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SURGICAL ENDOSCOPY
and Other Interventional Techniques

The impact of objective assessment and constructive feedback on improvement of laparoscopic performance in the operating room

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Abstract
Objectives: The study was carried out to demonstrate the impact of assessment and constructive feedback on improvement of laparoscopic performance in the operating room (OR).
Design: Sixteen surgical trainees performed a laparoscopic cholecystectomy in the OR. The participants were then divided into two groups. The procedure performed by group 1 was assessed by an experienced surgeon, and detailed and constructive feedback was provided to each trainee. Group 2 received no feedback. Subsequently, all subjects performed a new laparoscopic cholecystectomy in the OR. Both operative procedures were recorded on videotapes and assessed by two independent and blinded observers using a validated scoring system.
Main outcome measures: Error and economy of movements score assessed during the laparoscopic procedures in the OR.
Results: No differences in baseline assessments were found between the two groups (t-test, $p > 0.5$). Surgeons, who received feedback (group 1) made significantly greater improvement in their time to complete the following procedure (independent sample t-test, $p = 0.022$), error (t-test, $p = 0.003$) and economy of movement scores (t-test, $p < 0.001$).
Conclusions: Surgeons who received constructive feedback made significantly greater improvement in their performance in the OR compared with those in the control group. The study provides objective evidence that assessment is beneficial for surgical training and should be implemented in the educational programmes in the future.

Key words: Surgical training — assessment — Feedback — Laparoscopic surgery

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Surgical training has been a subject for intensive debate during the past decade and a number of scientific reports have suggested the need for assessment as an integrated part of the educational process [1, 2]. To date a number of tools, have been developed and validated to assess surgical performance in the OR, identify possible errors and insufficient performance and provide detailed feedback to the operating surgeon based on objective criteria [3, 4, 5]. However, these tools remain limited to research practice, probably due to lacking evidence on their impact on the quality of the training process and patient safety.

Previous reports have highlighted the importance of skills evaluation and active supervision on the quality of the teaching process [1], indicating that surgical errors are unlikely to be corrected unless clearly identified and communicated to the trainee. Despite these potential advantages, structured assessment of technical skills and systematic feedback have not been introduced into current practice of surgical education.

The hypothesis of the current study was based on the assumption that structured feedback based on objective assessment can be a valuable tool in current surgical training and can contribute to improve performance in the operating room.

Materials and Methods

The study was carried out at a department of abdominal surgery at a teaching hospital in Copenhagen, Denmark. Sixteen surgical trainees (nine females) with similar, limited experience in laparoscopic surgery [median two cholecystectomies (range 0–10)] were recruited in the study. The first eight consecutive participants performed a supervised cholecystectomy in the OR followed by a second cholecystectomy within a two-week period. The next eight consecutive surgeons performed a supervised laparoscopic cholecystectomy followed by a 60-minute structured constructive feedback based on an objective assessment of the performance demonstrated during the first procedure. The feedback was supported by review of the videotape from the first procedure where the supervisor was able to demonstrate the

technical deficiencies and possible errors performed by the trainee. The instructions included information on optimal exposure, avoidance of common tissue-handling and technique-precision errors, and efficient use of both instruments in a coordinated manner without unnecessary moves. The feedback was provided by the same surgeon with a large operative and teaching experience in laparoscopy. Finally, a second supervised cholecystectomy was performed in the OR within a two-week period from the initial procedure. Participants were assisted by four different laparoscopic surgeons, who were instructed not to provide verbal instructions during the procedures except in case the situation was considered dangerous to patient safety. None of the trainees performed laparoscopic procedures or participated in formal laparoscopic training during the course of the study. The operations performed by the surgical trainees were video recorded and assessed by two experienced laparoscopic surgeons (SS and VK). Assessment was performed using a previously validated global rating scale (Table 1). Only the part of the procedure, starting from the point where clips were applied on the cystic artery and cystic duct including the dissection of the gallbladder from the liver bed was used in the assessment process as this was considered a standard element without significant patient variations. The time parameter included the whole procedure from inserting the trocars to extraction of the gallbladder. All operative procedures were standardised on the basis of the patient history, pre-operative investigations and intra-operative findings, excluding patients with history of cholecystitis, pancreatitis, common bile duct stones and patients with body mass index (BMI) > 30.

The reviewers were blinded to the status of the residents and performed the evaluation independently.

All participants were included in the study after informed consent.

Statistical analysis

Data was analysed using SPSS 10.0 software package. Normal distribution of the data was confirmed using *Q-Q* plots. The primary outcome measure was the change in the performance scores during the laparoscopic cholecystectomy in the OR from the first to the second procedure. Independent samples t-test was used to examine the difference of improvements demonstrated by the two groups. Degree of agreement of assessment scores provided by the two reviewers was estimated by Cohen's kappa (κ) coefficient. $P < 0.05$ was considered statistically significant.

Results

Analysis included all sixteen subjects (eight in each group), whose operative procedures were video recorded. Results are illustrated in Figure 1.

There was good agreement in the assessment scores provided by the two reviewers (Cohen's $\kappa = 0.75$, $p < 0.001$).

No differences in baseline assessments of the first laparoscopic cholecystectomy were found between the two groups (*t*-test, $p > 0.5$). Surgeons who received feedback demonstrated significantly greater improvement in their time to complete the procedure (independent sample *t*-test, $p = 0.022$), error (*t*-test, $p = 0.003$) and economy of movement scores (*t*-test, $p < 0.001$).

Discussion

The present study provides for the first time objective and quantitative evidence that structured and constructive feedback based on objective assessment does have a positive impact on the training process and can contribute to improvement of the skills relevant for the performance of laparoscopic surgery in the OR.

Table 1. Rating scale of operative performance

1	2	3	4	5
Respect for tissue				
Consistently handled tissue appropriately with minimal damage		Careful handling of tissue but occasionally caused inadvertent damage		Frequently used unnecessary force on tissue or caused damage by inappropriate use of instruments
Precision of operative technique				
Fluent, secure and correct technique in all stages of the operative procedure		Careful technique with occasional errors		Imprecise, wrong technique in approaching the operative intentions
Economy of movements				
Consistently handled tissue appropriately with minimal damage		Careful handling of tissue but occasionally caused inadvertent damage		Frequently used unnecessary force on tissue or caused damage by inappropriate use of instruments
Confidence of movements				
Consistently handled tissue appropriately with minimal damage		Careful handling of tissue but occasionally caused inadvertent damage		Frequently used unnecessary force on tissue or caused damage by inappropriate use of instruments

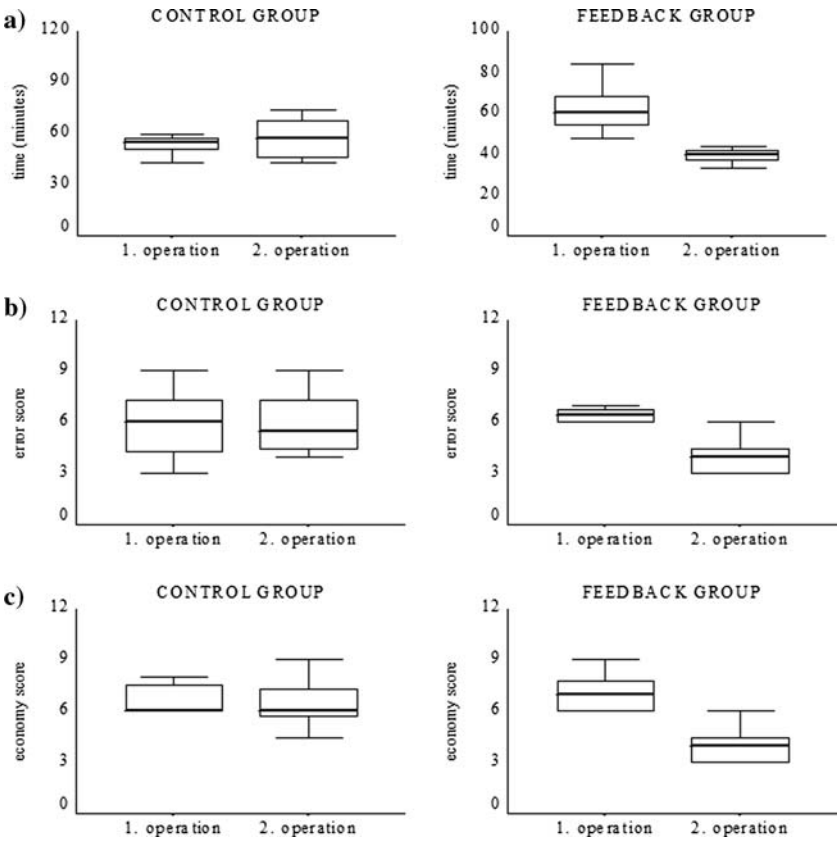

Fig. 1. Comparison of operative performance between the group with feedback and the control group. Time (minutes) to perform the procedure (a). Error scores (b). Economy scores (c). Horizontal bands indicate medians, boxes indicate 25th and 75th percentiles, and whisker lines indicate largest and lowest values. Statistical details are given in the text.

In current practice, a number of tools of surgical skill assessment have been designed and scientifically validated. These include virtual reality simulation, motion analysis and assessment in the OR using global and procedure specific checklists [3, 4, 5]. However, no teaching institutions worldwide have implemented these tools routinely into their clinical practice. This is probably due to the high cost of training and assigning personnel to administer activities not directly linked to the treatment process. Previous reports have indicated that evaluation of surgical competence can be of great benefit for the training process, patient safety and accreditation and certification [1]. Feedback based on objective assessment can play a major role in the process of acquisition of surgical skills. Reports have stressed that deficiencies in performance are unlikely to be corrected unless there is a mechanism to provide reliable and systematic feedback [6].

To date a few tools have been demonstrated to have impact on improvement of surgical performance in the OR. Previous studies have demonstrated that surgeons who receive training in a virtual environment perform better in the OR than controls [7, 8]. We believe that an ideal training program should implement all tools with proven benefit to the learning process to overcome the familiarisation curve associated with any new procedure in a safe and feasible fashion [9, 10].

We assessed the skills demonstrated during placement of the clips on the cystic artery and duct, transecting both structures and removal of the gallbladder from its attachment to the liver. This part of the procedure was considered as standard and independent of patient variations, thus providing a setting of similar difficulty level. Furthermore, standardisation of the procedures was performed on the basis of the patient history, preoperative investigations and intraoperative findings.

There existed significant agreement in the performance scores provided by the two observers, indicating that the assessment method was reliable and valid. The rating scale for assessment of operative performance was originally developed and validated by Martin et al. for assessment during live observation [4] and later modified for the use in video assessment [8].

The present study may have limitations. Scoring of the performance in the OR procedure was subjective. This was, however, minimised by defining objective and easily assessable scoring criteria using a previously validated rating scale. Assignment of trainees to feedback or control was not by randomisation, but by using two consecutive groups. The potential risk of selection bias was avoided by including only subjects with similar operative experience. Furthermore, we demonstrated similar baseline levels of technical skills between the two groups as measured during the first procedure in the OR.

Our results suggest that junior surgeons who receive structured assessment and constructive feedback by an experienced colleague demonstrate greater improvement of technical skills in the OR compared with subjects who receive no feedback. This indicates that assessment and feedback are valuable tools in the educational curricula

in minimally invasive surgery and can potentially contribute to shortening of the learning curve and avoiding complications in the OR. We believe that a modern training programme should incorporate all tools with proven impact on skills acquisition into a multimodal comprehensive programme. Our work provides valuable information to surgical programme directors and can be used for optimising the training process in the future.

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