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In Zusammenarbeit

mit der Klinik für Allgemeinchirurgie,

Viszeral-, Thorax- und Endokrine Chirurgie

des Johannes Wesling Klinikums Minden

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Titel der Dissertation:

Objektivierung des Lernerfolgs chirurgischer Fertigkeiten durch einen zweitägigen Viszeralchirurgischen Anastomosenkurs der Deutschen Gesellschaft für Chirurgie (DGCH)

Objective Assessment of Surgical Skills in a 2-Day Visceral Anastomoses Techniques Course held in the Annual Congress of the German Surgical Society (DGCH)

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My Parents

My Wife

My Teachers

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1. Summary

Introduction

Simulation skill laboratories are being increasingly marketed from different institutions and are widely accepted in Europe and the United States of America (USA). Furthermore, residency training programs in the USA incorporate such laboratories into their residency curricula after having been mandated by the American College of Surgery (ACS) since 2008 and use them in the last few years to evaluate the competency of their surgical residents (Varban et al. 2013).

Unlike to North America, the literature to date has shown a little or none about simulation skill laboratories and curricula in Europe, despite their existence in private institutes or few residency training programs. European training programs still rely mainly on traditional training methods and surgical simulators are still predominantly aimed at attracting attention at surgical equipment exhibitions.

One of the well-known simulation skill laboratories in Germany is held yearly in the annual meetings of the German Society for Surgery (DGCH) since 2005. This skill laboratory is subdivided into different courses over four days with different modules in station-setting which include common trunk surgical skills, visceral laparoscopic techniques, and conventional visceral anastomoses techniques as well as courses in vascular and orthopedic surgery.

A valid and reliable objective assessment tool was developed in Canada and is currently used widely by residency training programs in the USA and Canada to evaluate the efficacy of technical skill development outside the operating room in a bench setting. This tool is called, the Objective Structured Assessment of Technical Skills (OSATS) (Martin et al. 1997; Ault et al. 2001).

The aim of our study is to demonstrate the improvement of surgical skills through the participation in a selected training module using this validated international assessment tool (OSATS).

Materials und Methods

The visceral anastomoses course which includes five training modules on animal models and takes place over two days was selected for evaluation. Performance of the participants in one module (end-to-end bowel anastomoses) was measured by qualified surgeons using a task specific checklist at the beginning and at the end of the course with instructor to participant ratio 1 to 10. The improvement in OSATS scores pre-post the course was assessed using paired T-Test. Participants were asked to perform a baseline bowel anastomoses independent of the course and their scores were analyzed as a possible correlation factor with final OSATS scores. Demographic data of the participants as well as subjective evaluation forms were collected.

Results

A total of 38 surgical residents completed the 2-day visceral anastomoses course. The mean age was 34 ± 6 years. 58 % were males. Most of the participants were in their 4th and 5th year of residency training. 66% reported having performed ≤ 10 bowel anastomoses since the beginning of their surgical training. 21% were able to perform an end-to-end bowel anastomoses independent of the course in terms of self-reporting and scored a mean of 15 ± 3 in OSATS. OSATS scores improved significantly after completing the course (p= 0.000018) with a mean of 15.7 ± 3.5 vs. 18.8 ± 2.4 at the beginning and end of the course, respectively. In the regression analysis, factors like the ability to perform the procedure before the course, number of in-training so far performed bowel anastomoses or current level of surgical training did not predict the improvement of OSATS scores of the participants pre-post the curriculum (p= 0.6, 0.5 and 0.07, respectively). Furthermore, 95 %

of the participants reported subjective improvement in their skills and all participants gave a positive answer when asked whether to include simulation laboratories into their residency curricula.

Conclusions

Our results show a significant improvement of the surgical skills of residents regardless of their training level after participating in the simulation course as measured by OSATS. We highly recommend the integration of simulation laboratories in the curricula of our national residency training programs as a complementary part of traditional surgical training in the OR.

Zusammenfassung

Einleitung

Chirurgische Trainingslabore, sogenannte „Skills Labs“, gewinnen zunehmend an Bedeutung und sind sowohl in Europa als auch in den Vereinigten Staaten von Amerika (USA) in ihrer Bedeutung für die chirurgische Weiterbildung anerkannt. In den USA integrieren verschiedene chirurgische Weiterbildungsstätten diese Labore mittlerweile als festen Bestandteil des Curriculums in ihre Weiterbildungsprogramme. Darüber hinaus werden sie zur Einschätzung der Fertigkeiten der weiterzubildenden Ärzte genutzt. Trotz der umfangreichen Forschungen zum Nutzen verschiedener Simulatoren insbesondere in der minimalinvasiven Chirurgie existieren nur sehr begrenzt Daten zum Erwerb der konventionellen chirurgischen Fertigkeiten in „Skills Labs“ in der Literatur.

Eines der gut etablierten Chirurgischen Trainingslabore in Deutschland wird jährlich im Rahmen des Jahreskongresses der Deutschen Gesellschaft für Chirurgie seit 2005 realisiert. Es finden ein viszeralchirurgischer laparoskopischer Kurs, ein „Common Trunk“ Kurs, ein konventioneller viszeralchirurgischer Anastomosenkurs, ein unfallchirurgischer Kurs sowie ein gefäßchirurgischer Kurs in zwei Kursräumen während des viertägigen Kongresses statt.

Der konventionelle viszeralchirurgische Anastomosenkurs wird für 40 Teilnehmer angeboten und es werden die Standard-Anastomosen der Viszeralchirurgie über zwei Tage in fünf 90-minütigen Modulen an präparierten Tiermodellen vom Schwein trainiert. Eine objektive Evaluation des Lernerfolgs existiert zu diesem Kurs bislang nicht.

In Kanada wurde ein valider und reliabler Score zur Beurteilung des chirurgischen Lernerfolges in einem chirurgischen „Skills Lab“ entwickelt. Dieser „Objective Structured Assessment of Technical Skills“ Score (OSATS) findet neuerdings breite Akzeptanz in der praktischen Lernerfolgskontrolle in den USA und Kanada.

Ziel dieser Arbeit ist es zu prüfen, ob ein objektiv nachweisbarer Lernerfolg nach dem zweitätigen standardisierten viszeralchirurgischen konventionellen Anastomosenkurs im Rahmen des Deutschen Chirurgenkongresses nachzuweisen ist.

Material und Methoden

Der viszeralchirurgische Anastomosenkurs im Rahmen des Deutschen Chirurgenkongresses mit fünf Übungsmodulen an Tiermodellen findet über einen Zeitraum von zwei Tagen statt und wurde in dieser Studie zur Evaluation ausgewählt.

Die Teilnehmer wurden aufgefordert, eine Darmanastomose vor und nach dem Kurs durchzuführen. Die Fertigkeiten der Teilnehmer wurden in einem Modul (End-zu-End Darmanastomose) durch qualifizierte Chirurgen anhand einer übungsspezifischen Checkliste (OSATS-Score) zu Beginn und nach Abschluss des zweitägigen Kurses gemessen, wobei ein Instruktor jeweils für 10 Teilnehmer zuständig war. Die Auswertung der Verbesserung im OSATS Score im Vorher-Nachher-Vergleich erfolgte mittels gepaartem T-Test.

Demographische und weitere Daten der Teilnehmer wie z.B. die Selbsteinschätzung, ob sie bereits vor Kursteilnahme eine Anastomose eigenständig anlegen können, wurden als potentielle Einflussfaktoren erhoben.

Ergebnisse

Insgesamt komplettierten 38 Teilnehmer den zweitägigen viszeralchirurgischen Anastomosenkurs. Das mittlere Alter betrug 34 ± 6 Jahre. 58% waren männlich, 42% weiblich. Die Mehrheit der Teilnehmer war im vierten und fünften Weiterbildungsjahr. 66% hatten bislang weniger als zehn Darmanastomosen seit Beginn ihrer chirurgischen Weiterbildung angelegt. Acht Teilnehmer (21%) waren nach eigener Einschätzung schon vor

Teilnahme an dem Kurs in der Lage, eine Darmanastomose anzufertigen und bei einer Bewertung ihrer Technik in einer nicht instruierten Vorübung lagen deren OSATS-Werte bei 15 ± 3.

Der OSATS-Score verbesserte sich für alle Teilnehmer zwischen der ersten Übung zu Beginn des Kurses nach vorheriger theoretischer Instruktion aller Teilnehmer und der zweiten Übung nach Abschluss des zweitägigen Kurses ($p=0,000018$) mit einem Mittelwert von 15,7 ± 3,5 vs. 18,8 ± 2,4. In der Regressionsanalyse wurden verschiedene Einflussfaktoren untersucht, wie die “Fähigkeit, vor dem Kurs bereits eine Anastomose anlegen zu können”, “die Anzahl der bislang während der Weiterbildung durchgeführten Darmanastomosen” oder der “Stand der chirurgischen Weiterbildung”. Diese sagten nicht das Ausmaß der Verbesserung des OSATS Scores der Teilnehmer zwischen der Übung zu Beginn des Kurses und nach dem Kurs vorher ($p= 0,6$, 0,5 bzw. 0,07). 95% der Teilnehmer waren der Auffassung, sie hätten von dem Kurs profitiert und ihre Fertigkeiten durch diesen verbessert und alle Teilnehmer waren der Auffassung, dass die Aufnahme von Trainingskurse in Übungslaboren in ihr Weiterbildungscurriculum integriert werden sollte.

Schlussfolgerung

In dieser Arbeit wurde der Lernerfolg nach der Teilnahme an dem zweitätigen standardisierten viszeralchirurgischen konventionellen Anastomosenkurs objektiv nachgewiesen. Das Training am simulierten Modell kann deshalb zur Anwendung an Weiterbildungskliniken als wirksame ergänzende Maßnahme in der chirurgischen Weiterbildung empfohlen werden.

2. Introduction

2.1. Simulation: definitions and background

Simulation has been defined as a situation in which a particular set of conditions is created artificially in order to study or experience something that is possible in real life; or a generic term that refers to the artificial representation of a real world process to achieve educational goals via experimental learning (Flanagan et al. 2004). A simulator is defined as a device that enables the operator to reproduce or represent under test conditions phenomena likely to occur in actual performance (Al-Elq 2010).

The history of medical simulation goes back to the times when models of human patients were built in clay and stone to demonstrate clinical features of diseases and their effects on humans (Felipe 2015). We can find many examples in the literature where simulation was unsystematically used as an education tool in medicine. For example, in the 18th century in Paris, Grégoire father and son developed an obstetrical mannequin made of human pelvis and a dead baby. The phantom, as the mannequin was named, enabled obstetricians to teach delivery techniques which resulted in a reduction of maternal and infant mortality rates (Cooper and Taqueti 2008). Of note, simulation in the medical field was not systematically pursued until pioneering efforts took place over the last 3 decades, learning from simulation in aviation. In 1929, the Link simulator developed by Edwin Link, allowed the simulation of flights in difficult situations like those experienced in poor weather conditions. With the help of the Link simulator Link was able to teach his brother to fly during the same year. This simulator was subsequently purchased by the US Army corps which was put in charge in 1934 by President Roosevelt to deliver US postal mail and suffered crashes owing to insufficient experience to fly in bad weather conditions. Since then, simulation has become an essential training tool in aviation (Link Simulation & Training).

Simulation in the modern medical field can be tracked back to 1960s as Ausmund Laerdal, a plastic toy manufacturer, designed a realistic simulator to teach mouth-to-mouth ventilation encouraged by the work of Peter Safar who described the efficacy of mouth-to-mouth cardiopulmonary resuscitation (CPR) (Cooper and Taqueti 2008). He named the mannequin “Resusci-Anne”, inspired by a popular European history of a young girl that was found dead floating on the River Seine, back in the late 1890s. Resusci-Anne enabled physicians to simulate the practice of hyperextension of the neck and chin lift in the management of airway obstruction. Later, Laerdal was advised by Safar to include an internal spring attached to the mannequin’s chest wall, which permitted the cardiac compression simulation. This was the birth of the most widely used CPR mannequin of the 20th century (Cooper and Taqueti 2008; Rosen 2008; Felipe 2015).

In 1968, Dr. Michael Gordon from the University of Miami Medical School presented “Harvey”, a cardiology patient simulator. Harvey was named after Doctor W. Proctor Harvey, professor of cardiology at Georgetown University during Gordon’s cardiology fellowship. This mannequin simulator can reproduce almost any cardiac disease by varying blood pressure, heart sounds, heart murmurs, pulses, and breathing. It has been proven as an efficient simulation tool and has been applied for training and assessment of trainees. Resusci-Anne and Harvey represent cornerstones of the beginning of modern era medical simulation. After their development, many other types of simulators were developed for education and training (Cooper and Taqueti 2008; Rosen 2008).

2.2. Types of medical simulation

Simulators in the medical field can be divided into high fidelity or low fidelity simulators. It can be also divided into organic and inorganic simulators. Simulation modalities can be generally classified into five major groups (Reznick and MacRae 2006):

1. Bench models: low fidelity simulators used to teach basic and discrete skills for beginners. Such simulators have the advantage of being cheap, portable

and reusable with minimal risks. The disadvantages of these simulators are their acceptance by the trainees and the inability to simulate whole operations.

2. Live animals: high fidelity simulators used to teach advanced procedural knowledge or procedures where blood flow or dissection skills are important. The advantage of animal models is that they are available, allow trainees to work together as a team on a live operation through reinforcing team relationships, communications and gradients of authority. These models are used frequently in Europe and America. Moreover, the use of live animal tissues for practicing has been forbidden in the UK due to ethical concerns (Torkington et al. 2000). Although animals are very realistic models for practicing, they are expensive, vary anatomically from humans, their use cannot be reproduced, and require specialized facilities and trained personnel in perioperative monitoring and analgesia of the animals (Tan and Sarker 2011).

3. Cadavers: the only current high fidelity true anatomical simulators used in advanced procedural knowledge, continuing medical education and where dissection skills are important. Unfortunately, cadavers preserved by formalin lose some fidelity as a surgical simulation tool. Moreover, infection risks, high cost and single use have also limited their supply (Tan and Sarker 2011).

4. Human performance simulators: are high fidelity simulators used in team training and crisis management. They have the advantage of being reusable with ability to data capture and interactivity. Their limitations are the high cost, need of maintenance, and limited technical applications.

5. Virtual reality (VR) surgical simulators: high fidelity simulators used to teach basic laparoscopic skills, endoscopic, and transcutaneous procedural skills. They are reusable and have the advantage of their ability to capture data and requirement of minimal setup time. However, VR-simulators nowadays do not have a well three dimensions simulation and are limited with their high cost maintenance.

2.3. Methodology in surgical skills assessment

Assessment is crucial in providing feedback to the trainees. Dr. R. Reznick, whose group has many publications on the subject of teaching and evaluating surgical skills stated that in order to be a good assessment method, the assessment tool used must be feasible, reliable and valid (Reznick 1993). Reliability is the degree of the precision of a test and refers to the consistency of the results of a test given on two separate occasions to the same individual with no intervening changes or learning. Validity refers to the extent of the test to measure what is designed to measure. The most commonly used type of validity when examining the assessment methodology is construct validity, which is the extent to which we are measuring the trait we intend to measure.

There are five methods currently used to assess technical skills (Reznick 1993):

1. Procedure lists with logs: this is a method in which the resident maintains a log of the procedures performed during training without description of the quality of the performance. This method has a poor validity as an assessment method, since performing a certain number of a specific procedure does not mean that the procedure has been mastered.

2. Direct observation without criteria: this method lacks precision. For example, two tutors will not show a high level of agreement when observing a trainee doing a certain procedure without having structured criteria to refer to.

3. Direct observation with criteria: this method has proven to have a strong validity with a direct relationship between reliability and objectivity of the criteria defined in a given test. The most commonly used observational tool in this category is the Objective Structured Assessment of Technical Skills (OSATS). This tool assesses subjects being tested using an operation-specific checklist or global rating scales. OSATS was created by the same group learning from the Objective Structured Clinical Examination (OSCE), a successful tool designed to examine trainees

performing several clinical tasks in time-limited station-setting (Shaharan and Neary 2014).

4. Direct observation of procedures using animals or simulation models: this method has a strong validity and reliability when structured criteria are used in the assessment process.

5. Videotapes: in which a specific procedure is recorded and then reviewed for the purpose of assessment and giving feedback. This method is highly valid and reliable. However, it is costly and time-consuming.

2.4. Factors driving the emphasis on simulation in surgical training

2.4.1. Theories in the principles of surgical skills training and motor skills acquisition

A. Fitts and Posner proposed a theory of motor skill acquisition which consists of three stages and is widely accepted in the surgical literature (Fitts P M & Posner M I. 1967):

i. The cognitive stage: this stage describes when a task is newly introduced to the learner and in which the mechanism and discrete steps to perform the skill must be understood and repeated in order to achieve the required knowledge to perform the task. With practice and feedback, the learner reaches the next stage.

ii. The integrative stage: in this stage, the learner has a sufficient knowledge translated into appropriate motor behavior but still thinking about the skills used to execute the task. In this phase, the performance is more spontaneous as the previous phase.

iii. The autonomous stage: with time and practice the learner progresses to execute the task smoothly and no longer needs to think about the mechanism and the skill required for this particular task. For example, in this phase a surgical resident is able to perform the steps of specific operation spontaneously and focus on the other advanced details of the procedure.

According to this learning theory, it was proposed that the early phases of surgical training should take place outside the operating room until basic skills are achieved. Consequently, the surgical trainee is able to focus on other technical and non-technical details in the operating theater (Reznick and MacRae 2006).

B. Hubert and Stuart Dreyfus constructivist model of learning (Hubert Dreyfus and Stuart Dreyfus,1986):

A learner-centered theory that focused on the acquisition of a skill or set of skills. They argued that cognition originates with and develops from practice, rather than the reverse. The Dreyfus argument is based on a model of progress from novice to expert.

This model dictates that the learner advances from rigid adherence to rules to the increasing ability to judge each situation and act accordingly, with attendant accountability for their actions. Constructivist theories such as the Dreyfus' are most often cited as the raison d'être for simulation centers and skills labs: "the learner can practice at his or her own pace, developing technical and procedural skills in an authentic and patient-safe environment" (Tsuda et al. 2009).

C. Ericsson and Smith's expert performance model (Ericsson et al. 2009)

This model consists of three stages required to achieve the expert-performance:

i. The first stage in which representative tasks of expert performance must be identified and replicated within a controlled laboratory setting.

ii. The second stage involves an empiric analysis to identify the mechanisms underlying experts' superior performance.

iii. The last stage examines the effect of specific practice activity to discover influential factors in achieving mechanisms for expert performance.

2.4.2. Why we need simulation in surgical training

Restrictions in duty hours, costs associated with training junior residents in the operating room (OR), emerging technologies, and increased awareness of patient safety are believed to be the major factors driving the recent emphasis on surgical training outside the OR (Kohn et al. 2000; Bridges and Diamond 1999; European Union, Pickersgill 2001). Surgical skills have traditionally been taught through an apprenticeship model, and then subsequently through the rotating residency model transferred from Europe by William Halstead (Kerr and O'Leary 1999). The deficiencies of the current system of residency training are increasingly criticized and the ''learning by doing'' approach, based on the random opportunity of patient flow, is recognized to produce significant variability in educational experience (Reznick and MacRae 2006). Furthermore, the assessment of surgical technique has been predominantly subjective, without reliable correlation between dexterity and surgical outcomes (Darzi et al. 1999; Paisley et al. 2001).

As proposed in the educational model of Ericsson, expert performance can be developed through intentional and continuous practice (Ericsson et al. 2009). Simulation aims to represent reality to a level close to what the trainee would face in a real-patient setting (Woodhouse J. 2007). Moreover, simulation enables replication of a single task in a controlled setting and thus developing essential basic motor skills before encountering the complex issues faced during performing or assisting in the OR (Sturm L et al. 2007).

2.4.3. Evidence of Simulation

The introduction of simulation technologies served to fill the gap in the current training model. The acceptance of simulation based training began as the University of Toronto group introduced skills training at bench stations in the late 1980s which subsequently refined teaching methods that incorporated feedback and performance assessment with validated rating (Lossing et al. 1992; Martin et al. 1997; Reznick et al. 1997). The American College of Surgeons has already identified the potential for simulation techniques to make significant impacts on patient safety through its ability to permit learning in a risk-free environment, refresh techniques for surgeons returning to practice after an extended absence, correct case-mix inequalities during training, and allow prototyping of new procedures and testing of new devices in a simulated environment (Dawson 2002). Many academic medical centers and university hospitals have developed skills laboratories to accommodate learners through a range of surgical specialties, allowing them to practice their skills (Sachdeva et al. 2007; Dent 2001).

It is important to evaluate the utilized curricula in simulation laboratories even if these have been adopted from existing resources (Chipman and Schmitz 2009). Furthermore, transferability to real patient setting and thus better clinical outcomes should be evaluated. In order to prove the role of simulation in teaching surgical skills, it must be shown that skills acquired through training with simulators can be positively transferred to clinical practice, translating into better patient outcome. Numerous studies document improvement of performance during actual operations following laparoscopic curricula in the simulation skills laboratory (Seymour et al. 2002; Grantcharov et al. 2004). Of note, reviewing the literature to date has shown a stronger evidence for minimally invasive surgery than for traditional open procedures as to the transferability of learned skills in a simulation skills laboratory to the OR.

2.5. The purpose of the study

The aim of the present study is to evaluate the improvement in performance as well as the retention of surgical skills of candidates in a surgical skill simulation skill laboratory with a predefined curriculum including conventional visceral anastomoses course.

2.6. Questions of the study

2.6.1. Main question of the study

Do the participants, regardless of their level of training, have better checklist scores (OSATS) when performing an end-to-end bowel anastomoses before and after the participation in the 2-day conventional visceral anastomoses course held in the annual congress of the German Surgical Society (DGCH)?

2.6.2. Secondary questions of the study

Two questions arose when the participants were surveyed about their training level and the number of in-training so far performed bowel anastomoses:

1. Does the training level of participants predict the degree of improvement yielded through the participation in the conventional visceral anastomoses course?

2. Does the expertise level of participants, defined with number of in-training so far performed bowel anastomoses, affect the degree of improvement yielded through the participation in the conventional visceral anastomoses course?

3. Materials and Methods

3.1. Structure of the simulation skill laboratory

One of the well-known simulation skill laboratories in Germany is held in the annual German Surgical Society (DGCH) meetings yearly since 2005. This skills laboratory uses inanimate as well as animate and laparoscopic simulators and is subdivided into different courses over 4 days with different modules in station-setting. (Figure I)

Surgical skill laboratory (DGCH)

Figure I: A photo of the surgical skill laboratory held yearly in the annual meeting of the German Surgical Society (DGCH)

1. Common trunk surgical skills takes place over 9 hours and includes introduction to suturing materials, skin suturing, tracheotomy, intubation, insertion of thorax drains and central venous catheters.

2. Laparoscopic visceral techniques (13 hours divided in 2 days): basic techniques, laparoscopic suturing and knot tying, fundoplication, bowel-anastomoses, laparoscopic colon anastomoses using stapler or hand anastomoses.

3. Conventional visceral anastomoses techniques (12 hours in 2 days): bowel anastomoses, gastroenteric anastomoses, pancreatic anastomoses, Billroth II resection with foot point anastomoses, biliodigestive anastomoses, Roux-Y-Anastomoses as well as rectum anastomoses (Figure II).

Visceral anastomoses course

Figure II: Setting of the visceral anastomoses course

4. Vascular Surgery (10 hours in 2 days): vascular basic techniques, aortic prosthesis, vascular anastomoses, interventional vascular techniques, venous patch, composite-bypass, cuff- anastomoses.

5. Orthopedic surgery (10 hours): basic principles of osteosynthesis, intra-operative imaging, external fixation, osteosynthesis of the upper and lower extremities.

Every module was held in a bench setting and was introduced with a didactic session and video presentation of the techniques performed by a qualified surgeon expert. Trainees can participate in one or more of the five modules.

3.2. Simulated modules in the conventional visceral anastomoses course

1. Bowel anastomoses: this module took place over one and a half hours and was divided into two exercises on harvested porcine small intestine:
   a. End-to-end anastomoses of the small intestine using a single layer continuous suturing technique (figure III).
   b. End-to-end anastomoses using an interrupted suturing technique (figure IV).

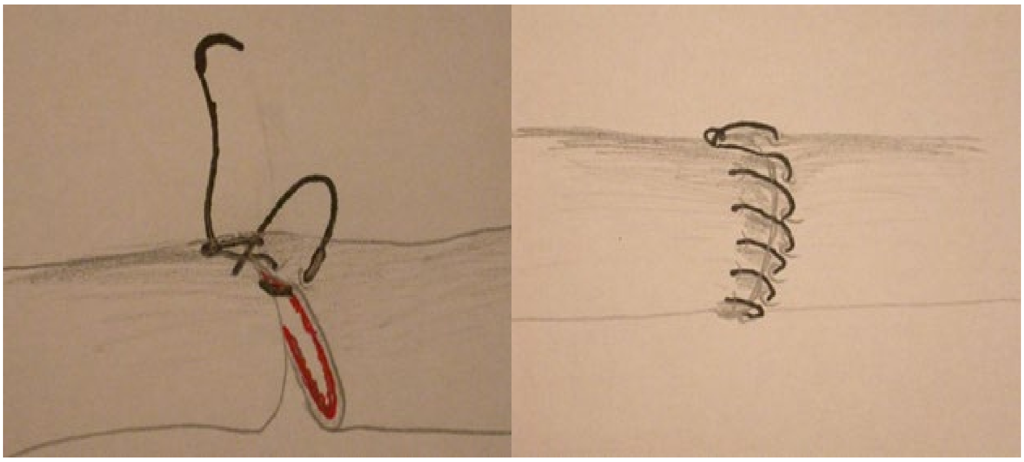

Figure III: Single layer continuous suturing technique (a)

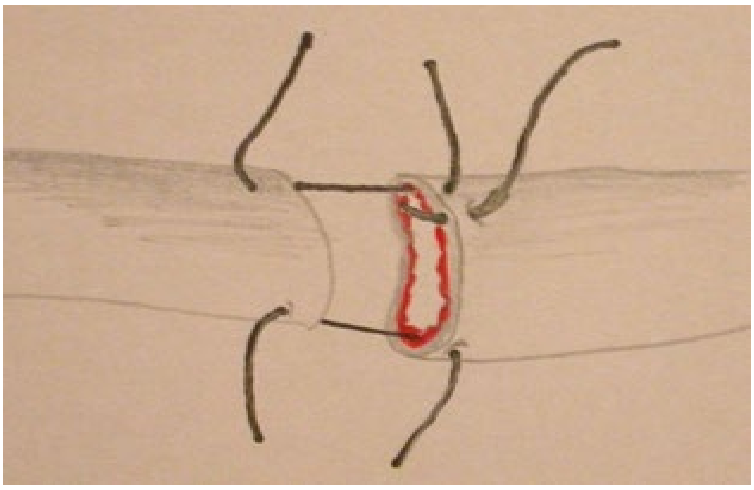

Figure IV: Interrupted suturing technique (b)

2. Gastroenterostomy and pancreas anastomoses (figure V):
    a. A posterior gastroenterostomy using a double layer continuous suturing technique on harvested porcine small intestine and stomach
    b. Pancreatojejunostomy simulating the anastomoses between the pancreatic body and jejunum after pancreatic head resection using the technique of Warren-Cartell (WARREN and CATTELL 1956). Synthetic pancreatic models with a 6 mm duct and porcine small intestine were used in this exercise.

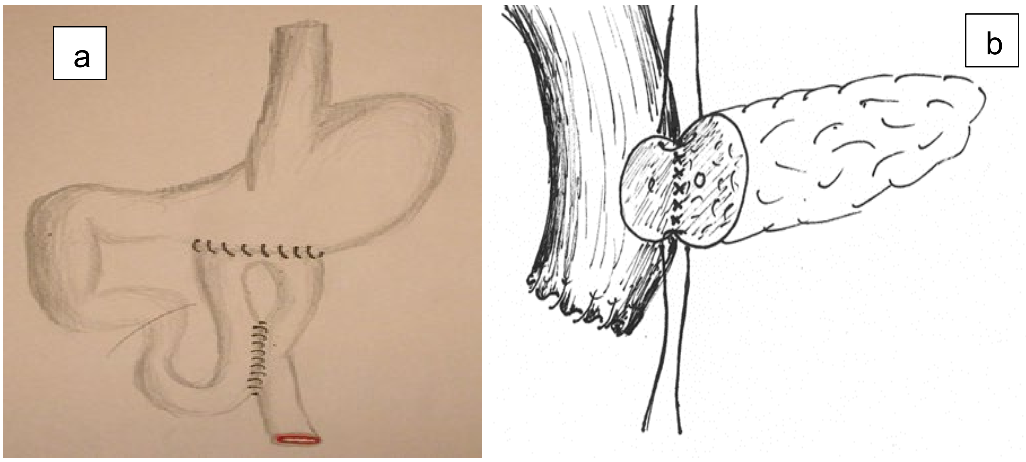

Figure V: posterior gastroenterostomy (a) und Pancreatojejunostomy using Warren-Cartell technique (b)

3. Billroth II resection with Braun´s Foot Point Anastomoses: In this exercise the participants are instructed to resect the previously performed posterior gastroenterostomy and to perform a gastroenterostomy using a double layer continuous suturing anastomoses technique after partial resection of the stomach analogue to Billroth II resection. Subsequently, the participants performed a side-to-side foot point small intestinal anastomoses using a single layer continuous suturing technique (figure VI).

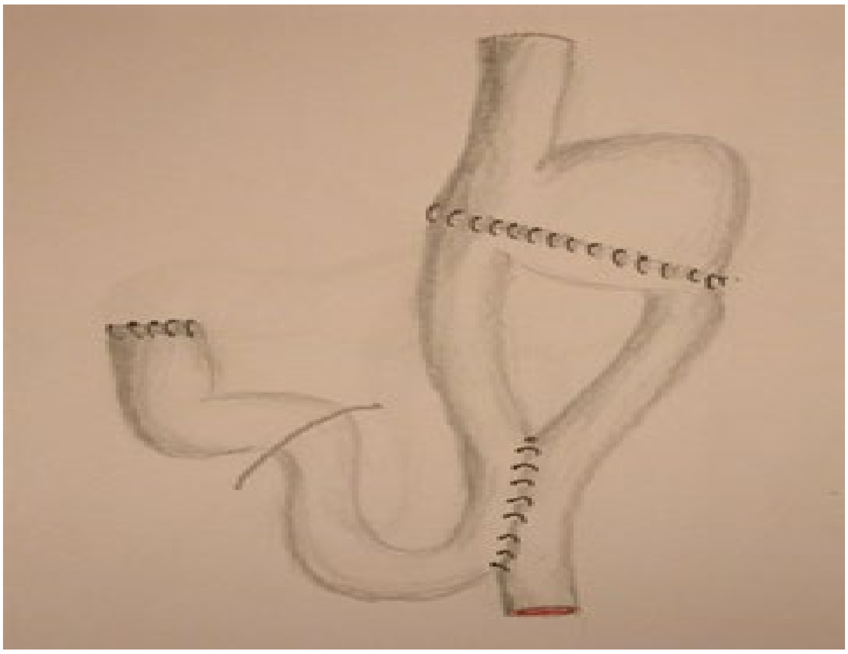

Figure VI: Billroth II resection with Braun´s Foot Point Anastomoses

4. Biliodigestive anastomoses and Roux-Y-Anastomoses: Using a polytetrafluorethylen (PTFE)- vascular prothesis simulating the bile duct and porcine small intestine the participants were instructed to perform a biliodigestive anastomoses once in continuous anastomoses technique and once in interrupted suturing technique (figure VII). Subsequently, the participants performed a side-to-end small intestinal anastomoses in a single layer anastomoses technique analogue to Roux-Y-Anastomoses.

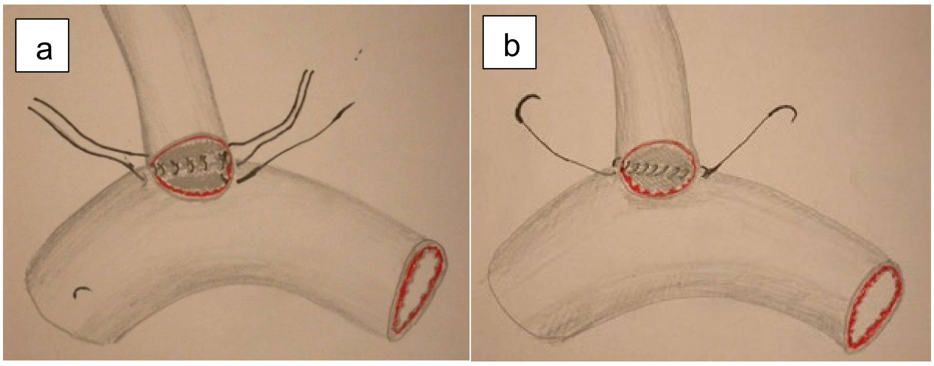

Figure VII: Biliodigestive anastomoses using interrupted suturing (a) and continuous suturing technique (b)

5. Rectal anastomoses: in this module it is required from the participants to perform rectal anastomoses in two different ways:
   a. Hand-anastomoses (figure VIII): in this session the participants were required to do a posterior wall anastomoses in Gambee-Technique with interrupted single layer suturing of the anterior wall using porcine large intestine (Gambee et al. 1956).

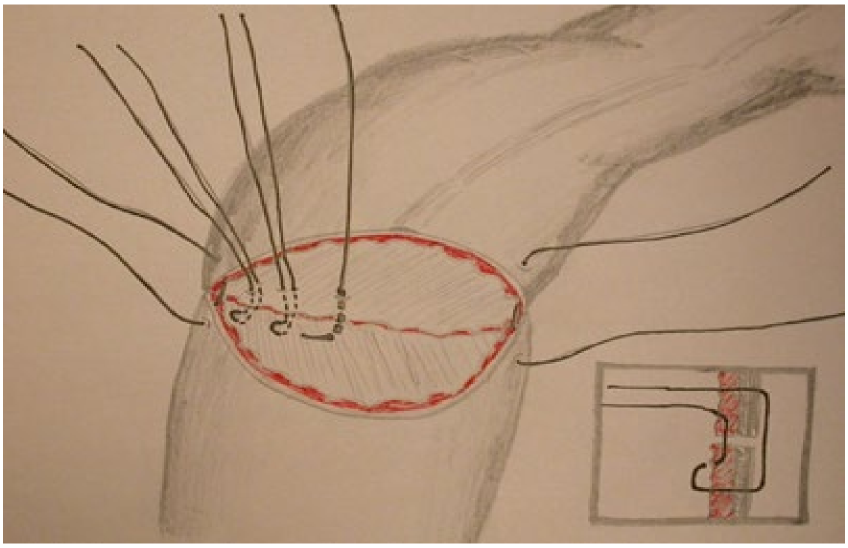

Figure VIII: Rectal anastomoses in Gambee technique

   b. Double-Stapling technique: using a pelvic model made of polystyrene the participants simulated resection of the rectum using a rigid linear stapler and a flexible one. Subsequently, after constructing a colon-J-pouch a rectoanal anastomoses was practiced using a circular stapler.

3.3. Assessment methodology

A task specific check list score designed for bowel anastomoses and adopted from the objective structured assessment of technical skills (OSATS) developed by Reznik and colleagues (Reznick et al. 1997) was used to score the participants (Appendix I). The check list consisted of 22 items. Each item was scored with one point when done correctly with a maximum score of 22. Four qualified consultants in visceral surgery had a 30 minutes training session in the scoring check list before the beginning of the course.

3.4. Design of the study

The study took place in the surgical skill training laboratory held in DGCH congress from the 26th until 29th of April 2016. One course had to be selected for evaluation since some of the different courses took place simultaneously. The 2-day conventional visceral anastomoses course which accommodates up to 40 participants divided into 4 groups at four stations with instructor to participant ratio 1:10 was selected. Of the seven predefined modules in the course, the end-to-end bowel anastomoses module using small intestine from pigs was selected for testing. The testing experts were blinded to the level of residency training of the participants. The participants were informed about the intention to test the improvement of their surgical skill and signed an informed consent before the beginning of the course (Appendix II). To standardize administration, all participants received a scripted orientation of the curriculum of the course (Appendix IV; analogue figures in chapter 3.2). To motivate the participants, we announced two prizes for two randomly selected participants at the end of the course (I-pad and the back payment of the fees of the course). Participants were surveyed if they have a prior experience in performing a bowel anastomoses before the beginning of the course. Those participants who gave a positive answer were asked to perform an end to end bowel anastomoses (practice 0) and their OSATS scores were analyzed as a possible correlation factor with the improvement in OSATS scores at the end of the curriculum. As with every other module, the intended to test module began with a projector video live presentation, in which an expert with a use of an assistant performed an end to end bowel anastomoses using a continuous single layer suturing technique (figure IX). At the end of the presentation, the participants were asked to perform an end-to-end bowel anastomoses and were scored by the experts who were randomly assigned to the participants at the beginning of the test (practice I). The participants worked in pairs, taking turns in practicing the procedure (figure X). A set of different suture materials with a set of instruments were available for each participant. The participants were evaluated for choosing the correct instruments and suture and were responsible of directing the assistant. We did not focus on the time needed to complete the test and did not include it in evaluating the participants.

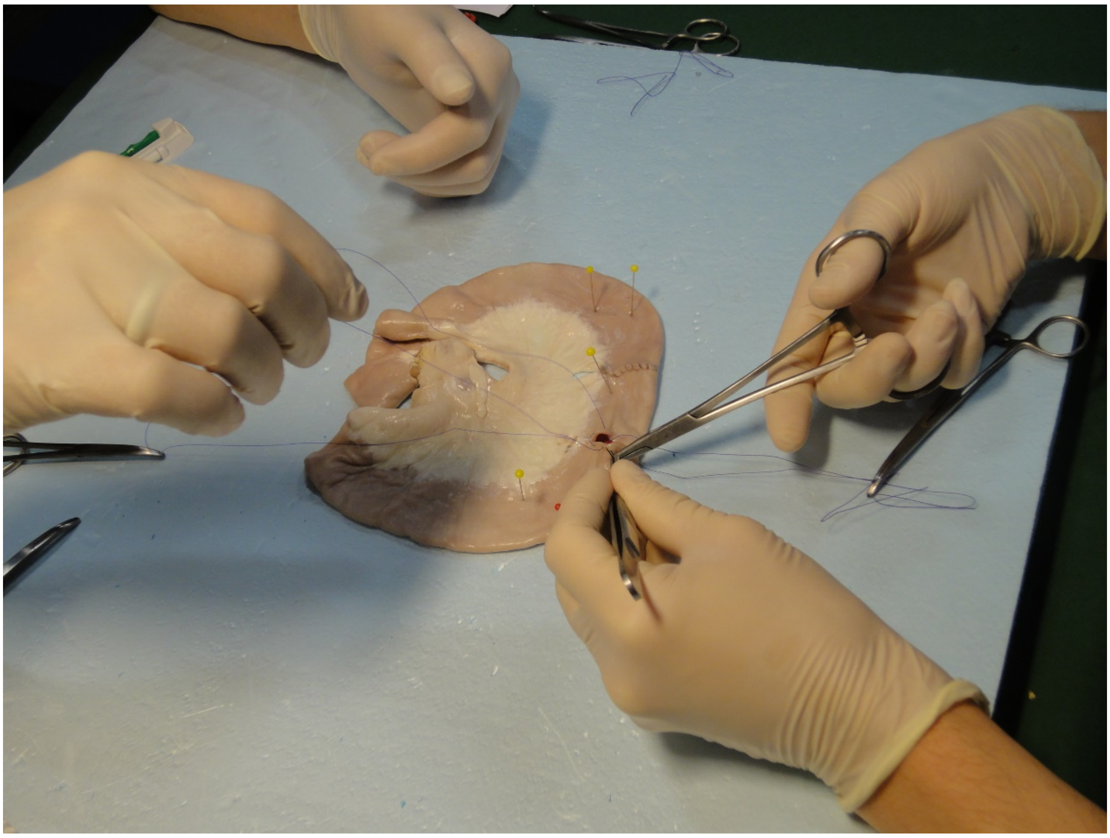

Figure IX: A photo of two participants taking turns in practicing an end-to-end bowel anastomoses on small bowel harvested from pigs

Figure X: Participants were scored by randomly assigned tutors using OSATS at the beginning and at the end of the course

The participants continued through the different modules predefined in the course curriculum. Following a short description and a video presentation of each module, the participants were given the opportunity to practice the procedures repeatedly, had the chance to ask questions, and were given an immediate feedback by the instructors with a special attention to the different items used in the check list. Of note, to avoid potential bias, the participants were assigned during the rest of the modules to instructors other than those assigned in evaluation process. At the end of the curriculum, we asked the participants to do the same end-to-end bowel anastomoses (done at the beginning of the course) and they were scored again using OSATS by the same four experts who were different randomly assigned to the groups of the participants (practice-II). Demographic data of the participants such as age, sex, level of residency training, and the number of bowel anastomoses already done by the resident on real patients were collected. A feedback survey was collected from the participants with regards to the subjective evaluation of the course’s curriculum on their skills and if they think that simulation skill labors curricula should be included as an integral part of the residency training (Appendix III).

3.5. Data analysis

Data of the participants as well as the OSATS scores were imported into the statistical package (Version 25; SPSS Inc., Chicago, IL). Total test score represents the sum of a participant’s checklist scores. Paired T-Test was used to assess the improvement of the OSATS scores of the participants. All data are presented as mean ± standard deviation. Correlations were done with Pearson’s correlation. Univariate analysis using Chi-square Test was used when appropriate. Interrater reliability was calculated using interclass correlation coefficient. Internal consistency, which is a measure of the reliability of the examination, was calculated using Cronbach´s coefficient alpha. One-way analysis of variance (ANOVA) was used to assess possible predictors of the improvement of OSATS scores. P values less than 0.05 were considered statistically significant.

3.6. Inclusion and exclusion criteria

3.6.1. Inclusion criteria

- All participants who registered in the conventional visceral anastomoses module in the surgical skill training laboratory held at DGCH congress from the 25th until 28th of march, 2016

3.6.2. Exclusion criteria

- Participants who do not complete the entire conventional visceral anastomoses course
- Participants who interrupt one or more of the different training modules assigned in the conventional visceral anastomoses course
- Participants who do not agree to participate in the study, to take the assigned performance evaluations or withdraw their informed consent during the course

3.7. Recruitment and Participants

The study was designed for up to 40 participants who can be accommodated in the conventional visceral anastomoses course. Recruitment of the participants took place using an informed consent (Appendix II) which was handed to all persons who registered in the conventional visceral anastomoses course offered online among other courses within the annual DGCH congress.

3.8. Data Protection and Pseudonymization

All data of the participants were encrypted with identification numbers and kept by the study investigator in a secure closed room.

3.9. Approval by the ethics committee

The study was approved by the ethics committee of Philipps University in Marburg on the 16th of January 2014.

4. Results

4.1. Demographics

A total of 38 participants completed the 2 Days visceral anastomoses course. The mean age of the participants was 34 ± 6 years. 58% were males and 42% were females.

35 participants were surgical residents under training at the time of the course. Most of the participants were in their 4th and 5th year of residency training (Table1).

Training level of participants

Training level	No. (%)
First year	3 (7,9%)
Second year	3 (7,9%)
Third year	7 (18,4%)
Fourth year	9 (23,7%)
Fifth year	10 (26,3%)
Sixth year	3 (7,9 %)
Specialist (Facharzt)	1 (2,6%)
Senior Physician (Oberarzt)	2 (5,3%)

Table I: Training level of participants in the conventional visceral anastomoses course

66% of the participants reported performing ≤ ten bowel anastomoses since the beginning of their surgical training (table 2).

Number of reported in- training bowel anastomoses

No. of Bowel anastomoses	No. (%)
<10	25 (65,8%)
10-50	11 (28,9%)
51-100	1 (2,6%)
>100	1 (2,6%)

Table II: Number of in-Training performed bowel anastomoses reported by the participants

A Spearman's rank-order correlation was run to determine the relationship between the training level of the participants and number of in-training performed bowel anastomoses reported by the participants (figure XI). There was a strong, positive correlation between them, which was statistically significant (rs= 0.509; p = 0.001).

Correlation of training level and No. of bowel anastomoses

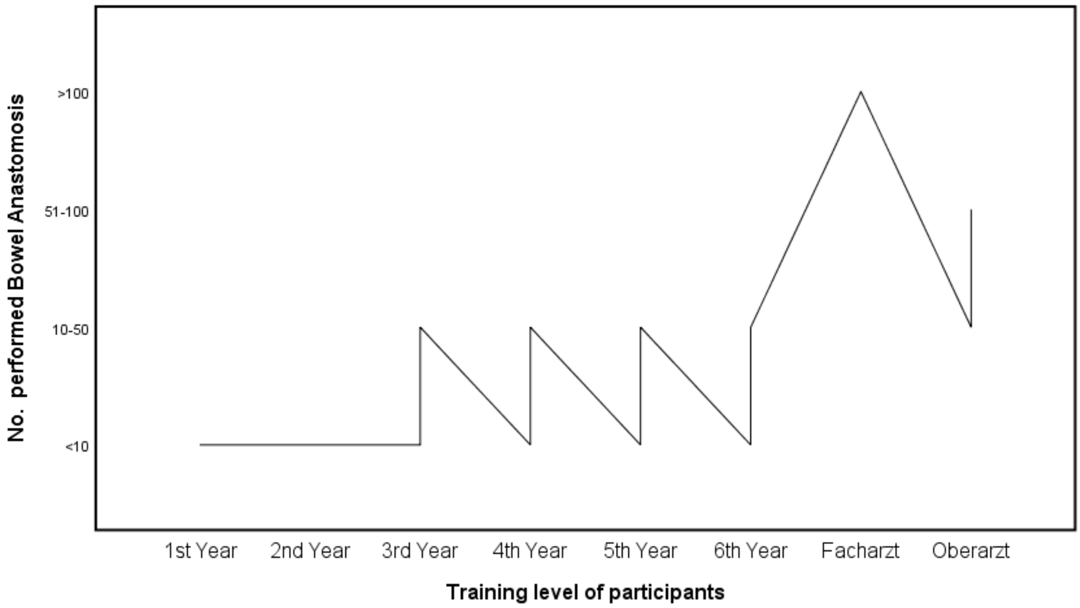

Figure XI: positive correlation between the trainings level of participants and number of in-training reported bowel anastomoses

4.2. Practice 0

Before the beginning of the course the participants were surveyed if they can already perform end-to-end bowel anastomoses. Eight participants (21%) gave a positive answer, were able to perform an end-to-end bowel anastomoses (practice 0) and scored a mean of 15 ± 3 in OSATS.

Furthermore, the results did not show a significant correlation between the OSATS scores obtained from those 8 participants in practice 0 and their training level or the number of in-training performed bowel anastomoses (p=0.7 and 0.8, respectively). Of note, 3rd year residents scored higher in practice 0 compared to their counterparts with advanced training level (Table 3 and 4)

Practice 0 mean score vs. Training level

No. of participants	Training level	OSATS scores (Mean)
3	3rd year	16
1	4th year	11
2	5th year	15
2	Senior physician (Oberarzt)	15

Table III: Checklist scores (practice 0) vs. Training level of the 8 participants group. OSATS: objective structured assessment of technical skills

Practice 0 mean score vs. no. of reported in-training bowel anastomoses

No. of participants	No. of Bowel anastomoses	OSATS scores (Mean)
3	<10	16
4	10-50	14,5
1	51-100	14

Table IV: Checklist scores (practice 0) vs. reported no. of in-training performed bowel anastomoses reported in the 8 participants group. OSATS: objective structured assessment of technical skills

4.3. Practice I

Analysis of Construct validity, which is the ability to distinguish among training levels, was assessed by analyzing participant´s performance in practice-I with a one-way analysis of variance with training level as the independent variable and was close to be significant (p=0.07).

Furthermore, analysis of the participant´s performance in practice-I did not correlate significantly with the training level when it is defined as the expertise level which is correlated with the number of in-training performed bowel anastomoses (p=0.5). (Table 5)

Practice I mean score vs. No. of reported in-training bowel anastomoses

No. of Bowel Anastomoses	OSATS scores (mean)
<10	16
10-50	15,36
51-100	18
>100	11

Table V: No. of in-training performed bowel anastomoses reported by the participants vs. Checklist scores obtained in practice-I. OSATS: objective structured assessment of technical skills

4.4. Practice 2

Improvement between pre- (practice 1) and post-curriculum (practice 2) scores

Checklist scores of all 38 participants improved significantly after completing the course (p= 0.000018) with a mean of 15.7 ± 3.5 vs. 18.8 ± 2.4 at the beginning and end of the course, respectively (Figure XII).

Checklist scores of all participants in Practice I vs. Practice II

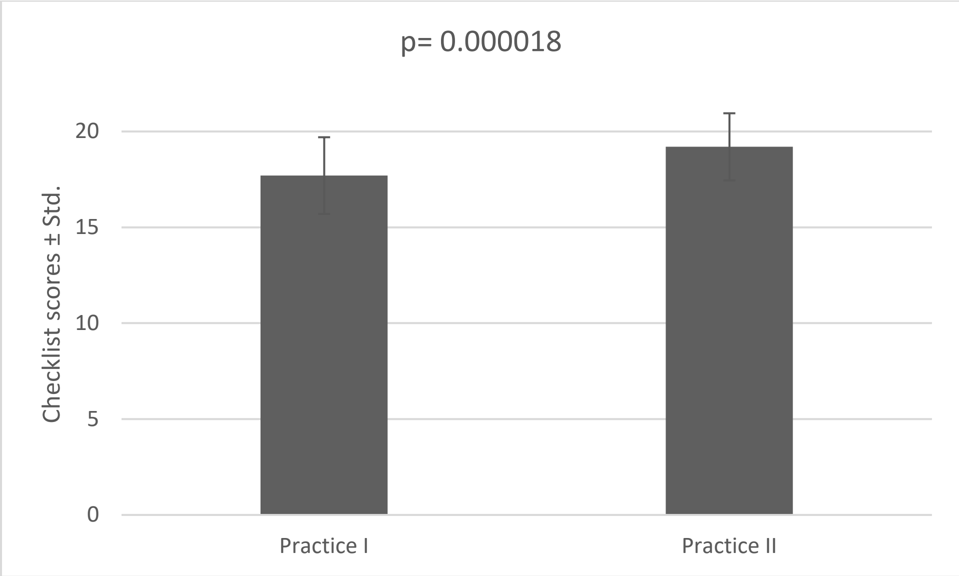

Figure XII: Improvement of the checklist scores (mean ± Std.) after participation in conventional visceral anastomoses course.

The statistical results did not change when the pre-post curriculum checklist scores were compared for just the 35 participants under residency training with a mean of 15.8 ± 3.5 vs. 19 ± 2.2 at the beginning and end of the course respectively (p= 0.000036) (figure XIII).

Mean checklist scores of trainees in Practice I vs. Practice II

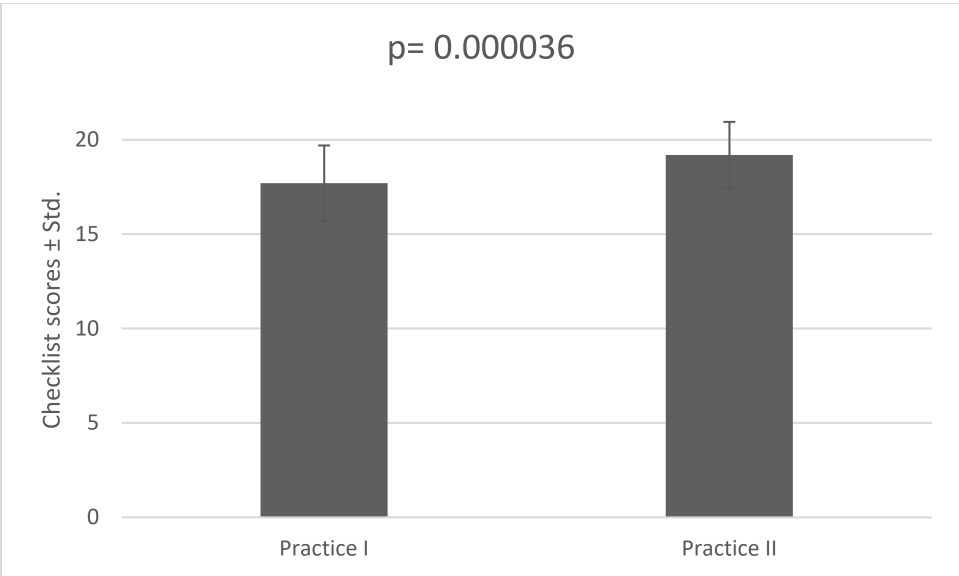

Figure XIII: Demonstration of improvement of the checklist scores (mean ± Std.) upon exclusion of participants who are not under residency training

Standardized internal consistency reliability coefficient (Cronbach's alpha) for scores generated from all 22 items in the OSATS rating tool was r = 0.77. Interrater reliability was 0.70 for the overall checklist. Upon analysis of the pre-post curriculum performance of the participants in the 22 items used in the checklist, 6 items showed statistically significant improvement. These items were loading the needle in the needle driver one half to two thirds from the tip, if the needle enters the bowel at right angle 80% of bites, forceps used on the seromuscular layer only majority of time, amount of tissue damage produced using the forceps, producing square knots and to cut the sutures to the appropriate length. Table 6 demonstrates the performance of the participants pre-post curriculum on each item in the checklist. In the regression analysis, factors like the ability to perform the procedure before the course, number of reported in-training performed bowel anastomoses or current level of surgical training did not predict the improvement of OSATS scores of the participants pre-post the curriculum (P= 0.6, 0.5 and 0.07, respectively).

When set as a benchmark, the eight participants group which performed the task before the beginning of the curriculum scored in OSATS at the end of the course almost equal to those who were not (mean 19.2 vs. 18.8, respectively). However, the pre-post curriculum checklist scores did not change significantly for those 8 participants with a mean of 17.7 ± 2 vs. 19.2 ± 1.75 at the beginning and end of the course respectively (p=0.07) (figure XIV).

Mean checklist scores of eight participants in Practice I vs. Practice II

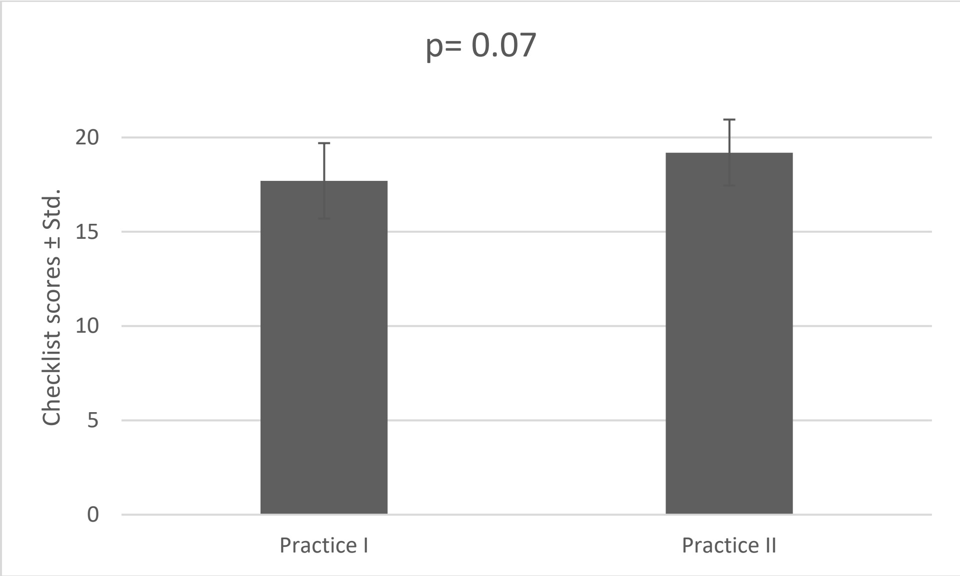

Figure XIV: Comparison of the mean checklist scores (mean ± Std.) for those participants who completed practice 0 before starting the course

Furthermore, 95 % of the participants reported subjective improvement in their skills and all participants gave a positive answer when asked whether to include simulation laboratories into their residency curricula.

Performance of participants of each task in the checklist pre- and post-curriculum

Task	Practice-I (% done correct)	Practice-II (% done correct)
1. Bowel oriented mesenteric border to mesenteric border, no twisting	100%	100%
2. Stay sutures held with hemostats	87%	95%
3. Selects appropriate needle driver (Gen surg, medtip/med or short length)	97%	100%
4. Selects appropriate suture (atraumatic, 3.0/4.0, PDS/Dexon/Vicryl/silk)	100%	100%
5. Needle loaded 1/2-2/3 from tip *(p=0.001)	40,5%	82%
6. Index finger used to stabilize needle driver	100%	100%
7. Needle enters bowel at right angles 80% of bites *(p=0.006)	51%	82%
8. Single attempt at needle passage through bowel 90% of bites	45%	66%
9. Follow through on curve of needle on entrance on 80% of bites	65%	82%
10.Follow through on curve of needle on exit on 80% of bites	53%	68%
11. Forceps used on seromuscular layer of bowel only majority of time*(p=0.037)	53%	76%
12. Minimal damage with forceps*(p=0.0008)	38%	76%
13. Uses forceps to handle needle	94%	100%
14.Inverting sutures	76%	82%
15. Suture spacing 3 to 5 mm	74%	90%
16. Equal bites on each side 80% of bites	55%	61%
17. Individual bites each side 90% of bites	58%	66%
18. Square knots*(p=0.006)	82%	100%
19. Minimum three throws on knots	94%	100%
20. Suture cut to appropriate length*(p=0.002)	76%	100%
21.No mucosal pouting	84%	79%
22. Apposition of bowel without excessive tension on sutures	71%	73%

Table VI: Performance of each task in the checklist pre- and post-curriculum. The numbers showed in the table represent the percentage of participants who did the task correctly. The star sign represents the items which were statistically significant. P values < 0.05 are considered significant.

4.5. Formal answering the questions of the study

4.5.1. Main question of the study

Do the participants, regardless of their level of training, have better checklist scores (OSATS) when performing an end-to-end bowel anastomoses before and after the participation the 2-day conventional visceral anastomoses course held in the annual congress of German Surgical Society (DGCH)?

Answer: yes, a mean of 15.7 ± 3,5 vs. 18.8 ± 2.4 at the beginning and end of the course, respectively.

4.5.2. Secondary questions of the study

Two questions arise when the participants were surveyed about their training level and the number of in-training so far performed bowel anastomoses:

1. Does the training level of participants predict the degree of improvement yielded through the participation in the conventional visceral anastomoses course?

   Answer: no, our results did not show significant results when the training level was analyzed as predictor factor related to the improvement of the performance of all participants on the checklist pre-post the course

2. Does the expertise level of participants defined with number of in-training so far performed bowel anastomoses predict the degree of improvement yielded through the participation in the conventional visceral anastomoses course?

   Answer: no, our results did not show significant results when the training level was analyzed as predictor factor related to the improvement of the performance of all participants on the checklist pre-post the course. Noteworthy, analysis of the performance of 8 participants group, who were able to perform a bowel anastomoses before the beginning of the course, showed relative improvement. Nevertheless, the degree of improvement did not reach statistical significance (p=0.07), which could be attributed to the small sample size.

5. Discussion

5.1. Traditional surgical training

Dr. William S. Halstead, the chief of surgery at Johns Hopkins Hospital (1892-1922) and considered one of the most innovative surgeons in the American medical history, was influenced by the German system of training, which emphasized the integration of basic sciences with practical teaching by full-times teachers, and established a residency training concept (the Halstedian concept) which spread through the USA and formed the basis of the current surgical training system in the modern era of surgery. This contribution to the training of surgeons was referred as Dr. Halsted´s greatest legacy (Kerr and O'Leary 1999).

Dr. Halsted introduced an apprenticeship model which placed a heavy emphasis on learning the science of surgery and related disciplines while simultaneously immersing trainees in a supervised clinical setting with increasing levels of responsibility (Tsuda et al. 2009, S. 271). This model of classic doctrine of "See one, do one, teach one" involving subjective assessment by a mentor has been the hallmark of residency training in Europe and North America.

With the evolving changes in our current health care system, this "Halstedian" model of training has been increasingly criticized to be time dependent and results in surgical training being prolonged in order to gain sufficient level of operative exposure (Shaharan and Neary 2014; Velmahos et al. 2004).

The need for alternatives such as simulation skill laboratories has been addressed early in the literature. Dr Barnes from the University of Arkansas stated in 1987 that less emphasis has been placed on optimal methods to teach manual surgical skills which he termed surgical handicraft. He emphasized that surgical program directors should bring into balance their efforts to teach the craft as well as the science of surgery for many reasons including the increasing complexity of operation along with the emerging technologies, increasing the constraints on the use of animal laboratories for the development of surgical skills, the limitations experienced by many teaching programs on numbers of available patients for the teaching material, increasing medicolegal pressures, and fiscal limitation which mandate that operative procedures are performed in cost effective manner (Barnes 1987). Moreover, the operation room serves no longer as the ideal atmosphere for surgical training of junior trainees and ethical issues about teaching on live patients have been addressed (Anastakis et al. 1999).

The release of the report "to err is human" in 1999 by the national academy of science institute raised the awareness of patient safety issues. It reported that as many as 98,000 deaths per year and their associated costs in the USA are related to medical errors with many of those errors being preventable, and attributed, among other causes, to errors in the performance of operations (Kohn et al. 2000). Furthermore, as the incidence of complications increased following the introduction of laparoscopic surgery during the 1990´s, the implications that surgical training could have on patient safety became apparent for the surgical community. Costs of adverse events were also an issue. Complications related to surgery can triple the length of stay and increase costs by more than 600% (Dimick et al. 2004). This increased the awareness that teaching new skills should take place effectively in a risk-free environment which fueled the interest in pursuing simulation-based training (Moore and Bennett 1995; Dent 1992).

The growing pressure on operating rooms as well as restriction of duty hours (48 h/week in Europe vs. 80 h/week in North America) and increasing complexity of operations have led to an increasing gap in resident-patient exposure, limited time spent in teaching the residents as well as the dependence on sheer volume of exposure in residency training rather than specifically designed curricula which subsequently made the reliance on this approach to teaching technical skills questionable with increasing interest in simulation skill laboratories aimed to train residents in a risk free environment which has the advantage of allowing the trainees to progress in the face of errors and learn the consequences (Pickersgill 2001; Park et al. 2002; Rattner et al. 2001). Furthermore, minimally invasive procedures have made it more difficult to acquire adequate experience performing traditional open operations. For example, open common bile duct explorations have become increasingly rare, which led to a dramatic rise in the incidence of technical complications (Schulman et al. 2007; Livingston and Rege 2005).

5.2. Skill Acquisition and Deliberate Practice

Kopta proposed three steps in which a learner progresses in technical skill development: perception, integration, and automatization. The surgical resident begins with a preliminary perception of the steps of an operation. These perceptions transform with time into a structured plan that allows the resident to proceed with the steps of an operation but not in the pace an experienced surgeon would perform the same procedure. With repeated practice and feedback the learner reaches the final stage in which the steps of the operation become automatized (Kopta 1971; Reznick 1993).

In the 90s of the last century, the Peyton method became of relevance. Peyton introduced a 4-step method which is widely used in skills lab training (Krautter et al. 2015).

The first step is demonstration of the whole procedure by the teacher without giving any comment to the learner. In the second step the teacher deconstructs the procedure in small steps while preforming each step slowly with giving an additional explanation. In the third step the learner explains every step to the teacher while the teacher performs it.

This step describes the comprehension of the procedure by the learner before exceeding to the fourth step in which the learner can execute and illustrate the steps of procedure simultaneously.

Reznick and colleagues have suggested that the earlier stages of teaching technical skills should take place outside the operating room and proficiency based surgical training, rather than years served, would become standard (Reznick and MacRae 2006). This proposal is based on the Fitts and Posner`s three stage theory of motor skill acquisition widely accepted in the surgical literature. This theory explains how the learner passes through three stages in developing a new motor skill until the last autonomous stage is achieved, in which the trainee no longer needs to think about how to execute this particular task and can concentrate on other aspects in the operation (Fitts P M & Posner M I. 1967). This is also supported by the adult learning theory of Ericsson in which he argues that achieving expertise depends on the time spent in deliberate practice, rather than the time spent in operation room (Ericsson 2004). In surgery, Ericsson defined experts with steadily better surgical outcomes in comparison to non-experts. The association between operative volume and clinical outcomes supports the hypothesis that practice is an important determinant of outcome (Halm et al. 2002). Nevertheless, operative volume is not the only determinant of the skill level among surgeons, since it has been shown that performance vary between surgeons working in high volume centers (Reznick and MacRae 2006).

Proficiency increases with deliberate practice which requires a defined task and involves separated practice along with coaching and immediate feedback on performance (Ericsson et al. 2009). The limited opportunities for deliberate practice in the current training model along with patient safety issues have led to increased interest in simulation skill laboratories with formed curricula to teach surgical skills (Bath and Lawrence 2011; Reznick and MacRae 2006).

Responding to the evolving challenges in the surgical training, the residency review committee (RRC) for graduate medical education in the USA requires since 2008 that all residency training programs have to provide surgical residents with access to surgical skills laboratory. Moreover, these facilities must address acquisition and maintenance of skills with a competency-based method of evaluation (Varban et al. 2013). Furthermore, the ACS and APDS developed a national skill curriculum in 2007 that is Web-based, free of charge, and uses proven methods for training, with an emphasis on distributed, deliberate, and structured practice using performance-based end points. The curriculum has been carefully structured and designed by content experts to enhance resident training through reproducible simulations, with verification of proficiency before operative experience and is available to programs as resource to turn to in developing a structured simulation skill curriculum (Scott and Dunnington 2008; Mittal et al. 2012). In 2006 the ACS established a program for accrediting educational institutes with simulation skill laboratories (Cooke et al. 2018). The ACS and the Society of American Gastrointestinal Endoscopic Surgeons launched the Fundamentals of Laparoscopic Surgery (FLS) which represents the first validated simulation module to be standardized and is now required for surgeons seeking board certification in general surgery in the USA. The FLS course uses laparoscopic simulators and consists of two parts. The first part assesses basic cognitive laparoscopic skills with multiple choice questions. The second part is a competency test of the manual skills attained in laparoscopy. (Fried et al. 2004; Varban et al. 2013). In a recent survey distributed to all residency programs in the USA, 99% of the responders (81 Programs) to the survey had a skill or simulation laboratory (Varban et al. 2013).

5.3. Simulation based learning: Evidence

To date, numerous studies document better performance of trainees using various assessment tools after participation in simulation skills curricula using high or low fidelity models. Assessment of laparoscopic skills dominates the articles to date owing to the growing interest in performing surgical procedures in minimally invasive approach. This is also attributed to the fact that in a simulated setting laparoscopic skills are easier to evaluate compared to open surgical skills (Shaharan and Neary 2014).

However, there is still a lack of studies showing the improvement of performance of open surgeries in the OR following curricula in laboratories providing training in open surgical skills.

Griswold et al. proposed a system in which simulation outcomes are measured in the literature (T1, T2, T3, T-value). At the T1 research level, simulation outcomes are measured in a laboratory setting. At the T2 level, transfer of skills acquired from simulation training is measured by clinical performance outcomes. T3 level studies assess patient safety. Finally, T-value studies measure the cost-saving benefits of simulation training (Griswold et al. 2012). The present study focuses primarily on the T1 and T2 levels to demonstrate the value of simulation.

5.3.1. T1 Studies: Simulation Outcomes

In a study by Olson et al. a structured simulation-based curriculum including bowel anastomoses, skin closure and laparotomy opening and closure and using OSATS in assessment was shown to be effective for first year surgical residents. The inter-rater reliability of OSATS scores was moderate with a correlation coefficient of 0.67. The study agreed with the believes of Reznik that simulation laboratories should be the place to train beginners before real experience with live patients in the OR (Olson et al. 2012).

Chipman and Schmitz designed a simulation curriculum to teach basic skills like suturing and excision of skin lesions for first year surgical residents and used OSATS as an evaluation tool. Construct validity for the OSATS tool used was measured by comparing the performance of first year residents to higher level resident on the same tasks. This study demonstrated a statistically significant improvement in basic surgical skills in first year resident measured by OSATS which was comparable to the performance of their higher colleagues by the end of the course (Chipman and Schmitz 2009).

A study by Goff et al. was designed to examine the administration of an OSATS exam on a national basis. The examination included five residency programs and assessed open as well as laparoscopic tasks. One of the residency programs included in the study already had a simulation surgical curriculum over a 4-year period. The study demonstrated significantly higher scores and shorter time to complete the tasks when comparing the residents who already participated in the simulation curriculum to those who did not (Goff et al. 2005).

A study by Wilhelm et al. evaluated the effectiveness of a 2.5-day intensive course on basic skills in vascular surgery. The participants were asked to perform a vein patch angioplasty before and after the course. Factors used for assessment were the time needed for suturing and the technical quality of the patch. The results of the study showed a significantly shortened time for the suturing and improved quality of the vein patch after participating in the course (Wilhelm et al. 2013).

5.3.2. T2 Studies: Clinical Performance Outcomes

Anastakis et al. compared the performance of surgical residents on six surgical tasks using cadaver models. Residents were divided in three groups prior to the assessment. One group received training on bench models and the second group on cadavers. The third group received no training other than learning from a prepared text. This study demonstrated a better and equivalent performance for the cadaver and bench model groups compared to the text learning group. The study concluded that simulated training on bench models could enforce resident learning and may be transferable to the operating room which was demonstrated by better performance on cadaver models (Anastakis et al. 1999).

Coleman and Muller compared the performance on partial salpingectomy in the operation room prior to and after the participation in an intensive laparoscopic simulation curriculum. This study used video recording in the operation room as an evaluation method and demonstrated a significant improvement in technical skills after the participation in the simulation curriculum (Coleman and Muller 2002).

Scott et al. demonstrated a significantly better performance of laparoscopic cholecystectomy in the OR for a group of residents who received daily training for 10 days on laparoscopic video-trainer in comparison to a control group which received no additional training (Scott et al. 2000).

A study by Seymour et al. compared the performance in laparoscopic cholecystectomy in the OR between two resident groups. A baseline assessment of skills was made for both groups followed by training on virtual reality laparoscopic simulator for the intervention group. The study demonstrated a significantly faster performance, better progression in the procedure, and lower gallbladder injury rate for the intervention group compared to the control group. This study concluded that skills achieved after training on virtual reality simulators are transferable to the operation theater (Seymour et al. 2002).

5.3.3. Is simulation cost effective:

Berg et al. described a method of developing a cost-effective surgery skills laboratory curriculum to train surgical residents in open and laparoscopic surgical skills. In this study bench models, box trainers, and animate models were used. They estimated the costs to be as low as 982$/year/resident (Berg et al. 2007). Simulation could be cost effective when compared to the costs of training in the OR investigated in one study to be as high as high as $47,970 per graduating resident (Bridges and Diamond 1999). A study by Babineau and colleagues documented an 8- to 44-minute increase in operative time for resident training cases and emphasized the tremendous opportunity costs for faculty time (Babineau et al. 2004). Systematic reviews comparing different types of simulators have shown the advantage of bench models simulation which include lower costs, portability, and the potential for repeated reuse of materials allowing residents unlimited practice (Anastakis et al. 1999). Trials which compared inexpensive traditional box trainers with virtual reality simulators at improving technical skills showed that both models were equally effective (Torkington et al. 2001; Hamilton et al. 2002; Munz et al. 2004). Furthermore, simulators related costs could be efficient when different surgical departments at one program share them to train their residents.

5.4. Evaluation of surgical skills: OSATS

Three general categories have been identified as a framework for assessing surgical quality: (1) cognitive/clinical skills, (2) technical skills, and (3) social/interactive skills (Aucar et al. 2005). It has been estimated that even within the context of operative performance, a skillful operation is 75% decision making and 25% dexterity (Spencer 2005).

Traditionally, trainees are assessed by examining the logbook and supervisor feedback. This evaluation methodology depends mainly on recollection of memories of surgical performance of residents from previous rotations. This method can be influenced by many factors such as the personal character of the resident of the assessing faculty team, performance on the surgical floor or the personal interactions of the resident in previous rotations. This method has been proven to lack reliability and validity since performing a number of procedures doesn’t ensure that the procedures have been done well. Additionally, it provides little information regarding the areas of technical skills that require special attention (Reznick 1993; Wanzel et al. 2002; Ault et al. 2001). Holmboe argued that successful completion of a certification examination is not an adequate measure of the overall clinical competence of physicians in-training (Holmboe 1998).

Until 1946 the Royal College of Surgeons of England assessed technical competence by asking candidates to perform an operative procedure on a cadaver. Due to shortage of cadavers, this component of the examinations was dropped and reliance was placed on the trainers assessment of the trainee (Pandey et al. 2004).

Many investigators have worked on to create standard assessment methods to evaluate resident´s skills outside the OR. Observational type assessment tools remain the instrument of choice in assessing surgical skills and OSATS is the most commonly used observational tool in this category (Fried et al. 2004; Martin et al. 1997; Shaharan and Neary 2014).

The objective structured assessment of technical skills (OSATS) has been proven as an instrument of high validity and reliability in measuring the improvement of performance in simulation skill curricula (Ault et al. 2001; Faulkner et al. 1996; Lossing et al. 1992; Martin et al. 1997). OSATS was developed by Martin and colleagues for general surgery residents, in which the trainees perform a number of standardized surgical tasks on simulation models under direct observation (Martin et al. 1997). Trainees are scored using two methods. The first is a task specific checklist consisting of several specific technical skills required for performing the examined task. The second is a global rating form, which includes five to eight surgical behaviors, such as flow of operation, knowledge of instruments, and respect for tissues (Reznick and MacRae 2006).

OSATS can be instrumental in not only assessing learners but in evaluating a specific curriculum. It has been used by some programs to assess the residents on annual basis, to compare them with their peer residents and help identifying the areas of the deficiencies in the resident´s performance and therefore, promoting actions in order to correct those deficiencies early in the training years (Goff et al. 2005). For example, a specifically designed simulation skill curriculum can be tailored to those residents who require a special attention in particular technical skill. Furthermore, there are several articles in the literature to suggest that surgical simulators are already being used as surrogate measures of surgical performance (Taffinder et al. 1998; Shah et al. 2003).

Other institutions have gone far in using surgical simulators in the selection process of candidates. For instance, Irish training programs have integrated surgical skills assessment on simulators to screen the applicants applying for higher surgical specialties (Shaharan and Neary 2014). On the day of the interview, applicants for vascular fellowship at Stanford university are assessed performing a renal artery angioplasty and stent insertion on simulators (Bath and Lawrence 2011).

Likewise to pilots who must be assessed on regular basis, a regular competence based assessment of surgeons has been suggested with the potential use of simulators in the credentialing process (Goff et al. 2005). However, there is still lack of studies demonstrating the implementation of simulators in surgical skills assessment for credentialing (Shaharan and Neary 2014).

5.5. Discussion of results

The assessment of surgical skills in the OR especially for open surgeries has been challenging owing to the variability of patients and to which degree the resident can be allowed to operate alone. It has been shown that more information about the performance of trainees can be gathered when they act as a primary surgeon (Goff et al. 2005). Simulation skill labor provides the opportunity of breaking down an operation to key steps and therefore better assessment of each step. In our study, the trainees were allowed to act as primary surgeons which includes unguided selection of instruments and sutures and providing direction to the first assistant. In this study, a significant improvement of the skills of trainees after participating in various simulation modules of open surgical techniques was demonstrated. Using a procedure specific Checklist used in OSATS, participants were shown to be more knowledgeable and technically proficient in hand-sewn bowel anastomoses

The results of this present study are consistent with the results of other investigators who have evaluated the effectiveness of training surgical residents on open surgical simulation models. (Chipman and Schmitz 2009; Jensen et al. 2008; Olson et al. 2012). Of note, the time to complete tasks was not assessed in this study as time has been found to be a poor surrogate for ability in previous studies (Lentz et al. 2001).

Reliability of an assessment tool is a measurement of the consistency and replicability of an exam when administered to the same subject on two occasions given that no intervening changes took place. Values close to 1.0 indicate a higher reliability of the exam. It has been reported that examinations with reliability indices above 0.80 can be used for high stakes exams, such as credentialing (Goff et al. 2005). Interrater reliability represents the level of agreement between examiner for each participant (Pandey et al. 2004).

In this study, reliability indices and interrater reliability were greater than 0.70 for the overall checklist. Comparable to other studies using OSATS as an assessment tool to evaluate the improvement of their surgical residents, this present study showed an acceptable interrater reliability (Goff et al. 2005; Olson et al. 2012).

Unlike to other studies, the construct validity of the test which has been measured by the correlation of surgical skills to the level of training of surgical residents was close to be significant in our study (p=0,07). This can be attributed to the relatively small number of participants in this study and to the fact that the evaluated participants in the surgical skill laboratory of this study are residents or board certified surgeons coming from different educational institutions and have different level in experience and operative exposure, which makes it difficult compared to other studies who evaluated the skills of residents trained in one educational program (Goff et al. 2005). The incapability to show significant construct validity in this study is consistent with the findings of Faulkner et al. Whether this was a failing of the OSATS or the rater´s rankings is not clear (Faulkner et al. 1996).

The results in this study show significant variability in the quality of training of residents in different surgical education programs in Germany. This can be concluded from the results of the survey during this study which showed that 66% of the participants reported performing ≤ 10 bowel anastomoses since the beginning of their surgical training with the majority of the participants being in their 4^{th} and 5^{th} years of residency training. Additionally, the scores of all participants in practice-1 did not correlate with the reported number of in-training performed bowel anastomoses. Moreover, just 8 participants had the confidence to do a bowel anastomoses before beginning the course and their scores in the checklist did not correlate with their training level.

The degree in improvement pre-post curriculum was not predicted with the training level or the number of in-training performed bowel anastomoses reported by the participants. Although statistical significance was reached just in six items in the checklist when measuring the degree of improvement pre-post curriculum, the degree of improvement in the overall checklist was significant.

Noteworthy, three participants in this study were specialists and senior surgeons. Nevertheless, the degree of significance in improvement pre-post curriculum did not change when these 3 participants were excluded from the data analysis which excludes this potential bias in the study.

Finally, participants who completed the curriculum in our skill laboratory felt more confident and knowledgeable about the procedures and technical skills required. All participants agreed with the recommendation to integrate simulation laboratories in the surgical education.

5.6. Key points

Surgical simulators are increasingly becoming invaluable instruments for training and technical skills assessment instead of just existing at surgical equipment exhibitions to attract attention (Aucar et al. 2005). They allow residents to progress on their own pace in a low stress, controlled and safe environment and give at the same time the opportunity for immediate feedback. Simulation laboratories are the places where residents are able to repeat key steps of procedures and therefore avoid potential harm to patients (Berg et al. 2007).

Simulation is a useful tool in the objective assessment of technical performance using validated skill measurement tools (Kneebone et al. 2004; Fraser et al. 2003). Performance in some simulators correlates with intraoperative performance and simulator training can improve both initial technical performance and its maintenance. (Fried et al. 2004; Sroka et al. 2010; Sturm et al. 2008; Seymour et al. 2002; Stefanidis et al. 2008)

As reported in the bulletin of the accreditation council for graduate medical education “Simulation enhances both safety and predictability; and it will be part of the new system of graduate medical education. Every patient deserves a competent physician every time. Every resident deserves competent teachers and an excellent learning environment. Simulation serves both of these core principles. (Leach 2005)

In surgical education, it is necessary to recognize the optimal method used in training. This can be recognized from the observations that the structure of the curricula used in simulation laboratories is determinant factor in the effectiveness rather than the simulator used in training (Stefanidis 2010).

Reviewing the literature to date, little information beside the sporadic use of simulation techniques in private institutes, is available about the role of surgical skill simulators in the surgical education in Germany. Training in Germany is still “halstedian”, done mostly per mentoring. Furthermore, assessment of residents is predominantly subjective based mainly on logbooks and yearly reports and few changes, mainly due to financial constraints, have been done coping with the evolving challenges in the residency training. The surgical community is required to recognize those challenges and start investigating if the current training model is producing technically excellent surgeons.

In conclusion, this study demonstrates a successful implementation of a surgical skill laboratory with a predefined curriculum and held on yearly basis since 2005. The results are consistent with other published studies, demonstrating the effectiveness of simulation skill laboratories. With growing pressure on operating rooms, I believe that simulation in training is an excellent additional model to fill the deficiencies in the current training model and is an effective way to examine the technical skill abilities of residents.

The “Halstedian” way to train residents is still valuable, since it may be an effective way of training a surgical personality and complex intraoperative decisions. Training of skills in skill laboratories is effective to shorten the learning curve during surgical education and should be introduced when climbing key steps in surgical training. All these aspects are relevant for patients in the OR.

5.7. Limitations of the study

This study is limited by the small sample number of participants, by assessment of just a single task from the various tasks predefined in our curriculum, and by the fact that surgical residents participating in the evaluated skill laboratory came from different training programs with variability of the skills they have already acquired during their training. Nonetheless, I believe that I have clearly demonstrated the value of a simulation-based curriculum to teach visceral anastomoses techniques.

Of note, no data exist in the literature comparing the training level of certified surgeons before and after the implication of surgical skills laboratories in the residency training of surgeons in the USA. Furthermore, this study does not compare the training level of surgeons trained in the USA to their counterparts in Europe. The discussion in this study focused mainly on the American training system since data are still lacking about the systemic implementation of surgical skill labors in training programs in Europe.

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Abbreviations and Definitions

ACS	American college of Surgery
APDS	Association of Program Directors in Surgery
ACGME	Accreditation Council for Graduate Medical Education
CPR	Cardiopulmonary resuscitation
DGCH	Deutsche Gesellschaft für Chirurgie
et al	et alia, „and others "
FLS	Fundamentals of laparoscopic Surgery
OSATS	Objective structured Assessment of technical skills
OSCE	Objective Structured Clinical Examination
OR	Operation Room
Practice 0	End-to-End bowel anastomoses task before Beginning of the Curriculum
Practice I	End-to-End bowel anastomoses task at Beginning of the Curriculum
Practice II	End-to-End bowel anastomoses task at Beginning of the Curriculum
RRC	Residency Review Committee
UK	United Kingdom
USA	United States of America
VR	Virtual reality

List of tables and figures

Appendix

Appendix I

OSATS –Small Bowel Anastomosis

Item	Not done or Incorrect	Done correctly
1. Bowel oriented mesenteric border to mesenteric border, no twisting	0	1
2. Stay sutures held with hemostats	0	1
3. Selects appropriate needle driver (Gen surg, medtip/med or short length)	0	1
4. Selects appropriate suture (atraumatic, 3,0/4,0, PDS/Dexon/Vicryl/silk)	0	1
5. Needle loaded 1/2-2/3 from tip	0	1
6. Index finger used to stabilize needle driver	0	1
7. Needle enters bowel at right angles 80% of bites	0	1
8. Single attempt at needle passage through bowel 90% of bites	0	1
9. Follow through on curve of needle on entrance on 80% of bites	0	1
10.Follow through on curve of needle on exit on 80% of bites	0	1
11. Forceps used on seromuscular layer of bowel only majority of time	0	1
12. Minimal damage with forceps	0	1
13. Uses forceps to handle needle	0	1
14.Inverting sutures	0	1
15. Suture spacing 3 to 5 mm	0	1
16. Equal bites on each side 80% of bites	0	1
17. Individual bites each side 90% of bites	0	1
18. Square knots	0	1
19. Minimum three throws on knots	0	1
20. Suture cut to appropriate length	0	1
21.No mucosal pouting	0	1
22. Apposition of bowel without excessive tension on sutures	0	1
Maximum Total Score	0	22

Total Score ______________

Examiner ______________

Appendix II

Studienleitung:
Prof. Dr. med. Berthold Gerdes,
Chefarzt der Klinik für Allgemein-,Viszeral-,Thorax-und Gefäßchirurgie
Johannes Wesling Klinikum Minden
Hans-Nolte Straße 1
32429 Minden

Saleem Elhabash
Hamburger Allee 18
30161 Hannover
Tel.: 017673807201

laufende Nummer

<u>Studientitel: Objective Bewertung des Lernerfolgs der chirurgen in der Weiterbildung in einem visceralchriurgischen Anastomosenkurs</u>

Probandenaufklärung

Im Rahmen dieser prospektiven Studie sollen die Probanden, unabhängig von ihrem bisherigen Stand in der Weiterbildung, zunächst am anfang des Kurses eine Dünndarm-Anastomose Übung (Die Übung beginnt mit einem 5 bis 10 minütigen Einleitungsvortrag incl. eines Lehrfilms) und anschließend die selbe Übung nach Abschluss des 2 tägigen Kursprogramms am präparierten Schweinedarm durchführen. Jede 8 Teilnehmer werden von einem Tutor betreut. Dieser Tutor nimmt ebenfalls die Bewertungen der Probanden während der ÜBUNG 1 und 2 vor.
Zusätzlich wird ein Fragebogen ausgefüllt.

Die Fragebögen werden anschließend sicher bei den Studienleitern in einem Studienordner in einem abgeschlossenen Raum verwahrt. Die Ergebnisse der Auswertung werden passwortgeschützt anonymisiert in einer Exeltabelle abgespeichert. Die Ergebnisse werden nicht an Dritte, wie z.B. Arbeitgeber etc. weitergegeben.
Wir bitten Sie um die Teilnahme an der o.g. Studie.

Einverständniserklärung

Ich, ... wurde von dem Untersucher vollständig über Wesen, Bedeutung und Tragweite der klinischen Prüfung mit dem o.g. Titel aufgeklärt. Ich habe den Text „Probandenaufklärung" aufmerksam gelesen und verstanden. Ich hatte die Möglichkeit, Fragen zu stellen und habe die Antworten verstanden und akzeptiere sie. Ich hatte ausreichend Zeit, mich zur Teilnahme an dieser Studie zu entscheiden und weiß, dass ich meine Zustimmung zur Teilnahme jederzeit und ohne Angabe von Gründen widerrufen kann. Hierdurch werden für mich keine persönlichen Nachteile entstehen. Mit der anonymen Speicherung in verschlüsselter Form der während der Untersuchung erworbenen Daten bin ich einverstanden.
Ich habe eine Kopie der Teilnehmerinformation und dieser Einwilligungserklärung erhalten. Ich erkläre hiermit meine freiwillige Teilnahme an dieser klinischen Studie.

Berlin, den ....20......

____
Unterschrift Proband

Berlin, den ....20......

____
Unterschrift Untersucher

Appendix III

Datenerhebungsbogen:

laufende Nummer

Objective Bewertung des Lernerfolgs der chirurgen in der Weiterbildung in einem visceralchriurgischen Anastomosenkurs

Alter:
Geschlecht:
Beruf:

Ausbildungsjahre (bitte ankreuzen):

- 0-3 Jahre
- 4-6 Jahre
- Facharzt
- Oberarzt/Chefarzt

Durchgeführte Darm-Anastomose Operationen (bitte ankreuzen):

- <10
- 10-50
- >50-100
- >100

Haben Sie das Gefühl, dass Ihre Fähigkeiten beeinflusst wurden? (bitte ankreuzen)

- Verbessert
- Verschlechtert
- Gleich geblieben

Glauben Sie, dass visceralchirurgische u.a. Simulation-Kurse als Maßnahme zur Anwendung an Weiterbildungskliniken in der chirurgischen Weiterbildung wirksam sind?

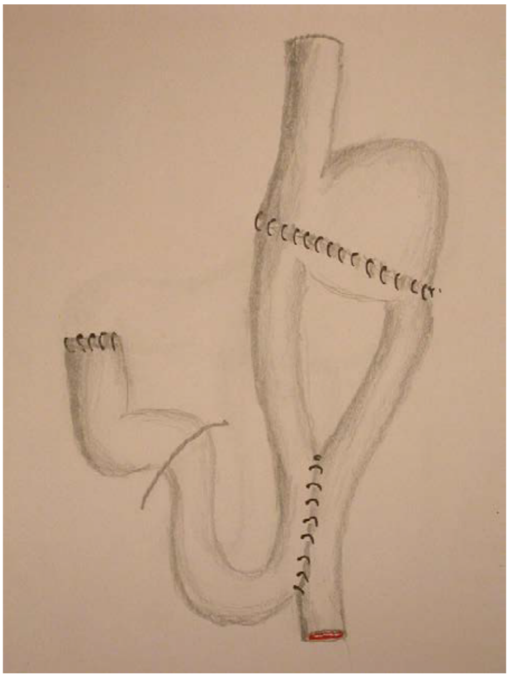
- Ja
- Nein

Vielen Dank für Ihre Teilnahme an der Studie.

Appendix IV

Curriculum

Visceralchirurgischer Anastomosenkurs



Jeder Kursteil beginnt mit einer Einführung in die Übungen für die Gesamtgruppe und anschließender praktischer Durchführung in je vier 2er Gruppen unter Anleitung durch einen Tutor.

Zu Beginn und zum Ende des Kurses wird die Anlage einer Dünndarmanastomose in fortlaufender Nahtechnik durch den jeweiligen Tischtutor anhand des OSATS-Scores bewertet. Der OSATS-Score wird den Teilnehmern vor Kursbeginn ausgehändigt.

Mittwoch

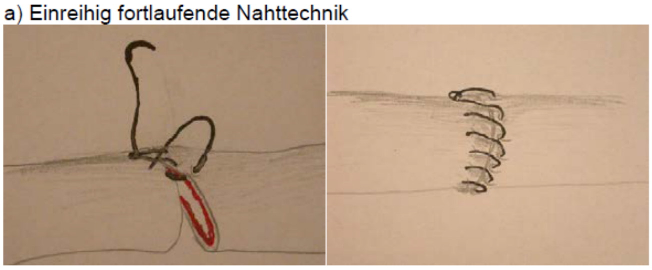
14.00-15.30 Uhr   Darm – Anastomose

Einführung: Zur Einführung wird ein Kurzvortrag zu den bei der Darmanastomose zu beachtenden Aspekten sowie den Anwendungsgebieten gehalten. Es wird hierbei die seromuskuläre fortlaufende Nahttechnik (1a) vorgestellt. Jeder Teilnehmer führt die Übung einmal vollständig mit Assistenz durch einen anderen Teilnehmer aus. Die Anastomosenanlage wird nach dem OSATS-Score bewertet.

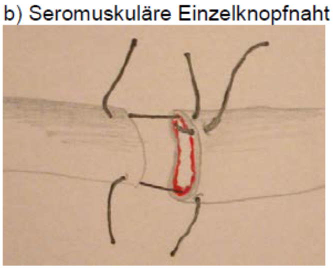
Optional (falls noch Übungszeit verbleibt) wird die End-zu-End-Anastomose außerdem in Einzelknopftechnik (1b) geübt. Die Seit-zu-Seit-Anastomose wird in der folgenden Einheit als Braun´sche Fußpunktanastomose bei der Magenresektion eingeübt.

Aufgabe 1a und 1b

1) End-zu-End-Anastomose   a) Einreihig fortlaufende Nahttechnik



b) Seromuskuläre Einzelknopfnaht

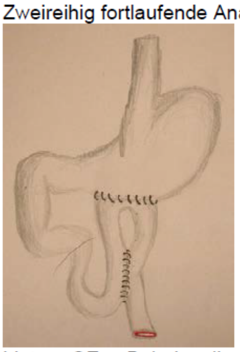


Anwendungsbeispiel	Dünndarm-Dünndarm-Anastomose Dünndarm-Dickdarm-Anastomose Dickdarm-Dickdarm-Anastomose
Material	Darm Kunststoffmodell
Nahtmaterial	a) Resorbierbares monofiles Nahtmaterial 4-0 doppelt armiert (2 Fäden) b) Resorbierbares geflochtenes Nahtmaterial 3-0 (20 Abziehfäden)

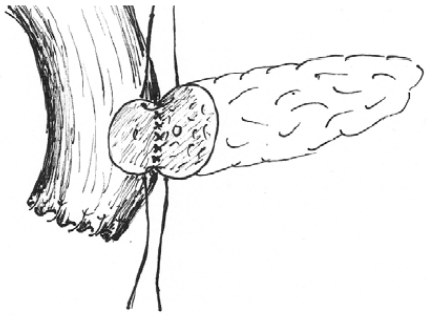
Mittwoch
16.00-17.30 Uhr Gastroenteroanastomose und Pankreasanastomose

Zur Einführung wird ein Kurzvortrag zur Technik der Gastroenteroanastomose gehalten, in dem auf unterschiedliche Anastomosentechniken hingewiesen wird und z.B. die Cross-Sectional-Technik erläutert wird. Außerdem wird die Pankreas-Anastomose vorgestellt.
In diesem Teil wird zunächst eine Gastroenteroanastomose in einreihig fortlaufender Nahttechnik geübt und eine Pankreatico-Jejunostomie nach Warren-Cartell (Disc-Excision am Dünndarm, Stichinzision Mucosa, Hinterwandnaht, Duct-to Mucosa-Naht, Vorderwandnaht) zwischen Schweinedarm und einem Pankreasmodell mit einem 6mm messenden D. pancreaticus angelegt.

Aufgabe 1

Gastroenteroanatomose (hintere GE)	Zweireihig fortlaufende Anastomose 
Anwendungsbeispiel	hintere GE, z.B. bei maligner Magenausgangsstenose bei einem nicht resektablen Pankreaskarzinom
Material	Dünndarm und Magen vom Schwein
Nahtmaterial	Fortlaufend: geflochtenes resorbierbares Nahtmaterial 2-0 (3 lange Faden)

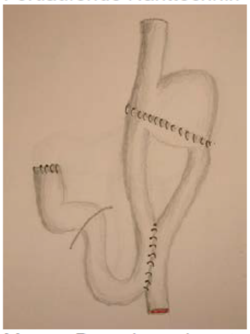
Aufgabe 2

2. Pancreatico-Jejunostomie	
Anwendungsbeispiel	Pankreasanastomose (Variante n. Warren-Cartell) nach Pankreaskopfresektion
Material	Dünndarm vom Schwein, Pankreasmodell aus weichem Kunststoff (6mm Pankreasgang)
Nahtmaterial	Hinterwand monofile resorbierbare 4.0 Einzelknopfnaht „Duct-To-Mucosa“ Anastomose 5.0 oder 6.0 monofile resorbierbare Einzelknopfnaht Vorderwand monofile 4.0 resorbierbare Einzelknopfnaht

Donnerstag

8.30-10.00 Uhr **BII-Resektion mit Braun´scher Fußpunktanastomose**

Einleitung: Zur Einleitung wird ein kurzer fünfminütiger Vortrag über die Einsatzgebiete und Techniken gehalten und darauf hingewiesen, dass mehrere gängige Techniken existieren.
In diesem Teil wird eine BII-Resektion am fixierten Schweinemage geübtn. Hierzu wird die hintere GE der Vorübung reseziert nun der Dünndarm mit dem Magen in einreihig fortlaufender Nahttechnik verbunden. Jetzt wird noch eine Braun´sche Fußpunktanastomose genäht.

Aufgabe 1a) Billroth II (BII-) Resektion	Fortlaufende Nahttechnik 
Anwendungsbeispiel	Magen-Dünndarm-Anastomose
Material	Dünndarm und Magen vom Schwein
Nahtmaterial	Resorbierbares monofiles resorbierbares Nahtmaterial 3-0 (1 Faden doppeltarmiert)
Aufgabe 1 b)	Einreihig fortlaufende Anastomose
Braun´sche Fußpunkt-Anastomose	
Anwendungsbeispiel	Seit-zu-Seit Dünndarm-Dünndarm-Anastomose
Material	Dünndarm und Dünndarm vom Schwein
Nahtmaterial	Resorbierbares monofiles resorbierbares Nahtmaterial 4-0 (1 Faden doppeltarmiert)

Donnerstag
10.30-12.00 Uhr **Biliodigestive Anastomose und Roux-Y-Anastomose**

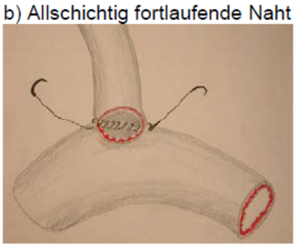
Einleitung: Zur Einleitung werden in einem kurzen fünfminütigen Vortrag die Technik und Indikation der biliodigestiven Anastomose und der Roux-Y-Anastomose vorgestellt.
In dieser Übung wird eine biliodigestive Anastomose geübt. Als Modell dient fixierter Schweinedarm und eine PTFE-Gefäßprothese. Anschließend wird eine Roux-Y-Anastomose am Schweinedarmmodell angelegt.

Aufgabe 1

1) Biliodigestive Anastomose (BDA)

a) Allschichtige Einzelknopfnaht

b) Allschichtig fortlaufende Naht



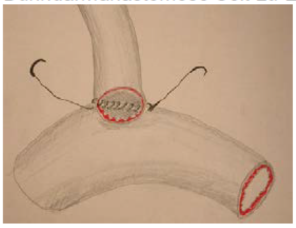
Anwendungsbeispiel: BDA beim Pankreaskopfkarzinom

Material: PTFE-Gefäßprothese (aus Übung 1) und Dünndarm vom Schwein

Nahtmaterial: a) Resorbierbares monophiles Nahtmaterial 4-0 (10 Abziehnähte)
b) Resorbierbares monofiles Nahtmaterial 4-0 (1 doppelt armierte Naht)

Aufgabe 2

Roux-Y-Anastomose =
Dünndarmanastomose Seit-zu-End



Material: Dünndarm vom Schwein

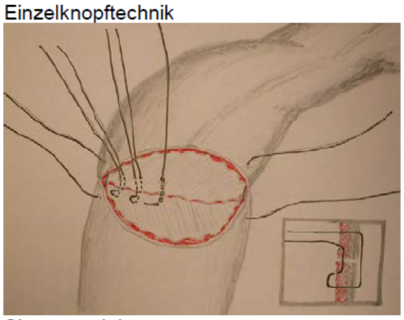
Nahtmaterial: Resorbiertbares monofiles Nahtmaterial 4-0 (kleine Nadel)
(1 doppelt armierte Naht)

Donnerstag

14.00-15.00 Uhr Rektumanastomose

Einleitung: Zur Einleitung wird ein kurzer fünfminütiger Vortrag zum Einsatzgebiet Sigma- und Rektumresektion gehalten.
In diesem Teil wird das Prinzip der TME erklärt. Anschließend wird eine Handanastomose nach Sigmaresektion einschließlich der Gambee-Naht in Gruppen zu zweit geübt und schließlich werden in Gruppen zu viert Pouchanale Klammernahtanastomosen angefertigt.

Aufgabe 1

Rektumanastomose (Handnahttechnik)	Hinterwand in Gambee-Technik, Vorderwand in seromuskulärer Einzelknopftechnik
	
Anwendungsbeispiel	Sigmaresektion
Material	Kolon vom Schwein
Nahtmaterial	Resorbierbares geflochtenes Nahtmaterial 3-0 (30 Abziehnähte)

Aufgabe 2

2) Kolon-Pouch-Anale Anastomose	„Double-Stapling“ Technik
Anwendungsbeispiel	Rektumkarzinom der unteren zwei Rektumdrittel
Material	Kolon vom Schwein, Beckenmodell aus Styropor
Nahtmaterial	Linear-Cutter (1 Stück z.B. 50 mm zum Absetzen des Colon) Linear-Cutter (1 Stück z.B. 80 mm für 6 cm langen Colon-J-Pouch), monofiles Nahtmaterial 0 (1 langer nadelarmierter Faden als Tabaksbeutelnaht) resorbierbares geflochtenes Nahtmaterial 3-0 (10 Abziehnähte zum Versenken der Klammernaht) Abgewinkelter Linear-Stapler (1 Stück z.B. 40 mm mit zwei Magazinen zum Doublestapling des distalen Rektum) zirkulärer Stapler (z.B. 28er), 1 Stück

15.00-15.30 Uhr Lernerfolgskontrolle

Von jedem Teilnehmer wird eine Dünndarmanastomose in fortlaufender Nahttechnik (siehe erste Übung (1a). Es wird kein Einleitungsvortrag gehalten. Alle Teilnehmer werden gebeten, die Anastomose technisch möglichst exakt und zügig anzulegen und alle erlernten Aspekte anzuwenden. Die Qualität der Anastomose wird wie bereits zu Beginn des Kurses anhand des OSATS-Scores von den Tischtutoren bewertet.

Anschließend: Zusammenfassung des Kurses und Überreichung der Zertifikate

Curriculum Vitae

Name, Vorname:	Elhabash, Saleem
Geburtsdatum:	4. Februar 1983
Adresse:	Rudolf-Virchow-Str. 3
email:	saleem_habbash@yahoo.com
Nationalität:	Deutsch

Berufserfahrung:

Oktober 2005 – November 2005

- Klinisches Praktikum in der Allgemeinchirurgie, unter Leitung von Dr. Bradford G. Scott, Dr. Frank Welsh, Baylor College of Medicine, Texas

November 2005 – Dezember 2005

- Klinisches Praktikum in der Notfall Chirurgie, unter Leitung von Dr. Bradford G.Scott, Dr. Frank Welsh Baylor College of Medicine, Texas

Januar 2006 - August 2006

- OP-Assistent unter Leitung von Prof. Dr. Sameer S. Awad Baylor College of Medicine, Texas

Juni 2008 - Juni 2009

- Assistenzarzt in der Allgemeinchirurgie unter Leitung von Prof. Dr. Ashley Stanley, Brigham and Women`s Hospital- Harvard Medical School, Boston, MA

Juni 2009 – Oktober 2009

- Assistenzarzt in der Allgemeinchirurgie unter Leitung von der Prof. Dr. Edwin Deitch, University of Medicine and Dentistry in New Jersey

September 2011- Oktober 2017

- Assistenzarzt in der Klinik für Allgemein-, Viszeral-, Thorax- und Endokrine Chirurgie unter Leitung von Prof. Dr. Berthold Gerdes im Johannes Wesling Klinikum Minden, Universitätsklinikum der Ruhr-Universität Bochum

Oktober 2017- Heute

- Weiterbildung spezielle Viszeralchirurgie in der Klinik für Allgemein-, Viszeral-, Thorax- und Endokrine Chirurgie unter Leitung von Prof. Dr. Berthold Gerdes im Johannes Wesling Klinikum Minden, Universitätsklinikum der Ruhr-Universität Bochum

Ausbildung:

1994 – 2000

- Gymnasium, Riad – Saudi Arabien

09.2000 - 06.2006

- Humanmedizin an der Jordan University of Science and Technology, Jordanien

04.2007 - 08.2007

Weiterbildung in den U.S.A.:

USMLE Step1
Step 2 Clinical Skills
Step 2 Clinical Knowledge
ECFMG Certification
Advanced Cardiac Support (ACLS)

Mitgliedschaft:

- Deutsche Gesellschaft für Allgemein- und Visceralchirurgie (DGAV)
- Vereinigung niederrheinisch-westfälischer Chirurgen
- Ärztekammer Westfalen-Lippe
- Marburger Bund

List of academic teachers

My academic teachers are Prof. Fuad Ammari, Prof. Abdullah M. Saadeh, Associate Prof. Basheer Y. Khassawneh, Assistant Prof. Mohammad Hassan H. Alhaidari, Prof. Faisal M. Abu-Ekteish, Prof. Mahmoud Y. Al Sheyyab (Jordan), Prof. Kamal Itani (USA), Associate Prof. Samir Awad (USA), Prof. Dr. med. Berthold Gerdes in Minden (Deutschland)

Acknowledgment

I would like to thank all persons who helped and supported me a lot in finalizing this project.

I would like to thank my supervisor, Prof. Berthold Gerdes, for giving me the opportunity to do this project, for the patient guidance, encouragement and advice he has provided throughout this project. I have been extremely lucky to have a supervisor who cared so much about my work, and who responded to my questions and queries so promptly.

To my family, thank you for encouraging me in all of my pursuits and inspiring me to follow my dreams. I am especially grateful to my parents, who supported me emotionally and financially and sacrificed a lot to make me the person who I am today.

I must express my gratitude to Aesha Albardawil, my wife, for her continued support and encouragement. Thank you for listening, offering me advice, and supporting me through this entire process.

.

This Dissertation is dedicated to my parents

For their Sacrifice, encouragement and their endless love

Ehrenwörtliche Erklärung

„Ich erkläre ehrenwörtlich, dass ich die dem Fachbereich Medizin Marburg zur Promotionsprüfung eingereichte Arbeit mit dem Titel

Objective Assessment of Surgical Skills in a 2-Day Visceral Anastomoses Techniques Course held in the Annual Congress of the German Surgical Society (DGCH)

in der Klinik für Allgemein-, Viszeral-, Thorax und Endokrine Chirurgie unter Leitung und Unterstützung von Prof. Dr. med. Berthold Gerdes ohne sonstige Hilfe selbst durchgeführt und bei der Abfassung der Arbeit keine anderen als die in der Dissertation angeführten Hilfsmittel benutzt habe. Ich habe bisher an keinem in- oder ausländischen Medizinischen Fachbereich ein Gesuch um Zulassung zur Promotion eingereicht, noch die vorliegende oder eine andere Arbeit als Dissertation vorgelegt.

Ich versichere, dass ich sämtliche wörtlichen oder sinngemäßen Übernahmen und Zitate kenntlich gemacht habe.

Mit dem Einsatz von Software zur Erkennung von Plagiaten bin ich einverstanden.

Ergebnisse der vorliegenden Arbeit wurden in der Zeitschrift „Clinics in Surgery" 2018, sowie 2016 als Posterabstract in der Zeitschrift für Gastroenterologie veröffentlicht.

Ort, Datum	Unterschrift

Die Hinweise zur Erkennung von Plagiaten habe ich zur Kenntnis genommen.

Ort, Datum	Unterschrift Betreuer

Publications, Abstracts, Presentations, Poster

1. Elhabash S, Gerdes B.
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Operation time for suprapubic transumbilical cholecystectomy: Results of a prospective randomized trial]. Chirurg. 2015 Sep;86(9):866-73. doi: 10.1007/s00104-014-2958-9
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Characteristics and microbiology of patients persenting with necrotizing Fasciitis, presented at the Association of VA Surgeons, 31st Annual Meeting, May 10–12, 2007, Little Rock, AR
7. Awad SS, van Doorn EC, Elhabash SI, Subramanian A.

Characteristics and microbiology of patients with perforated appendicitis, Presented at the 28th annual meeting surgical infection society, South Carolina 07-09 May 2008

8. Subramanian A, Elhabash SI, van Doorn EC, Awad SS
Outcomes of acute Appendicitis in the elderly, presented at Association of VA Surgeons, 32nd Annual Meeting, May 4–6, 2008

9. S. Elhabash, M. Sorleto, I. Dimopoulos, M. Thülig, B. Gerdes

Muslima mit schwerer Osteomalzie und spontaner Beckenfraktur aufgrund fehlender Enzymsubstitution nach Resektion eines Pankreaskopfkarzinoms, Alternativen in der Enzymsubstitution? Poster,134. Kongress der Deutschen Gesellschaft für Chirurgie, March 2017
(http://h2041619.stratoserver.net/chirurgie2017/timetable/abstract.php?id=669)

10. S. Elhabash, M. Sorleto, I. Dimopoulos, M. Thülig, B. Gerdes

A Case report: cystic pancreatic lesions in a Patient with a family history of a hereditary Pancreatic Carcinoma-Melanoma syndrome, Indication for OP? Presented at 185. Jahrestagung der Vereinigung Niederrheinisch-Westfälischer Chirurgen, June, 2018
(https://viszeralmedizin-nrw.de/inhalt/uploads/2018/05/VZM-NRW18_Hauptprogramm_Web_final.pdf)

11. Thülig M., Gerdes C., Elhabash S.I., Dimopoulos I., Sorleto M., Gerdes B.

Postoperative Results after Pylorus-Preserving Pancreaticoduodenectomy using Delpero's Omental Flap. Z Gastroenterol 2017; 55(08): e57-e299, DOI: 10.1055/s-0037-1604935. This Abstract was presented as poster presentation at the annual congress 2017 of the ”184. Jahrestagung der Vereinigung Niederrheinisch-Westfälischer Chirurgen”