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ORIGINAL ARTICLE

Virtual Reality Surgical Simulators- A Prerequisite for Robotic Surgery

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Abstract The field of computer assisted minimally invasive surgery is rapidly expanding worldwide, including in India. With more hospitals in India contemplating the acquisition of a robotic platform, training of robotic surgeons is becoming essential. Virtual reality simulators can be used for surgeons to become acquainted with the robotic console prior to live surgery. Our aim was to evaluate the amount of simulator training required before a surgeon first operates on the *da Vinci*® Surgical System. Simulations were conducted on the Intuitive Surgical's *da Vinci*® Robot Skill Simulator using the software obtained from Mimic Technologies. Participants included attending staff surgeons experienced in robotic surgery and novices. A set of seven activities were chosen for each participant. Based on the mean exercise score from the first attempt, staff surgeons outperformed the novices in all exercises. However, the difference in score between the staff and the novices decreased after the participants repeated the exercises and by the sixth attempt most of the novices obtained similar scores to the staff, suggesting that this might be at present the minimum set of repetitions indicated (or required) prior to performing life robotic surgery.

Keywords Robotic surgery · Surgical simulation · Virtual reality surgical simulator

Robotic assisted surgery has taken off in India and there is need for a standardized and safe training. We evaluated the minimum amount of simulator training required before a surgeon performs first robotic assisted surgery. Based on the results, at least six repetitions of a particular set of exercises seems to be the minimum requirement before a surgeon performs his/her first robotic surgery.

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Introduction

The field of robotic surgery or more precisely computer assisted minimal invasive surgery is rapidly expanding worldwide, including in India. The first robotic surgery in India was performed in 2001 and over the past few years the number of robots in India has increased to over 20. Although mainly in use in the fields of urology and gynecology, robotic surgery has been found useful in other specialities like cardiac gastrointestinal, and more recently laryngeal surgery. The advantage of robotic surgery over conventional laparotomy includes faster recovery time, shorter hospital stay, reduced blood loss, less postoperative pain, and improved cosmesis [1]. With more hospitals in India contemplating the acquisition of a robotic platform, training of robotic surgeons is becoming important. Although a surgeon may be skilled and competent in open or minimally invasive surgery, (s) he will need to become familiar with the utilization of the new technology prior to operating on patients.

Traditional surgical learning based on the Halstedian principles, required the orderly exposure to graded clinical experience under supervision from a skilled surgeon [2]. This approach to surgical teaching is less relevant to robotic surgery, because the learner is isolated within the surgical console, thus limiting the ability of the supervisor to provide hands-on guidance. However, the computer interface on the *da Vinci*® Robot provides opportunities for surgeons to

Table 1 Scores of the staff and novices for each activity

Activity	Mean first attempt Score		Mean Sixth attempt score
	Staff	Novice	Novice
Needle Targeting	93	84	91
Dots and Needles 1	94	60	81
Energy Dissection 1	93	72	81
Peg Board 2	92	80	98
Match Board 2	90	73	87
Suture Sponge 2	92	75	98
Ring Walk 3	88	53	89

experience enhanced levels in surgical training and simulation within a safe virtual environment. Instead of learning to manoeuvre a robotic console during live surgery, virtual reality simulators permit the surgeon to become acquainted with the platform prior to operating on an actual patient. The face, content and construct of various virtual reality simulators have been validated [3–6]. It has also been shown that training with virtual reality simulators improves performance on the DaVinci Surgical System [7]

Our aim was to evaluate the amount of simulator training required before a novice robotic surgeon should operate with the *da Vinci*® Surgical System.

Methods

This study was conducted at the Jewish General Hospital, Montreal, Canada during March and April 2012. Simulations were conducted on the Intuitive Surgical's *da Vinci*® Robot Skill Simulator using the software obtained from Mimic Technologies. A set of seven activities were chosen for each participant: Needle Targeting, Dots and Needles 1, Energy Dissection 1, Peg Board 2, Match Board 2, Suture Sponge 2, and Ring Walk 3. Exercises were scored with the help of a computerized built in algorithm, including time to complete exercise, instruments out of view, excessive instrument force, economy of motion, instrument collisions, and master workspace range. Participants included attending staff surgeons, fellows, residents, and medical students from the division of Gynecology Oncology. The staff surgeons had extensive experience in robotic surgery (totalling over 900 cases) and all the other participants were grouped together as novices with no experience in robotic surgery. The novices performed many repetitions of these seven set of exercises. Staff performed the entire set of exercises once and their scores were set as the standard to which novices were compared.

Results

Of the 41 participants, 3 were attending staff from the division of Gynecologic Oncology and the rest were novices, consisting of fellows, residents, and students. Based on the mean exercise score of the first attempt, staff outperformed the novices in all the exercises (Table 1). However, the difference in score between the staff and the novices decreased as the participants repeated the exercises and by the sixth attempt most of the novices were obtaining the same scores as the staff (Table 1). This improvement in learning was maximum during the first 4 attempts with the learning curve plateauing after that (Fig. 1). The learning curve of the novices plateaued after the sixth attempt and minimal improvement was noted with further attempts. (Fig. 1)

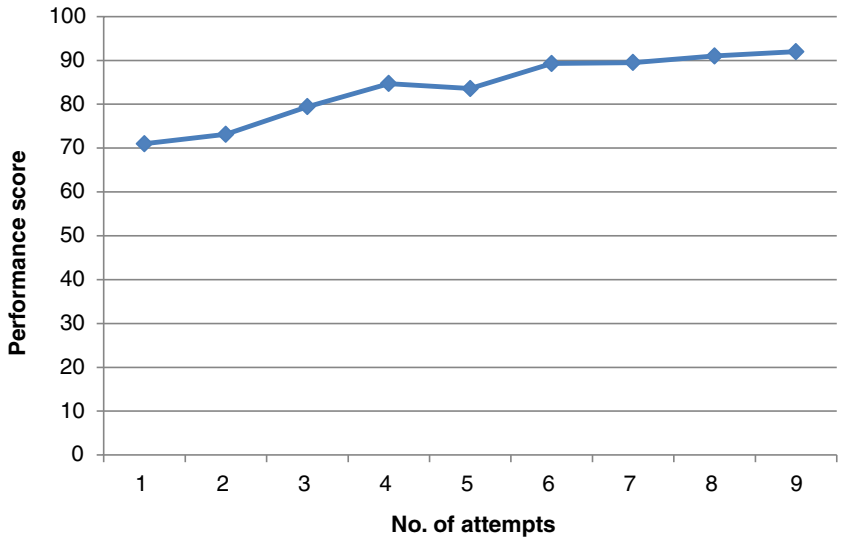

Fig. 1 Graph showing the improvement in performance of the novices with repeated attempts

Discussion

Robotic surgery requires surgeons to possess a new, unique set of surgical skills related to the technological features of the robotic platform. The need to develop competence with this new technology has resulted in the introduction of new training methods to allow surgeons to hone their skills in this arena prior to performing live surgery. Virtual reality simulators are one such training tool which replicates various surgical scenarios with standardized performance analysis. The training is intended to make the performance during the actual live surgical event more consistent, controlled, and automatic [8]. A number of surgical simulators are available today including the Robotic Surgical Simulator (RoSS, Simulated Surgical Systems, Buffalo NY), dV Trainer (Mimic Technologies, Seattle WA), ProMIS (Haptica, Ireland), SEP Robot (Sim Surgery, Norway), and the *da Vinci*® Skills Simulator (Intutive Surgical, Sunnyvale, CA).

Simulators must be validated with respect to face, content (provision of realistic surgical platform and basic skill sets), and structure (potentiating improvement through standardized performance analysis and metrics) [8]. The *da Vinci*® Skills Simulator which we used in our study has also been validated for the above three parameters [3].

There are reports that simulator training helps in improved handling and use of the *da Vinci*® Surgical System [9]. The report by Lerner at al. showed that there was significant performance improvement after four training sessions with the simulator and the simulator trained group had better results when using the *da Vinci*® Surgical System [7]. It has been suggested by SG Kang et al. that four hours of simulator training is required for a trainee to become proficient in the 'Tubes 2' task [9]. In the report by Brinkman et al., 10 repetitions were not sufficient for many novices to reach an expert level [10]. In our study, after 6 repetitions most of the novices, including fellows, residents, and medical students obtained equivalent scores to the experienced attending surgeons.

The aim of our study was to evaluate the minimum amount of simulator training required before a surgeon attempts his/her first robotic-assisted live surgery. Based on the results mentioned above it could be suggested that six repetitions of a particular set of exercises might be at present the minimum set of repetitions required prior to performing life robotic surgery.

Conclusion

Robotic-assisted surgery has taken off in India and there is a need for safe and standardized training. Virtual reality simulators provide a safe environment for surgeons to become accustomed to the new skills required in the field of robotic surgery. Further studies are needed to validate and quantify the exact set of exercises and repetitions needed on the simulator for each specific set of surgeries. In addition, it will be necessary to evaluate if improvement with the simulator exercises translates into surgical competence during live surgeries.

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