Self-confidence increased directly after the training program and was maintained six weeks later. Residents having completed the first three years of residency displayed an overall greater self-confidence than residents not having completed the first three years of residency, although the increase in self confidence was significantly larger in the latter after six weeks autonomous training.

Conclusion: There is a divergence between residents' objectified open knot tying skills and self-confidence in these skills. The ASC improved open knot tying skills

according to the OSATS, however this improvement decreased after a six-week period of autonomous practice. Self-confidence, in contrast, was maintained or increased. Further research is needed to correlate validated training programs with clinical outcomes and to determine whether residents open knot tying skill and self-confidence retain beyond 1 year.

Introduction

Despite the importance of technical skills, less than 1% of all surgical residents are tested on their open knot tying techniques[1]. Open knot tying and suturing skills are fundamental and critical to ensure safe performance of all operations[2]. Training in basic surgical skills should be a primary component in the education of a surgical resident. Considering patient safety, working hour restrictions and budgetary constraints, many hospitals have developed laboratory-based training programs using bench models and simulators to train surgical skills. Several structured proficiency-based curricula for the education and assessment of basic surgical skills have since been evolved, validated and implemented[3-6]. Detailed curricula training in open knot tying skills have not been extensively evaluated. To our knowledge, two prior studies focused on the utility of bench models for open knot tying skills[2;7]. However, these programs are educated during a medical students' surgical rotation, not surgical residents[8;9]. The assessment of open knot tying and suturing skills is typically performed at the end of a rotation and mostly based on a recollection of the student's performance during that rotation. This assessment has been proven to have poor reliability and validity and is often biased by factors other than technical

skill[10]. The gap between a medical student's training and implementation of knot tying skills during surgical residency results in a loss of skills during this time. Goova et al. assessed the baseline proficiency of primary-year surgical residents before and after participation in an open knot-tying and suturing training program, using the modified Fundamentals of Laparoscopic Surgery scoring system[11]. They found a significant score-increase during the course[12]. It may be important for trainees to rate their own personal skills and to assess the effect of training on these skills.
This subsequently encourages their own responsibility for professional skill and competence development[13;14]. The implementation of self-assessment moments within supervised training programs has been demonstrated to improve self-confidence[15;16]. The aim of this study was to evaluate residents' self-confidence in open knot tying techniques and compare this self-confidence with an objective measurement of these skills using the Objective Structured Assessment of Technical Skills (OSATS) assessment. The effect of a open knot-tying course was evaluated.

Materials and Methods

A prospective observational cohort study was conducted in The Netherlands and Belgium between February 1st and April 30st 2011.

Study group

A total of 99 surgical, gynaecological and urological residents voluntarily participated in the Advanced Suturing Course (ASC), a laparoscopic and open knot tying course organized by the VU Medical Center in Amsterdam, Netherlands. Residents were

allowed to enroll in this training program after having completed the first one-and-a-half years of their residency program, as basic open and laparoscopic knot-tying trainings are then completed.

Training program

The ASC consists of one training day followed by six weeks of voluntary autonomous training at home. The first training day entails an extensive repetition of open-, square-, surgeons- and slipping- knot tying techniques. These techniques were trained by using a knot-tying board and cotton thread. Training was intensively supervised by at least two senior (gynaecological) surgeons providing instructions and feedback. The resident-supervisor ratio during the course was 4:1. All equipment and supervisors were kept identical during both training days.

To perform an open knot, a valve-tube imitating a blood vessel put around an upside-down valve tightened to a board was used. A surgical clamp was held by the supervisor on the tube to enable participants to perform a square knot ligature around the valve-tube.

Evaluation of skills

The open knot tying skills of each participant was evaluated immediately before and after the first course-day, and again after the six-week autonomous training period. This evaluation included an evaluation of self-confidence using a VAS of 0-100 and an objective assessment using the OSATS by senior laparoscopic surgeons of the department of surgery or gynaecology.

Regehr et al. demonstrated that a global rating scale such as the OSATS demonstrates a high inter-observer reliability between surgeons of different skill

(construct validity)[17].The OSATS consists of five scoring items covering the fundamental aspects of open tying techniques (Appendix 1). A score of 1 to 5 is given for each item, resulting in a total score between 5 and 25. We did not score time as an indicator for performance since this is not necessarily a good surrogate for ability[18]. 75% of the maximum OSATS score was used as cut-off value[19;20].Trainees were given 5 minutes to complete an open knot.

Statistical analysis

Data were analyzed using SPSS 15.0 for Windows (SPSS Inc., Chicago, Illinois, USA). Data was tested for assumption of parametric testing which revealed it is safe to perform parametric tests. Differences between the evaluation points in mean confidence scores and mean OSATS-scores were assessed by using multilevel analysis statisticals. A comparison was made between baseline measurement and post measurement (effect of the training program) and between post measurement and follow-up measurement (long-term effect of the training program after six weeks of self-practice). Additionally, differences between residents with fewer than three years of residency and residents with four to six years of residency and differences between residents from gynaecology, urology and surgery were analyzed. The relation between self-confidence and OSATS scores was assessed using Pearson correlation analyses comparing difference scores between baseline measurement and post measurement (effect of the training program) and between post measurement and follow up measurement (long-term effect of the training program after six weeks of self-practice). Results are reported as mean (±SD) and all *p*-values reported are two sided; a significance level of less than 0.05 was considered statistically significant.

Results

Out of 99 residents, 57.6% (n=57) had completed less than three years of residency and 42.4% (n=42) were between fourth and sixth year of residency. Specializations included 81.8% (n=81) in generally surgery, 10.1% (n=10) in urology and 7.1% (n=7) in gynaecology (1 resident did not mention his or her specialization).

Objective assessment

Out of 99 residents, 70.7% (n=70) were evaluated at the start of the training program (baseline), 67.8% (n=67) after the first training day (post) and 48.5% (n=48) after six weeks of autonomous training (follow-up). OSATS scores are presented in Figure 1.

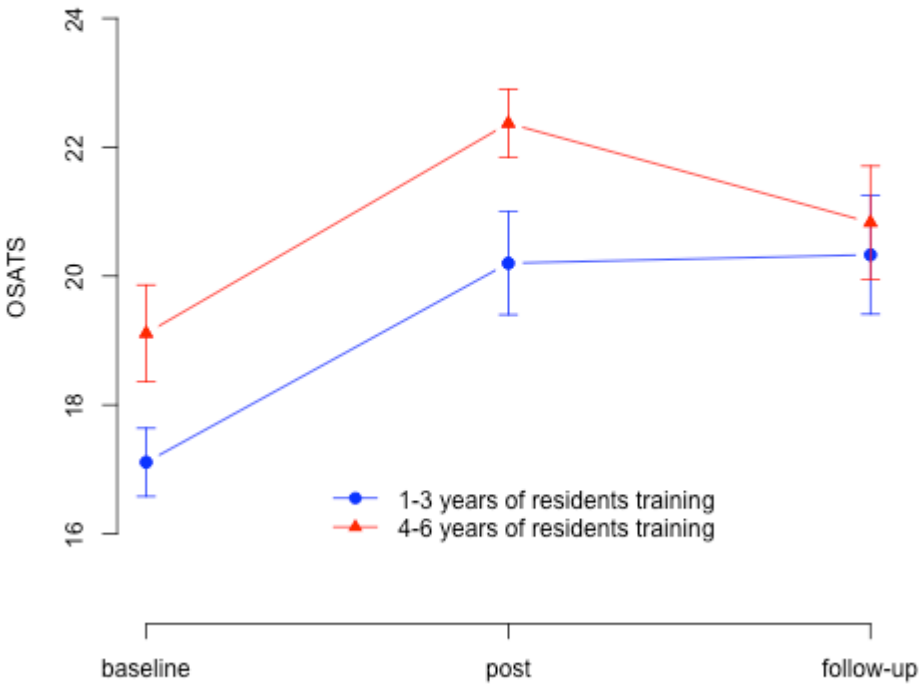

Figure 1. Means and standard errors of objective assessment of surgical techniques (OSATS-scores) for both experimental groups separately.

OSATS scores increased significantly between baseline and post measurement (p = .002). However, the objective evaluation of surgical techniques OSATS scores did not change significantly between post measurement and follow up measurement (p=.824). Overall, the changes in OSATS scores were similar for residents in their first three years of residency and residents after their first three years of residency (p = .841; p = .223) Overall, residents with 4-6 years of resident training demonstrated slightly higher mean OSATS scores compared to residents with 1-3 years of resident training, yet not statistically significant (p = .144). Overall, there was no significant difference in OSATS scores between residents from different specializations (p = .414). The changes in OSATS scores between baseline and post measurement and between post measurement and follow up measurement were similar for residents from different specializations (p=.866, p=.866).

Self-confidence

Of participating residents, 100% (n=99) evaluated their own self-confidence in open knot tying skills at baseline, 92.9% (n=92) at post measurement and 87.9% (n=84) at follow-up measurement. Self-confidence scores are presented in Figure 2.

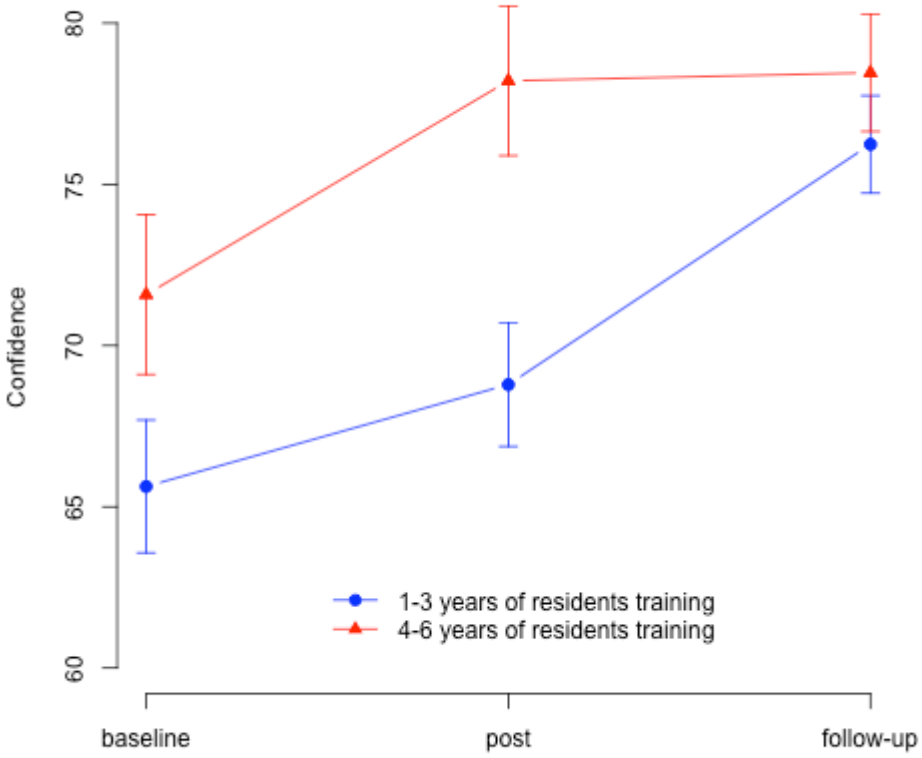

Figure 2. Means and standard errors of residents' confidence of surgical techniques for both experimental groups separately.

Mean confidence scores in open knot tying skills increased significantly between baseline and post measurement (p = .004). Also between post and follow up measurement, mean confidence scores increased significantly (p < .001). The increase in mean confidence scores between baseline and post measurement was similar for residents with different years of residency training (p = .580), but during the six-week period of self-practice the increase in mean confidence scores was significantly greater for residents with fewer than three years of residency experience than for residents with four to six years of residency experience (p = .010). However,

residents having completed four to six years of residency reported significantly higher mean confidence scores compared to residents with less than 3 years of residency (p = .002). Overall, there was no significant difference in self-confidence scores between residents from different specializations (p = .430). The changes between baseline and post measurement and between post measurement and follow up measurement were similar for residents from different specializations (p=.806, p=.779).

Self-confidence and objective measurement relations

The increase in reported self-confidence in open knot tying skills for both groups of residents between baseline and post measurement was not significantly related to the increase in objective score of these skills (r = .282, p = .172; r = -.007, p = .972). This relation was also not significant between post measurement and follow up measurement (r = .237, p = .234; r= .332, p = .193).

Discussion

Although it is known that basic skills acquired in a laboratory setting are transferable to the operating theatre[21;22], there is a lack of longitudinal assessment with objective feedback regarding open knot tying techniques[8]. To our knowledge, this is the first study comparing an objective assessment of open knot-tying skills to self-confidence in these skills. Proficiency based training curricula that consist of structured practice, using performance-derived training endpoints that provide constructive feedback, optimal learning, repetition and durable skill acquisition have not been widely reported.

Participating residents were relatively insecure regarding their open knot-tying skills at the start of the training program but did estimate their proficiency level in these skills as sufficient. The training program improved both residents' knot-tying performance and self-confidence. The increase in self-confidence over time was expected; experience in a procedure increases self-confidence[23]. Although self-confidence improved over time, the increase in self-confidence did not correlate to an objective improvement of performance. Residents were only minimally proficient six-weeks post training. Self-assessment scores have been shown to poorly correlate with the objective assessment of these skills[10] (as is shown in our study), this essentially contributes to the motivation of trainees to improve their technical skill[15]. Although self-assessment helps to recognize deficiencies and create an awareness of deficiencies, these results emphasize the need for repeated practice to improve not only residents' self-confidence but also objective performance. Draycott et al. found in a retrospective observational study that the introduction of shoulder dystocia training improved management and neonatal clinical outcomes of births complicated by shoulder dystocia[24]. Further study is needed to determine whether residents open knot tying skill and self-confidence retain beyond 1 year.

One training-day induced only a temporary improvement in open knot-tying skills. The authors feel the initial improvement during day 1 may be caused by a refreshment and training of the resident's knowledge and techniques in open knot tying skills during day 1. An absence in training or an absence of correction of skills during the 6-week autonomous training interval may explain unaltered scores on day 2.

It is known that technical skills are better retained by residents when training is distributed over a number of training sessions[25]. Our results emphasize the

requirement of repeated training of basic surgical skills –such as the open knot-tying technique in this study- to improve both confidence and objective performance of these skills.

Objective feedback might be crucial in the acquisition of clinical skills. Feedback induces motivation, supplies reinforcement for correct actions, dissuades incorrect actions and may provide information on errors as a basis for correction[26]. However, constant professional feedback outside the operating theatre is expensive and logistics infeasible. Thereby feedback during operations is not always constructive as most of the current generation supervisors did not participate in an open knot-tying course themselves or assume residents to be suitably qualified. In contrast to our study, a self practice format using video-based tutorials can minimize personnel resources and simplify scheduling issues[8]. We think that a validated basic skills curriculum for open knot tying techniques is needed to maintain a sufficient open knot tying skill level.

The task used in this study was robust and there were no problems with our training model. Although more complex assessment strategies including global ratings, video-based scoring systems, motion tracking devices or tensiometers have been successfully used in other studies[7;17;22;27-32], we used a simple scoring system using the elaborated validated OSATS. Cut-off values for OSATS have only been defined in a study by Bijen et al (2009) at 75% of the maximum OSATS score[19;20]. Further studies are needed to establish a benchmark proficiency level for credential purposes. Several previous studies have demonstrated the reliability and validity of the OSATS[17], therefore inter-rater reliability was not assessed in this study.

Our findings are limited for several reasons.

We only assessed residents participating in the ASC. Since the ASC is designed mainly to train in laparoscopic techniques, residents might have spent most time practicing laparoscopic skills and not their open knot-tying techniques. To more accurately assess the influence of autonomous home training on open knot tying techniques, future studies should investigate the time spent on training on this skill.
Second, objective evaluation of open knot-tying technique was by direct observation by a supervising surgeon. As such, observers were not blinded, introducing a possible risk of bias. A more objective – but expensive and time consuming - form of evaluation could be video-guided assessment.
Third, in contrast to other studies, we did not use time as a performance indicator[12]. Since there is a limited amount of studies available on open knot tying techniques assessment, we could not set any evidence based goals for assessment. However, we know that residents perform better if goals are set[33].
Finally we did not correlate this training with clinical outcome. Open knot tying is considered a very important basic surgical skill although rates of complications associated with insufficient knot tying skills are not known. The (surgical) consequences of poor knot tying skills, and therefore procedural skill, seem obvious. Associating the implications of this study in a clinical setting would be compelling, however it is hard to relate a decline in clinical complications to participation in this course as many factors are associated with complications, as well as it is ethically challenging.

Conclusion

We emphasize the need of repeated training of basic surgical skills and continuous feedback of skills. The training program improved both residents' knot-tying performance and self-confidence. Residents appear to be unable to adequately estimate their open knot tying skills. Further research is needed to correlate training programs with clinical outcomes and construct a validated basic skills curriculum including certification. In our opinion, constructing a validated basic skill curriculum for open knot tying techniques with predefined endpoints, assessment and external feedback is mandatory to ensure adequate basic surgical skills.

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Appendix 1

OSATS form, Open suture around vessel using clamp

Time of assessment: baseline / post / follow-up

1. Knowledge and handling of materials: **Correct position of suture around clamp**

1	2	3	4	5
Suture too far under clamp				Suture directly under clamp

2. Knowledge and handling of instrument: **Correct utilization of thread in hands**

1	2	3	4	5
No crossing of sutures at first knot *and* at second knot threads repacked		No crossing of sutures at first knot *or* at next knot threads repacked		Sutures crossed at first knot *and* at second knot threads not repacked

3. Use of assistants: **Order for removal of clamp delivered at correct time**

1	2	3	4	5
Removal of clamp too early		No or too late clamp removal		Clamp removed at correct time

4. Respect for Tissue: **Suture / hands movement towards tissue**

1	2	3	4	5
Tissue pulled towards hands during suture closure		During closure of suture tissue pulled partially towards hands		During suture closure hands moved toward tissue

5. Knowledge of specific procedure: **Square knots**

1	2	3	4	5
No square knots		Mostly square knots		Only square knots

6. Time: **Time to perform open suture around vessel using clamp:** … min … sec