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Robotic simulation: What about teaching

The introduction of robot assisted surgery has changed the game in the field of minimal invasive surgery. Today, robotic thoracic surgery is the secondly growing discipline in the world (personal communication with Intuitive). The paradigm shift in surgical procedures necessitates new training methods. When compared to open surgical simulations, the robotic system seems ideal for integrating various forms of simulations and assessments. While using simulation, surgeons can develop their skills and pass their basic learning curve on a simulator, hence avoiding the medico-legal aspects of surgical training. Implementing simulation has the potential to create high-quality, competence-based robotic training programs. This may help in shortening the learning curve and may provide patient safety with better surgical outcome. Simulation also provides experienced surgeons to develop or familiarize themselves with new instruments in a virtual environment. It has been reported that 50% of the hospitals were lack of specific criteria for the surgeon's competence before starting with robotic surgery.

There are several jobs in which the use of virtual reality simulation as a practice tool is a must, i.e. pilots. Robotic surgeons recently had more opportunities to learn virtual reality and simulation exercises before they perform their first robotic case. Surgeons may use simulators to develop their capabilities before using a robot. Several simulator protocols are available, particularly to develop general surgical skills.

Didactic Knowledge

When starting with robotic surgery the trainee/surgeon needs to gain knowledge and understand the robot technology, device functions, basic troubleshooting, device parameters and the limitations of the system. The next step will be the development of knowledge for specific surgical procedures. This includes patient selection and indications, preoperative preparation, patient and system positioning, port placement, procedural steps, complications and their management.

("da Vinci" as a surgical transformer)

If a surgeon has no feeling of combining himself with a robot, this surgery may be a kind of torture to the surgeon. Basic open surgical skills should have been learnt before deciding to become a robotic surgeon. Robotic learning may be a part of surgical education, but learning surgery with robotic surgery, at least for nowadays, is not acceptable. Robot is not an automate that teaches you to operate on. It is a machine to transfer your capabilities to operate on a patient. Having an extended experience on VATS may be helpful at the beginning. Several authors compared conventional laparoscopy with robotic assisted laparoscopy in a skills laboratory. Conventional exercises for laparoscopy can be used and can actually be performed faster and more accurately with robotic surgery. The exercises have a shorter learning curve and are performed more accurately with robot assistance. Residents without any laparoscopic experience demonstrated the capacity to rapidly learn basic surgical maneuvers.

The first thing a robotic surgeon candidate must do is to know the robot as a driver knows his own car.

Before a surgeon uses the surgeon console with the attached Skills Simulator, he should have a basic understanding of the da Vinci System itself.

• He should have watched case videos or observed live procedures.

• A “test drive” is essential to understand the capabilities of a robot. This could be obtained under the guidance of Intuitive employees.

• Exploring the website is useful.

(www.davincisurgerycommunity.com/group/davinci-community/training)

The Skills Simulator

The robotic surgeon should be comfortable with the chair, height and location of handles. Messages that appear in the monitor should be noticed. He should be able to receive information from monitor, like position of the camera, current situation of the arms, coagulation and etc. He or she must have knowledge of how to troubleshoot all problems and what to do with each error message prior to surgery. Essentially during the test drive he should have learnt these messages.

Basic Skills learning at the Simulator

After listening to teacher, individuals must complete a set of basic simulator education to refine their skills. A suggested order for this curriculum is given to all thoracic robotic fellows at the University of Alabama, Birmingham.

The simulated skill drills are designed to start users from the relatively simple ones to more difficult. This is a model of a “sequence of skill development”. If a surgeon is having trouble to complete one of the particular exercise, it is recommended that he looks for other exercises in the same skill category.

Simulation

The SEP Robot simulator (SimSurgery AS, Oslo, Norway) is part of a conventional VR trainer for laparoscopy, which can be converted into a simulator for robotic surgery. Both trainer modalities showed no significant difference for a standardized suturing task. Training of a robotic suturing skill on this simulator equaled training on a mechanical simulator and practice sessions improved the technical performance of novices. Concepts of face validity and construct validity for this simulator seem to be present. There are several advanced simulators. The Robotic Surgical Simulator (RoSS) and the dV-Trainer (dVT). Also several technological collaborative groups (*Mimic Technologies* and *Simbionix*) developed *Skills Simulator* exercises ranging from basic to advanced levels. dVT is a simulator that uses the same kinematics as the da Vinci Surgical System (dVSS). During the development phase of this system several validation studies demonstrated face, content and construct validity. Training on the dVT improved performance on the robot system equal to training with the robot itself. The software of the dVT is suitable to use within the actual robotic console, allowing virtual tasks to be performed in a real-life environment. The aim of simulation is shortly;

1- To increases adaptability with the *da Vinci* System. The time spent with the *Skills Simulator* allows surgeons to practice on the *da Vinci* System and he becomes comfortable as he is driving the car.

2- To provide learning technical exposure capabilities.

3- To provide an assessment score by the use of the *Skills Simulator,* so that the progress at capabilities of a particular surgeon could be noticed.

4- To be used as a warm-up before surgery

An over-view of Robotic Surgical Simulator (RoSS) _
- RoSS is a validated VR simulator for the daVinci Surgical System that provides an immersive interface by replicating the actual robotic surgical system.
- RoSS reproduces the feel and visualization of the da Vinci Surgical System while incorporating a graduated curriculum that allows trainees to progress from basic orientation tasks to more complex robotic surgical skills tasks.
- The ease of mobility allows RoSS to be located at easily accessible areas. It has undergone face and content validation and is considered as an appropriate tool to learn and evaluate robotic skills prior to real robotic console exposure in the operating room
- Validation of a newly developed training curriculum was recently performed and is currently being implemented at Roswell Park Cancer Institute
- At present, RoSS is the only simulator to offer procedure-based modules.
- Hands- on Surgical Training (HoST) technology guides a trainee through the steps of a procedure by moving the console arms and pinch devices in concert with the real robotic console surgeon.

For more information, please visit intuitive website at:

http://www.intuitivesurgical.com/products/skills_simulator

Simulation exercises for the following conditions:

Learning the Camera and Clutching: These exercises help users improve camera control and learn to use the clutch effectively.

EndoWrist Manipulation: These exercises teach to use the surgeon's hands combined with the handles.

Intracorpereal Knot tying and Suturing: These exercises teach how to tie knots intracorpereal and use left or right hand according to different conditions.

Fourth Arm Integration: For more advanced technical skills forth arm use could be adopted.

Needle Control and Driving: Needle manipulation and focusing on the affectivity of positioning

needle in different geometrical plans.

Surgery on a cadaveric or on an animal model

Finally; after the surgeon inherits basics of surgical skills at the skill simulator, he operates on an animal model or on a cadaveric model. Animal and cadaver simulation models have the advantage of simulating the human anatomy and these models can be used for procedural training. This kind of training was considered one of the most important components of a robotic training program and has hence been incorporated in several courses. These courses seem to enable participants to successfully incorporate robotic assisted surgery and maintain this technique in clinical practice in the short term and long term. Although operating on animal models is almost similar to operating on people, it is expensive and there are ethical concerns in some countries. The surgeon still needs to learn the docking. Docking could be learnt by observation or by performing at the wet lab. During the wet lab surgical model study, surgeon can dissect the vessels, lymph nodes and perihilar structures.

After all these exercises a surgeon with all capabilities of performing open operations may be able to perform a real robotic surgery.

Proctoring

Proctoring is providing a direct supervision of an expert to asses the skills and knowledge of the trainee. Although extended proctorship is an expensive way of training, it provides a relatively safe way to introduce a new techniques. Proctering also prevents surgeons from beginning to perform procedures before they have mastered the technique. There are different ways of proctoring. Usually the proctor will visit the hospital of the trainee, and surgery is performed together by increasing the responsibilities of the trainee depending on his or her skills. The

trainee may visit the proctor first to view a number of cases. Proctoring is a very time-consuming and expensive way of teaching. Alternatives of proctoring are tele-mentoring and tele-procotoring which may save time and travelling. A trainee can also make a video recording of the performed procedure and send it to a proctor; the evaluation can then be carried out by watching the video online together. Surprisingly, after a 5-day intensive robotic course only 37.5% of the attendees used the possibility of proctoring, even at no extra cost. This could be because most of the trainees attended as a team and on returning to their hospital they performed surgery together.

Mentoring

Mentoring during actual performance of a robotic operation can be carried out in several ways. First, the mentor can observe the trainee closely while performing an operation and give verbal instruction and take over the operation when necessary and secondly he may use the mentoring console. This is a second console, which facilitates the surgeon to collaborate with the trainee during surgery. The mentoring console has two collaborative modes: the ***'swap' mode***, which allows the mentor and the trainee to operate simultaneously and actively swap control of the robot arms, and the 'nudge' mode, which allows them both to have control over two robot arms. The ***'nudge mode'*** seems to be particularly useful for guiding the trainee's hands during some steps of an operation. There is also the possibility for the trainee to sit at the mentoring console and passively follow the motions of the telemanipulators of the instructor (haptic learning).

Learning curve

The ‘learning curve’ refers to the amount of surgical procedures performed before a surgeon reaches an accepted plateau in outcome parameters (operating time, blood loss, complication rate, quality of surgery). Complex surgical procedures may have a long learning curve. The length of a learning curve may also vary because of surgeon-related factors (general surgical experience, surgical experience with a similar technology, familiarity with the procedure) or hospital related factors (availability of theatre time, available case load). There are the different phases of the operation. First, there is the aspect of time needed for the operating team to prepare and activate the robot system (‘setup time’). Second, there is the time phase relating to positioning and installing the robot (‘docking time’). Third, one can differentiate the actual time needed to complete the robotic surgery procedure (‘console time’). Fourth, there is the whole time span in which the person is in the theatre (‘theatre time’). Setup time and docking time can be reduced quickly, when working in a high-volume setting with a dedicated team. The surgical outcome parameters are blood loss, complication rate, and the conversion rate to open surgery. For the quality of oncological surgery, parameters like ‘number of lymph nodes’, ‘tumor-free margins’ and ‘recurrence rate’ are known to be used.

Training future surgeons

There is an increasing need for sophisticated training programs for residents, fellows and surgeons. Courses are commonly used, some of them are pure didactic and other mainly consist of skills training, but many of them try to combine the two modalities. Several authors addressed the issue of training residents and fellows, and described their training program. In contrast to open surgery, robotic skills can improve significantly in a relatively short time.

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