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Surgeon experience, robotic perioperative outcomes, and complications in gynecology

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SUMMARY

OBJECTIVE: Robotic surgery is currently on the rise and has been widely applied all over the world. Gynecology offers great opportunities for the development of innovative techniques due to the magnitude of surgical needs. The aim of this study was to correlate perioperative complications, surgical time, and length of hospital stay with surgical diagnosis, procedure performed, and surgeon experience in robot-assisted gynecological surgeries in a 10-year period.

METHODS: This was a retrospective, transversal, cross-sectional study involving 632 patients who underwent robotic gynecological surgery from January 2008 to December 2017 in a community hospital in Sao Paulo, Brazil. Medical records of robot-assisted gynecological operations were searched for perioperative complications, operative time, and length of hospital stay, correlating these outcomes with surgical diagnosis, procedure performed, and surgeon experience, considering those with 20 or less robotic procedures and surgeons with more than 20 cases in their career as in-training or qualified surgeons, respectively.

RESULTS: Endometriosis (381 cases) was the most common surgical indication, followed by uterine myoma (171 patients). Qualified surgeons had 64% less complications than in-training surgeons (p=0.03) and achieved 20% lower surgical time and 15% shorter length of hospital stay.

CONCLUSION: In this study, qualified surgeons with more than 20 robotic procedures had better perioperative outcomes and less complications than in-training surgeons during their first 20 robotic surgeries.

KEYWORDS: Complications. Endometriosis. Fibroid tumor. Robotics. Surgeons.

INTRODUCTION

Robotic surgery is currently on the rise and has been widely applied all over the world[1]. At present, there are more than 50,000 certified surgeons and more than 6,730 robots distributed across 69 countries[2,3]. Gynecology offers many opportunities for the development of innovative techniques due to the magnitude of benign and malignant diagnoses with surgical needs[1,4]. To date, 84 hospitals in Brazil have the robotic daVinci system and these institutions, as well as medical associations and regulatory entities, have been searching and working for the safety in the use of this technology and its association with good results for the patient[3]. On this topic, we recently published an article on the importance of proctors in robotic gynecological procedures when surgeons are performing their first procedures, providing a learning curve without increasing risks to the patient[5]. But the literature is scarce, and there is no global credentialing rules to assure the best and safest outcomes to patients[1,4,6]. Barbash and Glied have recommended a minimum of 150–200 procedures for the surgeon to become skilled in the use of robotics, and Lenihan Jr described a shorter surgical time after 50 hysterectomies[7,8]. In contrast, Geller et al. showed consistent improvement in surgical time and robotic suture time after 20 procedures, including hysterectomies and sacrocolpopexies[4].

To seek for possible differences after some experience with the technology, we arbitrarily divided surgeons into two groups: those with more than 20 robotic procedures (qualified surgeons) and those with 20 or less procedures (in-training surgeons). Our goal was to correlate perioperative outcomes such as surgical time, complications, and length of hospital stay, with the surgical diagnosis, procedure performed, and surgeon experience.

METHODS

This was a cross-sectional, retrospective survey, including an analysis of 632 medical records from patients who underwent robotic gynecological surgeries from January 2008 to December 2017. All procedures were performed at the Hospital Israelita

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Albert Einstein (HIAE), Brazil. Cases in which the main procedure was not gynecological were not considered in our analysis. This study was approved by the Institutional Research Ethics Committee (no. 38045414.7.0000.007).

We collected information on the number of surgeries per year, patient's age, body mass index (BMI), diagnoses, procedures performed, surgical time, length of hospital stay, and complications, such as intraoperative injuries, transfusions, and conversions. Comorbidities and previous surgeries were not evaluated.

Surgeries included in the study were composed of those for benign and malignant pathologies. Surgical time was determined as the time for the whole surgical act, including the docking and undocking of the robot, but not the time for the anesthetic induction. Perioperative complications were identified, evaluated one by one, and divided into three major groups: perioperative injuries, transfusions, and conversions. Perioperative injuries that need extra care or treatment for correction were considered. The prescription of blood cell transfusion was individualized on a case-by-case basis, based on patient's background, bleeding amount, and decision of the surgical team. Conversions of robot-assisted laparoscopy, when necessary, took place for conventional laparoscopy or open surgery.

All the participating gynecological surgeons were board certified by the National Obstetrics and Gynecology Association (FEBRASGO) and the first six robotic procedures of each surgeon were always leaded by a proctor, with recognized experience in robotic surgery, according to the local protocol. We analyzed the results of 32 surgeons who were divided into two groups as follows: qualified (>20 previous robotic surgeries) and in-training surgeons (≤20 previous robotic surgeries). With these criteria, 9 qualified surgeons were responsible for 475 surgeries in the period (75% of the total), while the remaining 157 surgeries were performed by 23 in-training surgeons (25% of the total). We first considered those surgeons qualified in robotics who had done at least 20 procedures before the study period, considering that when reaching the preestablished threshold (20 cases) during the time of the study, the new surgical data had been changed to the qualified group from the next case on. Therefore, the initial 20 records were counted as in-training and from case 21 onward as qualified group.

Sample size was defined as the total number of surgeries performed in an established period of time, i.e., 10 years. Comparisons among surgeon experience, length of hospital stay, and duration of the surgery were performed using linear mixed models applied to the log-transformed data. The results are presented as mean ratios and p-values.

We used mixed logistic regression models, accounting for the dependence between different surgeries performed by the same surgeon. Results were expressed as odds ratios with 95% confidence intervals. All analyses were performed considering the level of significance as 5% (p=0.05).

RESULTS

The analyzed sample consisted of 632 robot-assisted gynecological surgeries performed at HIAE from January 2008 to December 2017. In the study period, the number of surgeries consistently increased. The number of surgeries performed in 2017 was 50 times higher than that in 2008, which confirmed a significant growth in the adoption of this technology by the gynecological surgeons at the institution over the years.

Patients' age ranged from 19 to 84, with a mean of 39 years old, and an interquartile range (IQR) of 34–46 years. BMI ranged from 16 to 49, with a median of 23 kg/m^2. A total of 632 patients underwent robotic surgery, with 756 main diagnoses. In total, 1,929 procedures were performed, since several patients underwent two or more procedures at the same time. Of the 756 indications for surgery, we observed 381 cases of endometriosis, which corresponded to 50.4% of the total, being the most common diagnosis in our sample. The same predominance was observed in the frequency of procedures, with endometriosis treatment representing 19.7% of the total, as other procedures often compose those patients' surgeries.

Surgical time varied from 30 to 600 min, with a median of 205 min (IQR: 135–270 min), and the length of hospital stay ranged from <1 to 13 days, with a median of 2 days (IQR: 2–4 days). Patients who underwent surgery with qualified surgeons had a shorter surgical time (p<0.001) and shorter hospitalization (p=0.005), compared with patients operated on by in-training surgeons (Table 1).

In the present study, we aimed to measure the incidence of perioperative complications, such as perioperative injuries, transfusions, and conversions. In 632 patients, we had 20 complications, corresponding to 3.2% of the total, composed by 1.6% incidence of blood cell transfusions, 1.1% of perioperative injuries, and 0.5% of surgical conversion. We tested the correlation of adverse events with the most relevant clinical categories such as indication of surgery, type of procedure, and surgeon qualifying status.

In the set of cases, it should be noted that the 3 of 632 conversions were necessary either because of heavy bleeding that made it difficult to continue the procedure or due to technical limitations to handle big fibroids robotically. The need for transfusion could be associated with patient's previous hemoglobin level. Therefore, we considered perioperative complication as only the cases where excess of bleeding in the procedure resulted in the need for blood transfusion (10 cases). It is also worth highlighting the perioperative injuries found in this 10-year period: one ureter injury, one intraperitoneal hematoma, one vaginal cuff dehiscence, one rectovaginal fistula, one abdominal bleeding, one hemorrhagic shock, and one post-spinal anesthesia headache (7/632).

Table 2 presents the analysis, in a multiple model, for these categories: qualified surgeon (yes vs. no), indication of surgery (endometriosis or myoma vs. other), procedure (hysterectomy vs. myomectomy vs. other), and endometriosis treatment (yes vs. no). We observed that qualified surgeons had 64% less adverse outcomes than in-training surgeons (p=0.038). Regarding the indication of surgery, no relation with perioperative complications was noted (p=0.654). When myomectomy was compared to hysterectomy, we found a 4.78 times higher probability of perioperative complications in patients who underwent myomectomy than in those who underwent hysterectomy (p=0.029). Regarding the endometriosis treatment, no difference was noted (p=0.480).

Considering perioperative complications, only blood cell transfusion had enough events to allow individualized statistical analysis. We used the simple mixed model and observed that in the qualified surgeons' procedures the percentage of blood transfusion was 79% lower (p=0.018), as can be seen in Table 3. Concerning the indication of surgery and procedures performed, no difference in the frequency of blood transfusion was noted in our set of cases.

DISCUSSION

Robotic surgery is a substantial breakthrough in the field of minimally invasive surgery, and this type of intervention has shown a large growth in the past decade[1,2,7]. There are more than 6,730 robots over 69 countries[2,3]. In the United States, there has been a 23% increase rate per year in the number of procedures using robotics[3]. In our hospital, in Sao Paulo / Brazil, this percentage growth was even higher in the past few years, with the number of robotic procedures increasing around 42% every year from 2008 to 2017.

Table 1. Surgical time and length of hospital stay *based on* surgeon experience.

Outcomes	Estimated mean (estimated standard error)		*MR (95%CI)	p-value
	In-training surgeons	Qualified surgeons		
Length of hospital stay, days	2.22 (1.09)	1.89 (1.10)	0.85 (0.77–0.95)	0.005
Surgical time, min	211.51 (1.08)	169.13 (1.09)	0.80 (0.73–0.88)	<0.001

*MR is the ratio between the mean surgical time and the length of hospitalization with qualified or in-training surgeons. The "in-training surgeons" is the reference category.

Table 2. Logistic regression analysis in a multiple model for adverse outcomes.

	Perioperative complications		Multiple model	p-value
	No	Yes	Odds ratio (95%CI)	
Qualified surgeon				
No	149	8	1.0	0.03
Yes	464	11	0.36 (0.13–0.94)	
Indication of surgery				
Other	156	4	1.0	0.654
Endometriosis or myoma	457	15	0.74 (0.20–2.77)	
Procedure				
Hysterectomy	211	4	1.0	
Myomectomy	128	10	4.78 (1.17–19.44)	0.029
Other	274	5	1.08 (0.26–5.10)	0.921
Endometriosis treatment				
No	246	6	1.0	0.480
Yes	367	13	1.56 (0.45–5.40)	

CI: confidence interval. Total of perioperative complications=20. Total of patients with perioperative complications=19 (one had both perioperative injury and need for transfusion).

Table 3. Simple mixed logistic regression models for blood transfusion.

	Blood transfusion		Odds ratio (95%CI)	p-value
	No	Yes		
Qualified surgeon				
No	151	6	1.0	0.018
Yes	471	4	0.21 (0.05–0.6)	
Surgical indication				
Other	157	3	1.0	0.732
Endometriosis or myoma	465	7	0.79 (0.20–3.08)	
Procedure				
Hysterectomy	212	3	1.0	
Myomectomy	133	5	2.66 (0.64–11.29)	0.186
Other	277	2	0.51 (0.07–3.08)	0.463
Endometriosis treatment				
No	248	4	1.0	0.993
Yes	374	6	0.99 (0.28–3.56)	

CI: confidence interval.

In this 10-year period, the most frequent diagnosis for surgery was endometriosis, representing 381 (50.4%) cases. Previous studies have shown benefits in the use of robotics for the endometriosis treatment, given its extension, depth, and complexity[1,9]. Advantages go beyond ergonomics, with more precise identification of lesions, as confirmed by Mosbrucker et al. showing a significantly higher rate of confirmed diagnosis in patients treated with robotic technology[9]. The robotic-assisted approach seems to better preserve ovarian function in patients with bilateral ovarian endometrioma when compared to traditional laparoscopy, based on AMH levels before and after ovarian cystectomy[10]. However, this growth in the adoption of the technology raises concerns regarding safety and surgical training[4,6,8].

There is no consensus on the minimum number of procedures to achieve good surgical performance[6,8]. Barbash and Glied, who evaluated robotic surgery in different specialties, concluded that 150–200 procedures were the requirements for a surgeon to become proficient[7]. Woelk et al. claimed that 91 cases are needed to reach feasibility in robotic hysterectomy, while Lenihan mentioned 50 as the number of procedures required to develop enough competence in the same procedure, according to suture and surgical time[8,11]. Geller et al. demonstrated improvements in surgical time for robotic hysterectomy after 20 cases, which is in accordance with the data presented on different procedures comparing surgeons with more than 20 robotic surgeries to those with 20 or less[4]. Qualified surgeons (>20 robotic surgeries) had a 20% decreasing in surgical time and 15% in length of hospital stay. Regarding the occurrence of unfavorable outcomes, these qualified surgeons had 64% less complications than in-training ones (≤20 robotic surgeries).

Comparison between robotic myomectomy and hysterectomy showed that patients who underwent myomectomy had risk of complications four times higher, therefore reflecting the complexity of myomectomy and enforcing the need of this procedure to be performed by a qualified surgeon with the most appropriate therapeutic tools. The number of perioperative complications was low, represented by 20 in total, making individual parameters difficult to be analyzed. No statistical significance was noted when comparing perioperative injuries and conversions due to the small number of occurrences, and a larger set of cases would be necessary to compare those numbers. Transfusion rate was the only adverse event with sufficient numbers to be separately analyzed and patients operated on by qualified surgeons had 79% less transfusions than those by in-training surgeons.

Taking into account patient safety priorities, although considering that our study has limitations of a retrospective descriptive noncontrolled trial, we present relevant data for establishing policies regarding the minimum number of procedures that a surgeon should perform under supervision of a proctor to assure low risks of perioperative complications to the gynecological patient. By adding suitable training to safety protocols and development of technology, robotics can be a very useful tool in the operating room. It is worth to highlight that this article has limitations, as only one medical institution was evaluated. In addition, there was no standardization on surgical technique and extension of procedures when gynecological surgeries were compared. There was a wide range of surgical complexity as endometriosis treatment, myomectomy, and oncological procedures are usually more complicated than benign hysterectomies and adnexal procedures.

CONCLUSION

Qualified surgeons with more than 20 robotic surgeries may have better perioperative results and less complications than in-training surgeons during their 20 initial robotic procedures.

AUTHORS' CONTRIBUTIONS

BB: Conceptualization. **BP:** Methodology. **RMM:** Visualization. **GB:** Formal Analysis. **EZ:** Funding acquisition. **SP:** Resources. **MTVG:** Supervision.

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