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REVIEW ARTICLE

A Review of Medical Education in Minimally Invasive Surgery

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ABSTRACT

The benefits of minimally invasive surgery have been well documented. The use of minimally invasive surgery has also been increasing in many specialties including gynecology. Medical education has a traditional motto which has been; see one, do one, teach one. However, with laparoscopy and robotics this paradigm may not be the best case for the practitioner or the patient especially with the increasing attempt to minimize the footprint of surgical education. With this in mind, we have to learn how to best educate future minimally invasive surgeons, particularly laparoscopic and robotic surgeons. The present study provides a review of similarities and differences in the medical education of laparoscopy and robotic surgery. This article also highlights the deficiencies and future work required to advance laparoscopic and robotic surgical training.

Keywords: Laparoscopic training, Robotic training, Robotic surgery, Laparoscopic surgery, Robotic surgical education, Laparoscopic surgical education, Robotic learning curve, Laparoscopy learning curve.

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INTRODUCTION

Based on World Health Organization (WHO) data from 29% of participating countries it is estimated that 234.2 million major surgical procedures are undertaken every year worldwide.[1] The hysterectomy is the most commonly performed gynecologic surgery, with an estimated 600,000 performed each year.[2] Minimally invasive surgical techniques currently make up a minority of the procedure; however, they are becoming increasingly common in many surgical specialties' including gynecologic surgery. Each minimal invasive system (robotics and laparoscopy) have documented benefits over traditional open surgery including less postoperative pain, shorter hospital stays, faster return to normal activities, and decreased blood loss and adhesion formation which make them attractive modalities for surgeons to incorporate in their repertoire.[3,4] However, laparoscopy and robotic surgery can be challenging to learn, to train surgeons in and to validate the educational process. The learning curve for many procedures has been documented and studied including the curve for robotic and laparoscopic surgery.[5-8]

Moreover, as the transition is made from conventional open to laparoscopy and robotic surgery, areas including learning these skills, assessment of proficiency in these areas and structured training for surgeons in practice and training is important.[9] Understanding how these surgical techniques are learned and how such learning can be best assessed will enable us to develop protocols for training and set standards for competence and proficiency. As laparoscopic has in use longer than robotic surgery, information on how to proceed with robotic training may be gained from reviewing the strides in laparoscopic education.

AIM

The aim of this article is to review the medical education involved in developing minimal access surgeons specifically laparoscopists and robotic surgeons. This review looks at some similarities and current differences in medical education.

MATERIALS AND METHODS

An electronic literature search was performed, restricted to the English language, of PubMed®, MEDLINE® and search engines, such as Google. Studies that were eligible for review included surgical skills training in postgraduate surgical trainees to capture studies reviewing the educational requirements of laparoscopic and robotic surgery education and training. The Google search engine, MEDLINE® and PubMed® databases were systematically searched until November 2012. References from retrieved articles were reviewed to broaden the search.

RESULTS

Laparoscopy

Laparoscopy was introduced into gynecology in the United States in the late 1960s and slowly advanced from a diagnostic procedure. In the early 1970s, Professor Kurt Semm of Germany expanded the therapeutic applications of laparoscopy by performing oophorectomies, appendectomies, myomectomies, and extensive adhesiolysis. However, other gynecologists did not immediately see the utility until the mid to late 70s. The early efforts were the ground work for later advanced laparoscopic operations.[10,11] Besides the lack of a larger incision as in conventional surgery, there are other benefits. Standard endoscopic instruments offer a magnified view, haptic feedback. However, there is monocular vision with some depth clues, only 4º of freedom, and reduced operative dexterity and tremor amplification.[12]

Robotics

The da Vinci (Intuitive Surgical, Inc., Sunnyvale, CA) surgical system is being used by surgeons across several surgical specialties. The da Vinci Robotic System is FDA-approved for surgical robotics, consists of three components: A surgeon console, the InSite vision system (which provides three-dimensional (3D) stereoscopic imaging), a patient-side cart with EndoWrist instruments, and either 3 or 4 robotic arms.

The console includes a stereoscopic viewer with an infrared sensor and hand and foot controls that allow the surgeon to control positioning and focus of the camera and activation of monopolar or bipolar energy sources. The vision system creates a 3D image, as the endoscope is composed of two parallel 5 mm telescopes with 0° or 30° lenses. The image is magnified 10 to 15 times. The laparoscopic surgical instruments articulate in 7° of freedom and 90° of articulation, allowing movements that imitate the surgeon's hand. They also decrease tremors and motion artifact. Laparoscopic instruments include energy sources such as monopolar and bipolar cautery, the Harmonic ACE, the PK dissecting forceps, and laser. Graspers, needle drivers, retractors and specialized instruments are also designed for the robotic arms.

The robotic interface is different not only to open surgery, but also to laparoscopy because it involves remote surgical control, stereoscopic vision and lack of haptic feedback. However, in summary, advanced surgical robotic systems offer precise instrument articulation, a magnified 3D visualization, camera stabilization and direct control, tremor filtration, motion scaling and improved ergonomics.[13,14]

EDUCATION IN LAPAROSCOPY AND ROBOTICS

Medical Education

Nine fundamental manipulations of tissues by surgical instruments that surgeons must learn are [both visual and haptic (touch)], aspiration/injection, incision, excision, extraction, evacuation, purposeful injury, closure and implantation/transplantation.[15,16] Learning curve and surgical dexterity are two measurement tools that are used to compare surgical learning and training. Medical education usually uses skill training and various exercises to decrease the learning curve and improve surgical dexterity. Comparing surgical skill acquisition and proficiency using conventional laparoscopy and robotic interfaces may help improve the education in these areas.

Laparoscopic education has been an important part of surgical education for the last two decades. So much so, starting in 2008 United States, The Accreditation Council for Graduate Medical Education (ACGME) changed the requirements for laparoscopic cases for surgical graduates. Moreover, the Fundamentals of Laparoscopic Surgery program that was introduced over a decade ago as a method of measuring competency with laparoscopic techniques is a mandatory component of laparoscopic education.[17]

Computer technology including virtual reality simulators offers an adjunct for surgical training. Having the ability to teach psychomotor skills, they help the progression along the learning curve for this rapidly developing surgical technique within a safe training environment. Hence, basic- and intermediate-level minimally invasive surgical maneuvers can be learned and practiced by trainees and instructors using computer-based virtual environments, and performances can be assessed objectively before trainees proceed to patients in the OR.[18-20]

Training centers and training programs are readily available in the area of laparoscopy, making the training of future surgeons possible. Education costs are manageable. Although not necessary it is also possible to the theater staff trained in laparoscopy.[21-23]

Education in Robotic Surgery

A fast learning curve to a competent level using the da Vinci system is possible helped by the system's intuitive motion. Motion analysis is a useful tool to measure performance in the da Vinci system compared to OSATS and time alone.[24]

Currently, on the market, five different robotic surgery simulation platforms are available. One meta-analysis looked at 11 studies that sought opinion and compared performance between two different groups; 'expert' and 'novice'. Experts ranged in experience from 21-2, 200 robotic cases. The novice groups consisted of participants with no prior experience on a robotic platform and were often medical students or junior doctors.

The Mimic dV-Trainer®, ProMIS®, SimSurgery Educational Platform® (SEP) and Intuitive systems have shown face, content and construct validity. The Robotic Surgical Simulator™ system has only been face and content validated. All of the simulators except SEP have shown educational impact. Feasibility and cost-effectiveness of simulation systems was not evaluated in any trial. Virtual reality simulators were shown to be effective training tools for junior trainees.[25]

DISCUSSION

Although these systems (laparoscopy and robotics) may seem to be inherently different they share some similarities. They are both newer areas of surgery than conventional surgery. Moreover, they are growing areas of surgery with more and more surgeons desiring to be educated in these modalities. Medical education in laparoscopy and robotics are both areas of current interest.

Several studies agree that simulation training used as an adjunct to traditional training methods to equip the next generation of laparoscopic and robotic surgeons with the skills required to operate proficiently and safely. Several valid and reliable monitoring tools for laparoscopic surgical training have been implemented successfully into various surgical training programs.

The development of laparoscopy has been driven by the surgeons; whereas robotic education is currently industry driven. Curriculum for laparoscopy has been developed and is being implemented in many surgical training programs. However, current simulation models have only been validated in small studies. There is no evidence to suggest one type of simulator provides more effective training than any other.

In robotics, simulation has been validated for certain aspects of education. However, more research is needed to validate simulated environments further and investigate the effectiveness of animal and cadaveric training in robotic surgery. However, the effectiveness of animal and cadaveric workshops has been validated in laparoscopy. Some of the current limitations in robotic surgical education include the cost, the availability of training centers, and the need to educate the operating room nursing staff.

CONCLUSION

There are many similarities between the education in laparoscopy and robotic surgery including the need for medical education, the need for continued development of curriculum and the need for continued advancement in technologies. Given the known benefits of these surgical modalities, there is continued need for research and advancing training programs in laparoscopy and training in robotic surgery and programs for safe and effective integration of these modalities into the surgical subspecialties.

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REFERENCES

1. Weiser TG, Regenbogen SE, Thompson KD, Haynes AB, Lipsitz SR, Berry WR, et al. An estimation of the global volume of surgery: A modeling strategy based on available data. The Lancet 2008 Jul;372(9633):139-44.
2. Keshavarz H, Hillis SD, Kieke BA, Marchbanks PA. Hysterectomy Surveillance—United States, 1994-1999. MMWR 2002 Jul;51(SS05):1-8. Available from: http://www.cdc.gov/mmwr/preview/mmwrhtml/ss5105a1.htm.
3. Catenacci M, Flyckt RL, Falcone T. Robotics in reproductive surgery: Strengths and limitations. Placenta 2011 Sep;32(3):S232-37.
4. Chapron C, Fauconnier A, Goffinet F, Bréart G, Dubuisson JB. Laparoscopic surgery is not inherently dangerous for patients presenting with benign gynaecologic pathology. Results of a meta-analysis. Hum Reprod 2002;17(5):1334-42.
5. Kaul S, Shah NL, Menon M. Learning curve using robotic surgery. Current Urol Rep 2006 Mar;7(2):125-29.
6. Zerey M, Adrales GL, Kercher KW. Learning curve in laparoscopic surgery. Minimally invasive surgery training: Theories, models, outcomes. A National Institute of Health and National Library of Medicine.
7. Raja R, Mishra RK. The impact of the learning curve in laparoscopic surgery. Available from: http://www.laparoscopyhospital.com.
8. Lenihan J Jr, Kovanda C, Seshadri-Kreaden U. What is the learning curve for robotic assisted gynecologic surgery? J Minim Invasive Gynecol 2008;15(5):589-94.
9. Roberts KE, Bell RL, Duffy AJ. Evolution of surgical skills training. World J Gastroenterol 2006 May 28;12(20):3219-24.
10. Semm DK. Operative manual for endoscopic abdominal surgery. Operative Pelviscopy. Chicago, London: Year Book Medical Publishers Inc 1987:5-15.
11. Reichert JA, Valle RF. Fitz-Hugh-Curtis syndrome. A laparoscopic approach. JAMA 1976;236:266-68.
12. Westebring-van der Putten EP, Goossens RHM, Jakimowicz JJ, Dankelman J. Haptics in minimally invasive surgery-A review. Minimally Invasive Ther Allied Technol 2008;17(1):3-16.
13. Chen CC, Falcone T. Robotic gynecologic surgery: Past, present and future. Clin Obstet Gynecol 2009 Sep;52(3):335-43.
14. Surgical. Available from: http://www.intuitivesurgical.com. Accessed 10/24/2012.
15. Heinrichs WL, Srivastava S, Pugh C, et al. Visual language to interface users of educational surgical simulators for fundamental surgical manipulations. In: Proceedings of 14th Annual International Meeting of Computer-assisted Radiology and Surgery (CARS). Lemke HJ, (Ed). San Francisco, Amsterdam: Elsevier Publishers; 2000;29-34.
16. Satava RM, Cuschieri A, Hamdorf J. Metrics for objective assessment of surgical skills workshop. Surg Endosc 2003;17(2):220-26.
17. Fried GM, DeRossis AM, Bothwell J, Sigman HH. Comparison of laparoscopic performance in vivo with performance in a laparoscopic simulator. Surg Endosc 1999;13:1077-81.
18. Grantcharov TP, Rosenberg J, Pahle P, Funch-Jensen P. Virtual reality computer simulation. Surg Endosc 2001;15(3):242-44.
19. Seymour NE, Gallagher AG, Roman SA, et al. Virtual reality performance improves operating room performance: Results of a randomized, double-blinded trial. Ann Surg 2002;236:458-64.

20. Aggarwal R, Moorthy K, Darzi A. Laparoscopic skills training and assessment. Br J Surg 2004 Dec;91(12):1549-58.
21. Aggarwal R, Grantcharov TP, Eriksen JR, Blirup D, Kristiansen VB, Funch-Jensen P, et al. An evidence-based virtual reality training program for novice laparoscopic surgeons. Ann Surg 2006 Aug;244(2):310-14.
22. Adrales GL, Chu UB, Hoskins JD, Witzke DB, Park AE. Development of a valid, cost-effective laparoscopic training program. Am J Surg 2004 Feb;187(2):157-63.
23. Powers KA, Rehrig ST, Irias N, Albano HA, Malinow A, Jones SB, et al. Simulated laparoscopic operating room crisis: An approach to enhance the surgical team performance. Surg Endosc 2008 Apr;22(4):885-900.
24. Hernandez JD, Bann SD, Munz Y, et al. Qualitative and quantitative analysis of the learning curve of a simulated surgical task on the da Vinci system. Surg Endosc 2004 Mar;18(3):372-78.
25. Abboudi H, Khan MS, Aboumarzouk O, Guru KA, Challacombe B, Dasgupta P, et al. Current status of validation for robotic surgery simulators-a systematic review. BJU Int 2012 Jun 6 [Epub ahead of print].

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