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Development of a Standardized Training Course for Laparoscopic Procedures Using Delphi Methodology

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BACKGROUND: Content, evaluation, and certification of laparoscopic skills and procedure training lack uniformity among different hospitals in The Netherlands. Within the process of developing a new regional laparoscopic training curriculum, a uniform and transferrable curriculum was constructed for a series of laparoscopic procedures.
The aim of this study was to determine regional expert consensus regarding the key steps for laparoscopic appendectomy and cholecystectomy using Delphi methodology.

METHODS: Lists of suggested key steps for laparoscopic appendectomy and cholecystectomy were created using surgical textbooks, available guidelines, and local practice. A total of 22 experts, working for teaching hospitals throughout the region, were asked to rate the suggested key steps for both procedures on a Likert scale from 1-5. Consensus was reached with Crohnbach's $\alpha \geq 0.90$.

RESULTS: Of the 22 experts, 21 completed and returned the survey (95%). Data analysis already showed consensus after the first round of Delphi on the key steps for laparoscopic appendectomy (Crohnbach's $\alpha = 0.92$) and laparoscopic cholecystectomy (Crohnbach's $\alpha = 0.90$). After the second round, 15 proposed key steps for laparoscopic appendectomy and 30 proposed key steps for laparoscopic cholecystectomy were rated as important (≥ 4 by at least 80% of the expert panel). These key steps were used for the further development of the training curriculum.

CONCLUSION: By using the Delphi methodology, regional consensus was reached on the key steps for laparoscopic appendectomy and cholecystectomy. These key steps are going to be used for standardized training and evaluation purposes in a new regional laparoscopic curriculum. (J Surg ■:■■■-■■■. © 2014 Association of Program Directors in Surgery. Published by Elsevier Inc. All rights reserved.)

KEY WORDS: training, laparoscopy, cholecystectomy, appendectomy, Delphi technique

COMPETENCIES: Practice Based Learning and Improvement

INTRODUCTION

Minimally invasive techniques for an ever-growing number of surgical indications are adopted around the world and are becoming the gold standard for certain indications. Therefore, the need for well-trained and certified laparoscopic surgeons will increase. As working hours of surgical residents are now restricted by European directives and legislation, exposure to

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clinical material and the opportunity to operate is substantially limited in the current climate by comparison with 20 years ago. Therefore, a structured and focused training curriculum is needed for optimal utilization of the available training hours. The traditional "Master-Apprentice Model" is still most commonly used to train surgical residents, sometimes in combination with preclinical training sessions in a skills laboratory. In this model, the apprentice or resident learns to perform a procedure at first by observing the master or surgeon how it needs to be done. When the resident has assisted the surgeon several times, he will gradually be allowed to perform parts of the operation under the master's supervision until the apprentice can eventually perform it in total. The judgment of "proficiency" is solely based on the subjective opinion of the training surgeon. Moreover, when the resident has to learn a procedure from multiple surgeons, there will be a subsequent difference in what is taught and what is regarded as proficient. In an effort to overcome this nontransferrable and subjective method of grading performance, the Objective Structural Assessment of Technical Skills (OSATS) global rating scale has been adopted as a scoring system to evaluate a resident's performance on both open and laparoscopic procedures.[1,2] The OSATS global rating scale scores are saved in the digital portfolio that is implemented in all Dutch surgical training programs. A drawback of the OSATS global rating scale methodology is that it is not designed to be procedure specific. Therefore, it cannot be used for step-by-step feedback and the scoring of procedural steps. Furthermore, the OSATS global rating scale is still an instrument that displays the observer's perception of the trainee's technical skills that can have certain interobserver variability.[3,4] Therefore content, evaluation, and certification of laparoscopic skills and procedure training lack uniformity among different hospitals in The Netherlands, but probably worldwide.

We are within the process of developing a new laparoscopic training curriculum for the North-East Surgical School of The Netherlands. We aim to construct a curriculum that provides a safe, uniform, efficient, and procedure-specific training program for a series of laparoscopic procedures and make it transferrable throughout the region. Within a uniform learning curve for procedural training, we identified 6 different steps for each curriculum, from basic skills up to certification (Table 1). The identification was based on the clinical and educational experience of the teaching surgeons of the surgical school of our region. Successfully completing 1 step will be giving access to the next step, thus only teaching the residents new skills when their own learning curve is sufficient.[5]

TABLE 1. The 6 Steps of the New Laparoscopic Training Curriculum

Step 1	Hand-eye coordination on a simulator
Step 2	Basic laparoscopic skills and safety measures in the skills laboratory
Step 3	Specific procedural training in skills laboratory
Step 4	Video-assisted side-by-side training in the hospital operating room
Step 5	Operating under supervision in the hospital operating room
Step 6	Feedback through registration of results and certification

With the opportunity of simulating minimally invasive surgery (MIS), we aim to start training outside of the operating room. In our surgical school, the validated virtual reality simulator curriculum by SIMENDO (SIMENDO BV, Rotterdam, The Netherlands) is used to teach and assess the basic laparoscopic skills of the resident.[6,7] Translational studies have shown that when a surgical resident successfully completes a simulator curriculum, their performance in the operating room improves.[8,9] After successfully passing simulator practice, the resident will then learn basic laparoscopic skills at obligatory cadaver practice. What is new in our curriculum, and what distinguishes it from other existing curricula, is that we then move on to practicing procedure-specific skills on animal models or human cadavers. We will be using instruction videos to demonstrate the key steps while the resident performs them. We have already shown that INtraoperative Video-Enhanced Surgical procedure Training (INVEST) has a positive effect on the completion of the early learning curve for surgical procedural training by both increased efficiency and increased effectiveness.[10,11] After this step is passed, the resident will go to the operating theater to actually perform laparoscopic procedures on patients while being trained with the INVEST videos and supervised by an experienced instructor. The INVEST videos will be shown on 1 of the 2 (or 3) monitors available during the operations on patients, meaning a short break in actual operating. In the meanwhile, the resident and supervisor keep complete control of the operation field, because they are being able to see the live camera feed on the other monitor(s). We have also already shown that total procedure time was not lengthened by INVEST.[7]

The aim of this study was to determine expert consensus regarding the key steps required for teaching a laparoscopic appendectomy and cholecystectomy using Delphi methodology. The outcome of the Delphi panel will be the key steps that are going to be used for creating the INVEST videos for both procedures.

By teaching all surgical residents the same key steps for every laparoscopic procedure, we aim that eventually a procedure-specific assessment tool can be validated. The final goal would be to create an objective assessment, which leads to procedure-specific accreditation to be given valid for every (teaching) hospital the surgical resident will be working at. There are procedure-specific evaluation tools that have already been validated and are being used in clinical practise like the Global Operative Assessment of Laparoscopic Skills or the Operative Performance Rating System.[12-14] However, these tools are still used to evaluate residents who underwent nonstandardized training. Evaluating surgical residents on the performance of the key steps that have been the foundation of their training curriculum is a method that, for as far as we know, has not been validated.

METHODS

Study Design

To reach consensus on the key procedural steps for teaching the laparoscopic appendectomy and cholecystectomy, the Delphi methodology was used. The Delphi method is a well-established, completely anonymous, group process in which ideas are expressed to the participants in the form of a questionnaire.[15,16] Responses to the items in the questionnaire are collected and analyzed along with added comments of the experts. This leads to adding, revising, or dropping of items to be used in a second or further subsequent round until group consensus is reached.[16,17] The Delphi method avoids the possibility that the highest positioned expert is the most influential in reaching consensus and, secondly, prevents that an expert will adjust to the group opinion regardless of the evidence that supports his own opinion.

Expert Panel

In the literature, there is no guideline for the number of experts required for a Delphi survey. For this study, 21 experts were asked to participate in the study. All were experienced and currently practicing laparoscopic surgeons who are involved in training laparoscopic procedures to residents and fellow surgeons. Furthermore, they were members of the North-East Surgical School of The Netherlands and therefore representatives from every teaching hospital and some nonteaching hospitals throughout the region. The individual experts were not informed about their fellow participants in the panel.

The Delphi Questionnaire

We constructed a list of the possible key steps required to perform a laparoscopic appendectomy and cholecystectomy and they were mailed to the experts. The nonresponders received digital versions as reminders. The key steps were compiled from surgical textbooks and current guidelines from the Society of American Gastrointestinal and Endoscopic Surgeons,[18,19] the European Association for Endoscopic Surgery,[20] and the Association of Surgeons of The Netherlands.[21] Each possible key step indentified from these sources was included in the survey for completeness (Tables 2 and 3).

For the first round of the Delphi questionnaire, each expert was asked to rate the key steps on a Likert-scale from 1 (strongly disagree) to 5 (strongly agree) to what extent, they believed, a step should be considered a key step and should be included in the final training curriculum. In addition, the experts were offered the opportunity to comment on each key step or clarify their ratings. This led to removing key steps because there was consensus on these key steps not being useful (>80% of the expert panel rating it ≤2 after the first round). Key steps that were rated as important (≥4 by at least 80% of the expert panel) are going to be used for the further development of the training curriculum.

For the second round of the Delphi questionnaire, we used the comments provided by the panelists on the suggested items as input for modification of the key steps that did not meet the aforementioned criteria (marked with an in Tables 2 and 3). This led to the fusion of key steps or revising a key step into a more general key step. With these alterations, we are leaving more room for performing a part of the operation depending on anatomical or other situational variations. We provided additional information to clarify these key steps in an open forum discussion and gained a new opinion of the experts.

TABLE 2. The List of Proposed Key Steps Identified for Laparoscopic Appendectomy

Preoperative preparing
Checking of instruments, devices, and optics
Positioning of the patient (right arm out and left arm alongside the patient)
Positioning of the operating team
Positioning of the monitors
Placement of a gastric tube
Antibiotic prophylaxis
Disinfection and draping (from nipple line to os pubis)
Access and port insertion
Open introduction using Hasson technique (SU)
Creating pneumoperitoneum using a Veress needle
Placing of 2 additional ports under direct vision (SP and LLQ)
Diagnostic laparoscopy
Inspecting the intraperitoneal organs
Identifying an appendix sana or appendicitis
Exposure
Placing the patient in Trendelenburg position and tilted to the left
Grasping the mesoappendix with the clamp through the SP port
Retracting the appendix in the direction of the ventral abdominal wall
Taking care of the mesoappendix
Preparation of the mesoappendix and appendicular artery*
Placing 2 clips on the appendicular artery at the cecal base*
Cutting the appendicular artery and mesoappendix*
Looping and cutting
Placing 2 loops around the appendix
Cutting the appendix between the loops
Ending the operation
Introducing the extraction bag through the LLQ port*
Placing the appendix in the extraction bag*
Irrigation and suction around the appendicular stump on indication
Removing the appendix
Removing the ports under direct vision*
Closing of fascial defects >5 mm*
Closing of the skin with intracutaneous sutures
Removing the gastric tube

LLQ, left lower quadrant; SP, suprapubic; SU, subumbilical.
*Key steps discussed in round 2.

TABLE 3. The List of Proposed Key Steps Identified for Laparoscopic Cholecystectomy

Preoperative preparing
Checking of instruments, devices, and optics
Positioning of the patient (right arm alongside of the patient)*
Positioning of the operating team*
Positioning of the monitors
Placement of a gastric tube
No indication for antibiotic prophylaxis
Disinfection and draping (from nipple line to well below the umbilicus)
Access and port insertion
Open introduction using Hasson technique (SU)
Creating pneumoperitoneum using a Veress needle
Placing of 3 additional ports under direct vision (EG and 2 × RUQ)
Diagnostic laparoscopy
Inspecting the intraperitoneal organs*
Exposure
Placing the patient in reversed Trendelenburg position and tilted to the left
Retracting the fungus from the most lateral port in a cephalad and anterior direction
Adhesiolysis flush on the gall bladder
Identifying the infundibulum and the hepatoduodenal ligament
Retracting the infundibulum in a caudal and lateral direction
Opening the peritoneum
Opening the peritoneal envelope from the infundibulum
Opening the peritoneum medial and lateral from the infundibulum to the fundus
Dissection of the triangle of Calot
Dissection of fat and fibrous tissue step by step and flush on the gall bladder
Exposing the cystic duct at the gall bladder
Identifying the cystic duct
Exposing the cystic artery at the gall bladder
Identifying the cystic artery
Critical view of safety
Establishing the critical view of safety
Documenting the critical view of safety
Intraoperative cholangiography
Placing a clip on the cystic duct where it enters the gall bladder
Cutting the cystic duct until gall is discharged
Catheterizing with flushed cholangiocatheter and occluding the cystic duct around it
Creating and interpreting the intraoperative cholangiography
Clipping and cutting
Clipping the cystic artery (2 clips central and 1 at the side of the gall bladder)
Cutting the cystic artery
Clipping the cystic duct (2 clips central and 1 at the side of the gall bladder)
Cutting the cystic duct
Retrograde cholecystectomy
Further opening the peritoneum
Dissecting the gall bladder from the liver bed
Establishing hemostasis of the liver bed
Ending the operation
Introducing the extraction bag through the SU port*
Placing the gall bladder in the extraction bag and removing it through the SU port*
Removing the ports under direct vision
Closing of fascial defects >5 mm*
Closing of the skin with intracutaneous sutures
Removing the gastric tube

EG, epigastric; RUQ, right upper quadrant; SU, subumbilical.
*Key steps discussed in round 2.

Statistical Analysis and Consensus

Crohnbach's α was chosen as the statistical index to quantify the reliability of the group of panelists.[16] When the responses of the experts are highly correlated, in this study when Crohnbach's $\alpha > 0.90$, they are considered as internally consistent and thus suggesting consensus. Means and standard deviations were calculated for all key steps. Crohnbach's α was calculated for laparoscopic appendectomy and laparoscopic cholecystectomy. All statistical analysis was performed using SAS version 9.2.

RESULTS

Of the 22 experts asked to participate in the Delphi panel, 21 (95%) completed and returned the survey. Data analysis of the first round already showed consensus on the key steps for laparoscopic appendectomy (Crohnbach's $\alpha = 0.92$) and laparoscopic cholecystectomy (Crohnbach's $\alpha = 0.90$). After the second round, 15 key steps for the laparoscopic appendectomy and 30 key steps for the laparoscopic cholecystectomy were rated as important (Tables 4 and 5). These key steps are going to be used for the further development of the training curriculum.

DISCUSSION

The purpose of this study was to compile a list of key steps for the creation of INVEST instructional videos for laparoscopic appendectomy and cholecystectomy. The final lists were developed through a survey using the Delphi methodology. They represent consensus of experts in training MIS from the North-East Surgical School of The Netherlands. This is a next step in the development of a new standardized training course for laparoscopic procedures. The procedural steps in laparoscopy cholecystectomy and appendectomy that have been published in earlier research have been determined and evaluated by a relatively small group of experts.[22,23] To our knowledge, this is the first study that uses a previously validated method[11] in combination with a large group of 21 participating experts to establish consensus on which specific procedural steps should be seen as key steps for a standard laparoscopic procedure.

TABLE 4. The Key Steps for Laparoscopic Appendectomy

Preoperative preparing
Positioning of the patient (right arm out and left arm alongside the patient)
Positioning of the monitors
Disinfection and draping (from nipple line to os pubis)
Access and port insertion
Open introduction using Hasson technique (SU)
Placing of 2 additional ports under direct vision (SP and LLQ)
Diagnostic laparoscopy
Inspecting the intraperitoneal organs
Identifying an appendix sana or appendicitis
Exposure
Placing the patient in Trendelenburg position and tilted to the left
Retracting the appendix in the direction of the ventral abdominal wall
Taking care of the mesoappendix
Clipping and cutting or coagulating the appendicular artery with diathermia depending on anatomy
Looping and cutting
Placing 2 loops around the appendix
Cutting the appendix between the loops
Ending the operation
Protecting the abdominal wall against contamination by removing the appendix in an extraction bag or in the trocar depending on the situation
Removing the ports under direct vision
Closing of fascial defects >5 mm

LLQ, left lower quadrant; SP, suprapubic; SU, subumbilical.

The most important point of attention is that the identified key steps can only be used for treating uncomplicated appendicitis or gall bladder disease. For example, when performing an appendectomy for retrocecal appendicitis, the key steps do not include the then needed mobilization of the right colon. We think that the traditional Master-Apprentice Model is momentarily the most frequent used method to learn to deal with this specific situation. The same applies for dealing with a necrotic appendicular stump, an abscess, the decision to drain or not to drain, and the indications and timing for a decision to convert to an open procedure. Similar situations that are not covered with the key steps can also be encountered when performing a cholecystectomy. For example, dealing with an intraoperative perforation of the gall bladder, with or without spillage of stones, or an acute cholecystitis. The implementation of teaching procedural decision making should be during (procedure specific) training in the skills laboratory. Studies using a cognitive task analysis to identify the key decision making points, potential errors and complications, and problem-solving strategies seem to be valuable to design a method to teach these nontechnical aspects of operative performance.[24,25] Studies that translate the transfer of these skills to the operating room have not yet been performed.

Consensus for both procedures was already achieved with the first round of the Delphi questionnaire. Still, for some of the more important key steps of both procedures, we did not reach >80% of the expert panel to rate them as important. Analysis of the comments from the panelists led to rephrasing some of the key steps. These slightly altered key steps were presented to the expert panel and approved in an open forum discussion. We used this method for the second Delphi round, because some of the key steps in the first round were not unequivocally formulated.

For both the laparoscopic appendectomy and cholecystectomy, the first round of the Delphi questionnaire showed 3 major points of discussion. First and most notable was the difference between the need to use laparoscopic equipment on trolleys or having equipment available in columns attached to a ceiling-mounted suspension system. The latter mostly being available in modern(ized) operating rooms designed as dedicated MIS suites. In most hospitals in our teaching region, both situations do occur, so we needed to combine key steps for the preoperative preparation to suit both needs. We reached consensus for both procedures on positioning the patient in such manner that an equipment trolley can be set up on the floor while still optimizing efficient and ergonomic use by the operating team.

Second, the method of extraction of the appendix or gall bladder proved to be much dependent on the preference of the surgeon, e.g., through which trocar opening, whether to use an extraction bag and if this depends on the degree of contamination. These factors are most of the time not

TABLE 5. The Key Steps for Laparoscopic Cholecystectomy

Preoperative preparing
Positioning of the patient (right arm alongside of the patient)
Positioning of the operating team
Disinfection and draping (from nipple line to well below the umbilicus)
Access and port insertion
Open introduction using the Hasson technique (SU)
Placing of 3 additional ports under direct vision (EG and 2 × RUQ)
Diagnostic laparoscopy
Inspecting the intraperitoneal upper abdominal organs
Exposure
Placing the patient in reversed Trendelenburg position and tilted to the left
Retracting the fundus from the most lateral port in a cephalad and anterior direction
Adhesiolysis flush on the gall bladder
Identifying the infundibulum and the hepatoduodenal ligament
Retracting the infundibulum in a caudal and lateral direction
Opening the peritoneum
Opening the peritoneal envelope from the infundibulum
Opening the peritoneum medial and lateral from the infundibulum to the fundus
Dissection of the triangle of Calot
Dissection of fat and fibrous tissue step by step and flush on the gall bladder
Exposing the cystic duct at the gall bladder
Identifying the cystic duct
Exposing the cystic artery at the gall bladder
Identifying the cystic artery
Critical view of safety
Establishing the critical view of safety
Documenting the critical view of safety
Clipping and cutting
Clipping the cystic artery (2 clips central and 1 at the side of the gall bladder)
Cutting the cystic artery
Clipping the cystic duct (2 clips central and 1 at the side of the gall bladder)
Cutting the cystic duct
Retrograde cholecystectomy
Further opening the peritoneum
Dissecting the gall bladder from the liver bed
Establishing hemostasis of the liver bed
Ending the operation
Protecting the abdominal wall against contamination by removing the gall bladder in an extraction bag depending on the situation
Removing the ports under direct vision
Closing of fascial defects >5 mm

EG, epigastric; RUQ, right upper quadrant; SU, subumbilical.

predictable before actually performing the laparoscopy. By making these factors variable within the revised key step, we reached consensus in the second Delphi round.

Closing the fascia of the trocar sites >5 mm after laparoscopy was a third point of discussion for both operations. Overall, 6 experts (28%) responded that closure of the trocar sites can be difficult, mostly when the patient has more subcutaneous fat, and that they do not want to make bigger wounds to close the fascia at all costs. Our intention with this key step was to teach closure of the fascia to minimize the incidence of trocar site hernias. When we explained this to the experts who did not favor this key step, they agreed that the intention of closing bigger fascia defects is a key stone of laparoscopic surgery.

For the laparoscopic cholecystectomy, the expert panel was much divided on whether to perform a routine intraoperative cholangiography (IOC) in the training for surgical residents. Therefore, we went back to the opinion of the Association of Surgeons of The Netherlands reflected in their latest guideline. They advice that, although IOC has a high sensitivity and specificity for detecting choledocholithiasis, best practice is to diagnose and treat choledocholithiasis preoperatively.[21] We are also taking into account that IOC lengthens the procedure and has its own morbidity.

CONCLUSION

The Delphi methodology was successfully used to determine consensus regarding the operative key steps for laparoscopic appendectomy and cholecystectomy. These key steps are going to be used for creating procedure-specific instruction videos as a next step toward standardized procedural training in a new regional laparoscopic training curriculum for the North-East Surgical School of The Netherlands. By using

the Delphi methodology, we hope to reach a high level of participation when these key steps are implemented in the assessment of standard laparoscopic procedures.

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