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BRIEF COMMUNICATION

Low confidence levels with the robotic platform among senior surgical residents: simulation training is needed

Francisco Schlottmann[1,2] · **Jason M. Long**[1] · **Sean Brown**[1] · **Marco G. Patti**[1,3]

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Abstract

Acquisition of robotic surgical skills by surgical residents is usually hindered by time pressure and financial imperatives. Robotic simulation training offers an attractive solution because it allows residents to learn in a safe, controlled, and standardized environment. We aimed to determine the confidence levels of senior surgical residents with the robotic platform, and how those levels were affected by simulation training. Twenty senior residents participated in a simulation course using perfused porcine tissue blocks to perform the following robotic procedures: Nissen fundoplication, Heller myotomy, sleeve gastrectomy, colectomy, and lobectomy. Procedural steps evaluated included port placements, docking process, suturing, using energy devices, and using staplers. Mean baseline confidence levels were low for all the surgical steps analyzed, and all these values significantly increased after the 3-day robotic training in the simulation center. A standardized formal robotic simulation program with realistic hands-on training should be incorporated in the general surgery residency curriculum.

Keywords Robotic surgery · Residents · Training · Simulation

Robotic surgery offers significant advantages such as three-dimensional imaging with improved visibility, increased amplitude of surgical movements through the robotic arms, and improved ergonomics. These features have encouraged the rapid embracement of the robotic platform in the US [1–3]. However, the adoption of robotic surgery in a residency program can be challenging. In fact, a recent study showed that the introduction of robotics in the program had a negative impact on residents training due to a significant decrease of resident's participation in the procedures [4].

Robotic surgical skills are unique and not derivative from either open or laparoscopic surgery. Unfortunately, acquisition of those skills by surgical residents is usually hindered by time pressure and financial imperatives. Robotic simulation training offers an attractive solution because it allows residents to learn in a safe, controlled, and standardized environment. For this reason, in our simulation center we have focused our efforts on developing realistic simulators for robotic surgery. Our simulators consist of porcine tissue blocks, which are perfused with artificial blood, and mounted in a human mannequin. We have recently described our foregut model that allows for training in robotic fundoplication, Heller myotomy, and sleeve gastrectomy [5]. Currently, we also have large bowel models and perfused lung models, which allow the training in robotic colectomy and lobectomy, respectively.

We aimed to determine the confidence levels of senior surgical residents (3rd, 4th and 5th year) with the robotic platform, and how those levels were affected by simulation training. We conducted a 3-day robotic simulation course with one entire day for each sub-specialty (thoracic, colorectal, and foregut). Twenty senior residents participated in the course using the Da Vinci Surgical System Xi (Intuitive Surgical, Inc.) under supervision of six attending surgeons, performing the following robotic procedures: Nissen fundoplication (Fig. 1), Heller myotomy, sleeve gastrectomy, colectomy (Fig. 2), and lobectomy (Fig. 3). Resident's confidence levels on different robotic surgical steps were measured with a questionnaire (0–10 Likert scale based, with 0 being extremely unconfident and 10

✉ Francisco Schlottmann
fschlottmann@hotmail.com

[1] Department of Surgery, University of North Carolina, 4030 Burnett Womack Building, 101 Manning Drive, CB 7081, Chapel Hill, NC 27599-7081, USA

[2] Department of Surgery, Hospital Alemán of Buenos Aires, University of Buenos Aires, Buenos Aires, Argentina

[3] Department of Medicine, University of North Carolina, Chapel Hill, NC, USA

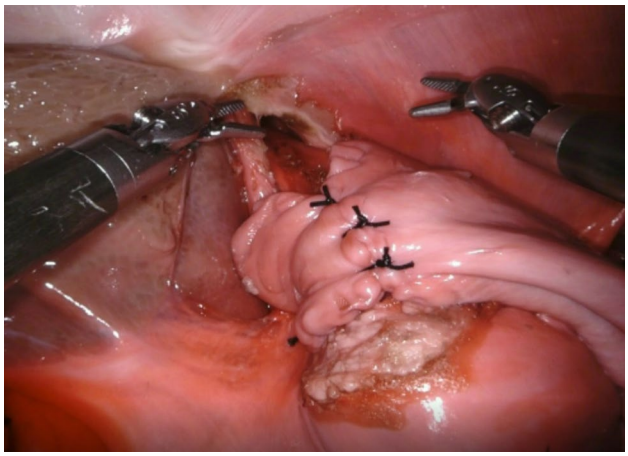

Fig. 1 Nissen fundoplication

Fig. 2 Bowel transected with a linear stapler

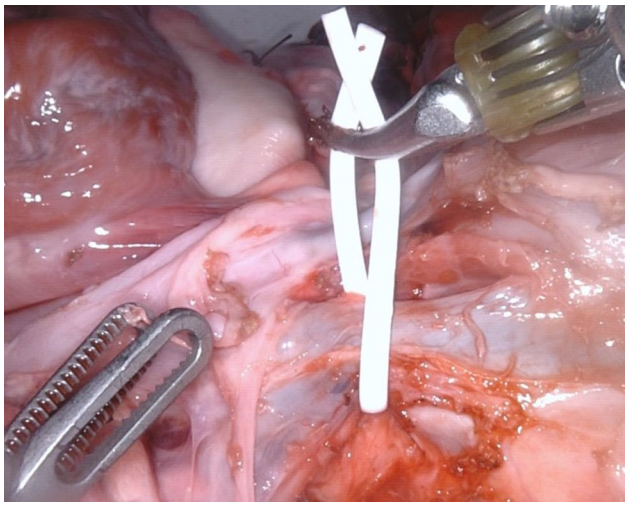

Fig. 3 Left superior pulmonary vein dissected and encircled with a vessel loop

Table 1 Confidence levels (scale 0–10) on robotic surgical steps among senior residents before and after simulation training with perfused tissue blocks

	Mean (pre)	Mean (post)	*p* value
Port placement	5.36	7.05	0.007
Docking	5.59	7.18	0.01
Suturing	5.05	7.50	< 0.001
Using energy device	5.36	7.36	< 0.001
Using staplers	4.91	7.41	< 0.001

being extremely confident). Procedural steps evaluated included port placements, docking process, suturing, using energy devices, and using staplers. The questionnaire was delivered immediately before and after the training session. Mean pre- and post-training confidence levels were compared with the student *t* test, and *p* values < 0.05 were considered statistically significant.

Mean baseline confidence levels among senior residents were low for all the surgical steps analyzed: port placement (5.36), docking process (5.59), suturing (5.05), using energy devices (5.36), and using staplers (4.91). All these values significantly increased after the 3-day robotic training in the simulation center (Table 1). Remarkably, the highest levels of confidence growth were noticed for skills that residents are often unable to develop in the operating room (suturing and using energy devices or staplers). However, even for procedural steps that residents are more familiar with (port placements and docking) simulation training was useful.

Robotic-assisted procedures have undergone rapid growth over the last years in the US [6]. However, there are currently no standard requirements for robotic surgery training in residencies. A previous survey-based study aimed to identify resident's perception of robot-assisted procedures in general surgery residency [7]. Overall, 63% of residents indicated that they had participated in robotic cases, with the most frequent activities being assisting with the robotic trocar placement, docking, and undocking the robot. Only 18% reported experience using the robotic console, and 60% of the residents indicated that they received no prior education or training before their first robotic case [7]. In addition, another study showed that residency programs with robotic curricula often remain grounded in initial industrial efforts to train practicing surgeons, and do not include discussion of operative technique and surgical concepts [8]. In line with these results, our residents expressed low confidence levels on operating the robotic console (e.g., suturing or using staplers). However, confidence grew significantly after a

structured robotic training course with realistic simulation models.

Most of the studies addressing resident training in robotic surgery have been limited to urology and gynecology residency programs [9–11]. This could be explained by the earlier adoption and acceptance of the robotic platform for prostatectomies and gynecological procedures. For instance, obstetrics and gynecology residents are usually exposed to a wide variety of robotic training modalities [11]. In general surgery programs, however, the integration of residents into robotic procedures while achieving the learning curve for both staff surgeons and trainees is very challenging. This is mostly determined by the lack of formal and mandatory robotic simulation curricula and the absence of realistic simulation models [12]. Virtual reality simulators, such as the Da Vinci skills simulator, are the most preferred in terms of ergonomics and usability [13, 14]. However, they have a very high initial cost and the artificial environment created does not correlate accurately with the real-world intraoperative skills. In addition, virtual reality simulation becomes somehow tiresome to residents as they advance over time. Cadavers and live animals offer high fidelity training to practice entire operations. Nevertheless, they have significant drawbacks such as costs, availability, and even ethical concerns [15]. The use of perfused porcine tissue block simulators is capable of overcoming these drawbacks, offering a valuable and realistic training tool. Residents can effectively learn complex robotic procedures if properly supervised and mentored using simulation. Consequently, implementing a high-quality simulation curriculum has the potential to create robust, comprehensive, and safe robotic training programs for surgical residents.

Besides resident's training, patient safety should be another major motivation to adopt simulation. In fact, surgical errors represent a large proportion of the paid malpractice claims in the US [16]. Specifically for robotic surgery, previous studies have shown that hospitals largely ignore risks and underreport surgical complications [17, 18]. As the market for robotically assisted surgery continues to grow, it is critical to establish standardized simulation protocols to maintain patients' safety. In this sense, robotic simulation can be used to identify skill deficits not only among residents but also among practicing surgeons. Finally, in light of the growing concerns of the high costs associated with robotic surgery [19–21], simulation will certainly promote efficiency and improve performance through skills acquisition [22].

We intended to determine confidence levels with the robotic platform among senior residents and we found low levels in all the procedural steps analyzed. In addition, we found that the use of realistic simulation models for robotic surgery is capable of increasing confidence among surgical residents. To our knowledge, this is the first study that evaluates residents' confidence with the robotic surgical platform. Although there could be a significant gap between confidence and real proficiency, this study demonstrates the benefits of robotic simulation training in surgical residency programs. Therefore, we strongly believe that a standardized formal robotic simulation program with realistic hands-on training should be incorporated in the general surgery residency curriculum.

Compliance with ethical standards

Conflict of interest Francisco Schlottmann, Jason M. Long, Sean Brown, and Marco G. Patti declare that they have no conflict of interest.

Ethical approval All applicable international, national, and/or institutional guidelines for the care and use of animals were followed.

Statement of human and animal rights This study does not contain any studies with human participants performed by any of the authors.

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