Session VII: Innovations in Minimally Invasive Surgery Simulation

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Simulation

• Although simulation is considered integral to general surgery training, its role has only recently been recognized in thoracic surgical education, perhaps due to a lack of widely available, validated simulators for advanced thoracic procedures.
Simulation

• Simulation of a case:
  • for planning
  • for teaching

• Construct validity = ability of the simulator to discriminate between users of different skill levels

• Content validity = simulator requires same steps and decision-making as a clinical lobectomy
Simulation in Thoracic Surgery Education

2011 Award Recipients
2010 Award Recipients
2009 Award Recipients

The deadline for the 2014 TSFRE Simulation awards is October 15, 2013.

Mission Statement

To foster the development of surgeon scientists in cardiothoracic surgery; increasing knowledge and innovation to benefit patient care.

Donating to TSFRE
The future...


• Like a pilot, we will also be expected to be fully trained on simulators prior to operating on patients
• Like a pilot, our work may soon be recoverable and recorded for review when something goes wrong
• We will be expected to perform at a high level and increasingly more complex airplanes
VATS Lobe Simulation
Shari Meyerson’s work

Low fidelity system

VATS Lobe Simulation
Shari Meyerson’s work

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VATS Lobe Simulation
Shari Meyerson’s work

- Goal: to evaluate the construct, content and face validity of an inexpensive, easily reproducible simulator for teaching thoracoscopic lobectomy.

VATS Lobe Simulation
Shari Meyerson’s work

• 31 residents participated in the study (12 experienced, 6 intermediate and 13 novice)

• Differences between groups were statistically significant for
  • experienced vs. novice (P < 0.001)
  • experienced vs. intermediate (P < 0.04)
VATS Lobe Simulation
Shari Meyerson’s work

• Content validity was assessed by the 18 participants who had previously seen a thoracoscopic lobectomy with a mean of 9.2 of 10 possible points.

The thoracoscopic lobectomy simulator used in this study demonstrates acceptable validity and can be a useful tool for teaching thoracoscopic lobectomy to trainees or experienced surgeons.

Simulation
Global Assessment of Skill

Simulation Courses

• Allow supervised simulation
• Didactic sessions
• Feedback and continued mentoring
Simulation Telementoring

- Telesurgical mentoring has evolved as an important subset of telemedicine.

- Is used when an experienced surgeon assists or directs another less experienced surgeon who is operating at a distance.

- The images viewed by the operating surgeon can easily be transmitted to a central "telesurgical mentor" and permit an intraoperative interaction.
Simulation
Proctoring in the OR

• Proctor
• Coach
• Mentor
• Teacher
• Instructor
Simulation
Telestration

• Is feasible and safe
• Experienced surgeons performed better with less errors than inexperienced surgeons in telestration tasks

Simulation

3-d planning for chest wall reconstruction

- 3 cases of non-palpable metastatic chest wall lesions in which the preoperative surgical planning and the intraoperative identification of the tumour, and thus the subsequent chest wall reconstruction, was supported using computer-based surgery.

- The application of high-resolution three-dimensional imaging technology and navigational systems is used in preoperative surgical planning to provide virtual simulations of a patient's skeletal changes and new soft tissue profile. Intraoperatively, a mobile navigation probe was used to identify the lesion, matching surgical landmarks and the preoperative computed tomography imaging, achieving the radical resection of the tumour with correct but not excessive surgical margins. Two patients underwent partial sternectomy followed by sternal allograft reconstruction. The third patient underwent chest wall resection followed by reconstruction using titanium bars and vicryl mesh. In all cases, the postoperative period was uneventful. After a follow-up period of 13.9 and 8 months, respectively, all patients are disease free, without complications.

- Application of navigation technology in thoracic surgery should be encouraged because it is easy to use and requires a limited learning curve.

Simulation
Coronary anastomosis

• The study objective was to assess the impact of dedicated instruction and deliberate practice on fourth-year medical students' proficiency in performing a coronary anastomosis using a porcine heart model, compared with nonsimulator-trained senior general surgery residents.

• Ten fourth-year medical students were trained to perform a coronary anastomosis using the porcine simulator. Students trained for 4 months using deliberate practice methodology and one-on-one instruction. At the end of the training, each student was filmed performing a complete anastomosis. Eleven senior general surgery residents were filmed performing an anastomosis after a single tutorial. All films were graded by 3 independent cardiac surgeons in a blinded fashion. The primary outcome was the median final score (range, 1-10) of a modified Objective Structured Assessment of Technical Skill scale. The secondary outcome was time to completion in seconds. Statistical analysis used both parametric (Student t test) and nonparametric (Wilcoxon rank-sum) methods.

• The median combined final score for medical students was 3 (interquartile range, 2.3-4.8), compared with 4 (interquartile range, 3.3-5.3) for residents (P = .102). The overall median individual final scores were 3 (interquartile range, 2-6) for grader 1, 3 (interquartile range, 2-5) for grader 2, and 4 (interquartile range, 3-5) for grader 3. For each individual grader, there was no difference in median final scores between medical students and residents. The mean time to completion was 792.7 seconds (95% confidence interval, 623.4-962) for medical students and 659 seconds (95% confidence interval, 599.1-719) for residents (P = .118).

• Dedicated instruction of fourth-year medical students with deliberate and distributed practice of microvascular techniques using a porcine end-to-side coronary artery anastomosis simulation model results in performance comparable to that of senior general surgery residents. These results suggest that focused tissue simulator training can compress the learning curve to acquire technical proficiency in comparison with real-time training.

Simulation
ECMO

• Developed and tested a clinical simulation program in the principles and conduct of postcardiotomy extracorporeal membrane oxygenation (ECMO) with the aim of improving confidence, proficiency, and crisis management.

• Twenty-three thoracic surgery residents from unique residency programs participated in an ECMO course involving didactic lectures and hands-on simulation. A current postcardiotomy ECMO circuit was used in a simulation center to give residents training with basic operations and crisis management. Pretraining and posttraining assessments concerning confidence and knowledge were administered. Before and after the training, residents were asked to identify components of the ECMO circuit and manage crisis scenarios, including venous line collapse, arterial hypertension, and arterial desaturation.

• In the hands-on portion, residents had difficulty identifying the gas source and flow rate, centrifugal pump head inlet, and oxygenator outflow line. Timely and accurate ECMO component identification improved significantly after training. The arterial desaturation crisis scenario gave the residents difficulty, with only 22% providing the appropriate treatment recommendations in a timely and accurate fashion. At the end of the simulation training, most residents were able to manage the crises correctly in a timely manner. Posttraining confidence-related scores increased significantly. Most of the residents strongly recommended the course to their peers and reported simulation-based training was helpful in their postcardiotomy ECMO education.

• We developed a simulation-based postcardiotomy ECMO training program that resulted in improved ECMO confidence in thoracic surgery residents. Crisis management in a simulated environment enabled residents to acquire technical and behavioral skills that are important in managing critical ECMO-related problems.

Simulation
Cardiac curriculum

- Goal was to determine the feasibility of developing a cardiac surgery simulation curriculum using the formal steps of curriculum development.

- Cardiothoracic surgery residents (n = 6) and faculty (n = 9) evaluated 54 common cardiac surgical procedures to determine their need for simulation. The highest scoring procedures were grouped into similarly themed monthly modules, each with specific learning objectives. Educational tools consisting of inanimate, animate, and cadaveric facilities and a newly created virtual operating room were used for curriculum implementation. Resident satisfaction was evaluated by way of a 5-point Likert scale. Perceived competency (scale of 1-10) and pre-/post-self-confidence (scale of 1-5) scores were collected and analyzed using cumulative mean values and a paired t-test.

- Of the 23 highest scoring procedures (mean score, > 4.0) on the needs assessment, 21 were used for curriculum development. These procedures were categorized into 12 monthly modules. The simulation curriculum was implemented using the optimal simulation tool available. Resident satisfaction (n = 57) showed an overwhelmingly positive response (mean score, > 4.7). The perceived competency scores highlighted the procedures residents were uncomfortable performing independently. The pre-/post-self-confidence scores increased throughout the modules, and the differences were statistically significant (P < .001).

- It is feasible to develop and implement a cardiac surgery simulation curriculum using a structured approach. High-fidelity, low-technology tools such as a fresh tissue cadaver laboratory and a virtual operating room could be important adjuncts.

Simulation CPB

- Developed/tested a clinical simulation program in the principles and conduct of cardiopulmonary bypass with the aim of improving confidence and proficiency in this critical aspect of cardiac surgical care.

- 15 residents from 6 resident-training programs who reported no prior cardiopulmonary bypass observation or simulation-based perfusion experience participated in a cardiopulmonary bypass course involving both didactic lectures and hands-on simulation. A computer-controlled hydraulic model of the human circulation was used in a specifically designed multidisciplinary simulation center environment to give the participants hands-on training with both basic operations and specific perfusion crisis scenarios. Pretraining and posttraining assessments concerning confidence, knowledge, and applications with regard to cardiopulmonary bypass were administered and compared.

- Likert scale scores on confidence-related items increased significantly (P < .001), from 59% +/- 16% to 92% +/- 8%. Pretraining versus posttraining scores (72% +/- 14%) on similar cognitive items were not significantly different (P=.3636). Scores on similar open-ended application items before and after training improved from 62% +/- 25% to 85 +/- 10% (P < .0001). All subjects agreed that simulation-based cardiopulmonary bypass training was superior to classroom- and clinic-based education and that the scenarios enhanced their learning experience.

- Simulation-based cardiopulmonary bypass training appears to be an effective technique to build the confidence of thoracic surgery residents regarding knowledge and applications. Scenario-based practice in a specifically designed simulated environment is a valuable adjunct to traditional educational methods and has the potential to improve the training of thoracic residents. Copyright 2010 The American Association for Thoracic Surgery.

Simulation
VATS lobectomy simulation training

- 28 surgical residents were randomized to either virtual-reality training on a nephrectomy module or traditional black-box simulator training.

- After a retention period they performed a thoracoscopic lobectomy on a porcine model and their performance was scored using a previously validated assessment tool.

- The groups did not differ in age or gender. All participants were able to complete the lobectomy.

- The performance of the black-box group was significantly faster during the test scenario than the virtual-reality group: 26.6 min (SD 6.7 min) versus 32.7 min (SD 7.5 min).

- No difference existed between the two groups when comparing bleeding and anatomical and non-anatomical errors.

- Simulation-based training and targeted instructions enabled the trainees to perform a simulated thoracoscopic lobectomy.

- Traditional black-box training was more effective than virtual-reality laparoscopy training.

- Thus, a dedicated simulator for thoracoscopy should be available before establishing systematic virtual-reality training programs for trainees in thoracic surgery.

Simulation
3-d planning

• Chest wall cases
• Complicated anatomy
• Pancoast cases
Mayo Clinic
3-d printing
Mayo Clinic
3-d printing
Telementoring
Robotic Simulation


1st Surgical VATS Lobe digital simulator

- Industry’s First Simulated Video-Assisted Thoracoscopic Surgery (VATS) Lobectomy using LapSim laparoscopic simulator
- Provides trainees simulated practice performing each step involved in removing the upper right lung lobe:
  - including the dissection of hilum/vessels
  - vessel identification
  - sequential stapling of veins, arteries, bronchus & fissure
  - presenting structures to stapler
  - bleeding control
VATS Lobe Simulator

VATS Lobectomy

Video-Assisted Thoracoscopic Surgery (VATS) Lobectomy

Surgical Science has released the first Video-Assisted Thoracoscopic Surgery (VATS) Lobectomy procedure module for virtual reality. The VATS module offers training on key steps in the removal of the upper right lung lobe, utilizing a three-port anterior approach.

KEY TRAINING ELEMENTS FOR VATS LOBECTOMY:

- Dissection of hilum/vessels
- Identification of vessels
- Use of elastic vessel rubber loop
- Sequential stapling of veins, arteries, bronchus and fissure
  - Bleeding control
- Avoid critical structures, e.g. the Phrenic nerve

With the addition of VATS, LapSim’s suite of validated fully customizable procedure modules, Surgical Science now offers an even more complete training solution for medical professionals across multiple disciplines.

With clearly defined learning objectives, procedural deconstruction capabilities and endless variations and challenges, LapSim’s library of software modules provides surgeons with unparalleled access to skill practice essential to building surgical proficiency.
VATS Lobe Simulator

- Engine behind the simulator that records all events
- Demonstrates transfer/having an impact into the OR
- Mandated in some countries like board certification
- Tissue stress
- Errors
- Bleeding
Gaming
What happens when you make it fun?
Questions & Discussion

“As simulated surgical education continues to gain widespread adoption, we believe our continued innovations, like VATS, will help contribute to safer surgeons and improved patient outcomes.”

Hans Uddenberg, global product manager for LapSim