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Adoption of Robotic Sacrocolpopexy at an Academic Institution

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ABSTRACT

Objectives: To describe the introduction of robotic sacrocolpopexy (RSC) in a urogynecology fellowship program, including operative times and patient outcomes.

Methods: Data were retrospectively extracted from all women who underwent RSC between May 1, 2009 and December 31, 2011 by a single urogynecologist with fellow and resident assistance. Patient demographics, operative times, intraoperative complications, length of hospital stay, and postoperative course were analyzed. Cases were grouped chronologically in blocks of 10 for analysis. Trend analysis of operative time was done with linear and negative binomial regression. Fisher's exact test was used to compare complications among blocks.

Results: Fifty-two patients (mean age 58.5 ± 8.4 years) underwent RSC. The majority (75%) had stage III prolapse. Forty-one patients (79%) had concomitant procedures, including supracervical hysterectomy (44%), bilateral salpingo-oophorectomy (9.6%), midurethral sling (9.6%), and lysis of adhesions (40.4%). There was no trend toward decreased operative time with increased surgical experience (linear regression $P = .453$, negative binomial regression $P = .998$). Mean operative time was 301.1 ± 53.1 minutes (range 205–440). Overall complication rate was not associated with number of robotic cases performed ($P = .771$). Nine cases (17.3%) were converted to laparotomy. Five of these occurred in the first 15 cases. There were 2 bladder injuries (3.8%) and no bowel injuries.

Conclusions: Although a learning curve was not demonstrated, the adoption of RSC into a urogynecology fellowship program yields similar rates of bladder/bowel injuries, postoperative complications, and operative times when compared with other published studies.

Key Words: Pelvic organ prolapse, Robotic surgery, Sacral colpopexy, Sacrocolpopexy.

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INTRODUCTION

Abdominal sacrocolpopexy is a common procedure for pelvic organ prolapse with excellent long-term success rates ranging from 78% to 100%.[1] However, patients undergoing laparotomy often require an extended hospitalization and recovery period. Transvaginal prolapse repair with mesh was designed to combine the durable success of abdominal sacrocolpopexy with the benefits of a minimally invasive approach. However, studies have shown that vaginal mesh kits may have a mesh erosion rate as high as 15.6%, which is significantly higher than 3.4% seen with abdominal sacrocolpopexy in pooling multiple studies.[1,2]

Realizing many of the problems with both vaginal and abdominal approaches, surgeons have adopted minimally invasive techniques such as laparoscopic sacrocolpopexy in efforts to maximize success and minimize complications. However, the surgical skill required and the inherent limitations of laparoscopic instrumentation may prevent this approach from being widely accepted. Thus, performing sacrocolpopexy with the use of the da Vinci robot (Intuitive Surgical Inc, Sunnyvale, California) aims to combine the advantage of open sacrocolpopexy with the decreased morbidity of laparoscopy.[3]

Robotic-assisted sacrocolpopexy (Robotic sacrocolpopexy) has been shown to result in decreased hospital stays, low complication rates, and high patient satisfaction.[4] Mean operative times for RSC have been reported to range from 172 to 328 minutes with a 1% to 3% conversion rate to open abdominal surgery.[3–5] This is congruent with mean operative times for abdominal sacrocolpopexy that range from 170 to 418 minutes.[3,6]

It has been suggested that operative time is increased at an academic institution that involves direct teaching and hands-on participation of clinical fellows/residents at the robotic console, but this remains speculative.[3] A previous study at an academic institution has shown a 25.4% reduction from an initial mean of 197 minutes after the first 10 cases.[7] Similarly, Elliot et al[4] reported that with experience, they were able to decrease operative time from over 4 hours to <2.5 hours. Although these previous studies touch on the length of a learning curve at their institutions, we believe it is necessary to continue to study this surgical technique as it is adopted into a fellowship program.

While initial data suggests that RSC can be performed safely with decreased patient morbidity and good short-term outcomes, it still does not fully describe what happens when this new technique is introduced into a fellowship program with no previous robotic experience for attendings or trainees. In order for RSC to become a standard option across the country, it must be taught effectively and efficiently to practitioners. During its introduction to a training program, it must undergo a learning curve for both the attending and the fellow. This paper will describe our experience during the introductory phase of this technique, specifically focusing on surgeon operative times and learning curves and intraoperative and postoperative complications.

MATERIALS AND METHODS

Data were retrospectively extracted from the medical records of all women who underwent RSC between May 1, 2009 and December 31, 2011 by a single fellowship-trained urogynecologist, encompassing his entire initial robotic experience. All cases had fellow and/or resident involvement, neither of whom had any prior robotic experience. The attending and fellows had previously performed laparoscopic hysterectomies, but not sacrocolpopexies. Furthermore, the attending surgeon had previously been performing all sacrocolpopexies via laparotomy and also had no prior robotic experience. Institutional review board approval was obtained prior to any data collection.

Demographics, past medical and surgical histories, and pelvic organ prolapse quantification system exams were extracted from the medical record. Surgical and postoperative variables included the following: operative times, defined by time from skin incision to closure; intraoperative and postoperative complications; blood loss; concomitant procedures; and lengths of hospital stay.

Data were analyzed using SPSS (version 19.0; SPSS Inc, Chicago, Illinois). Results are presented as means with standard deviations for continuous normally distributed variables and medians with full ranges for continuous not normally distributed variables. Categorical variables are presented as counts and percentages. Trend analysis of operative time was done with linear and negative binomial regression. Fisher's exact test was used to compare complications among periods. Statistical analyses were considered significant with P-value < 0.05.

Our convenience sample of the first 32 months of robotic sacrocolpopexies was chosen to correspond with published learning curve data. Studies suggest that robotic operative times plateau after as few as 10 cases.[4,7] Cases were grouped chronologically in blocks of 10 for analysis for multiple reasons. First, with the learning curve potentially as low as 10 cases, this should show a decrease in operative time and complications from the first compared with subsequent blocks. Second, complications were relatively rare events and the grouping would aid analysis for decreasing complications with increasing surgical experience. Third, due to the inherent large variability of operative times, grouping would aid in analysis of decreasing times.

RSC was performed as has been previously described by Geller et al.[3] If a uterus was present, a supracervical hysterectomy was performed. Polypropylene mesh (Gynecare Gynemesh PS, Somerville, New Jersey) was then attached to the vagina using delayed-absorbable monofilament sutures, with approximately 8 to 12 interrupted sutures on both the anterior and posterior vagina. The mesh was then attached to the sacrum with 2 permanent braided sutures (Surgilon; Covidien, Mansfield, Massachusetts). The peritoneum overlying the mesh was closed with interrupted sutures. Cystoscopy confirmed ureteral patency and absence of bladder injury.

The introduction of RSC into our institution involved the training of 1 attending surgeon via proctored cases and training sessions. After the attending surgeon was privileged, fellows began involvement with the robotic cases, which included originally structured simulation labs, then assistance with docking and incrementally increased participation on the robotic console based on their level of experience.

RESULTS

Fifty-two patients with mean age 58.5 ± 8.4 years underwent RSC for stage II (8%), III (75%), or IV prolapse (17%). Baseline characteristics and demographic information are presented in **Table 1**. Forty-one patients (79%) had concomitant procedures **(Table 2)**. The proportion of cases that included hysterectomy and other concomitant procedures was similar among blocks of 10.

Mean operative time was 301.1 ± 53.1 minutes (range 205–440). There was no significant trend toward decreased operative time with increased robotic surgical experience (linear regression $P = .453$, negative binomial regression $P = .998$) **(Figure 1)**. Mean estimated blood loss was 66.2 ± 65 mL (range 25–300 mL). Estimated blood loss was not correlated with the number of cases performed ($\rho = -0.017$) and only weakly correlated with operating room time ($\rho = 0.230$) and length of stay ($P = 0.124$).

Forty-two of 52 patients (80.8%) had fellow involvement. The cases with no fellow involvement had an additional attending or resident with little robotic experience as second assist. Seven different fellows were involved over the period of interest with a median number of cases of 4 (range 2–17).

Table 1.
Patient Characteristics

Characteristic	**Robotic Sacrocolpopexy, *n* = 52**
Age, yrs[a]	58.5 ± 8.4
Gravity[b]	3 (0–8)
Parity[b]	3 (0–6)
Vaginal deliveries[b]	3 (0–6)
BMI, kg/m[2a]	27.6 ± 4.9
Race[c]	
White	51/52 (98.1)
African American	1/52 (1.9)
Other	0/52 (0.0)
Preoperative stage of prolapse[b]	3 (2–4)
Prior hysterectomy[c]	29/52 (55.8)
Current smoker[c]	2/52 (3.8)
Diabetes[c]	4/52 (7.7)

[a]Mean ± standard deviation
[b]Median (range)
[c]*n/N* (%)
BMI, body mass index.

Table 2.
Concomitant Procedures Performed

Concomitant Procedures	***n* (%)**
Robotic supracervical hysterectomy	23 (44.0)
Lysis of adhesions	21 (40.0)
Midurethral sling	5 (9.6)
Robotic salpingo-oophorectomy	5 (9.6)

Intraoperative and postoperative complications occurring in the first 6 weeks after surgery are summarized in **Table 3**. We were unable to demonstrate a difference in complications between blocks, suggesting no association between robotic experience and surgical complications ($P = .771$).

Nine cases (17.3%) were converted to laparotomy secondary to limited exposure or adhesions, and no cases were converted to laparoscopy. Five of the conversions occurred in the first 15 cases. Thereafter, conversion rate decreased to 10.8% (4 of 37). There were 2 bladder injuries (3.8%) and no bowel injuries. All injuries were diagnosed and repaired intraoperatively without adverse sequelae.

Six patients (11.5%) were readmitted including 2 (3.8%) with small bowel obstructions requiring surgical management. One occurred in a woman who had extensive intra-abdominal adhesions, and it was thought her small bowel obstruction was secondary to the same adhesions. The second patient self-reported 2 small bowel obstructions that were surgically corrected at an outside institution. Two patients (3.8%) required admission to the hospital for intravenous antibiotics. Another patient was found to have a pneumomediastinum on postoperative day 3 that improved with supportive care.

Fifty of 52 patients (96%) had ≥1 follow-up visit with mean follow-up time of 5.1 ± 3.0 weeks.

DISCUSSION

This research has shown that RSC can be safely integrated into a fellowship training program with similar initial operative times and complication rates as those in published series.[3,8] Historically, RSC has been associated with reduced morbidity and shorter hospitalizations with similar rates of success compared with traditional abdominal sacrocolpopexy.[3] As there is a shift toward minimally invasive sacrocolpopexies, it is important to describe the incorpora-

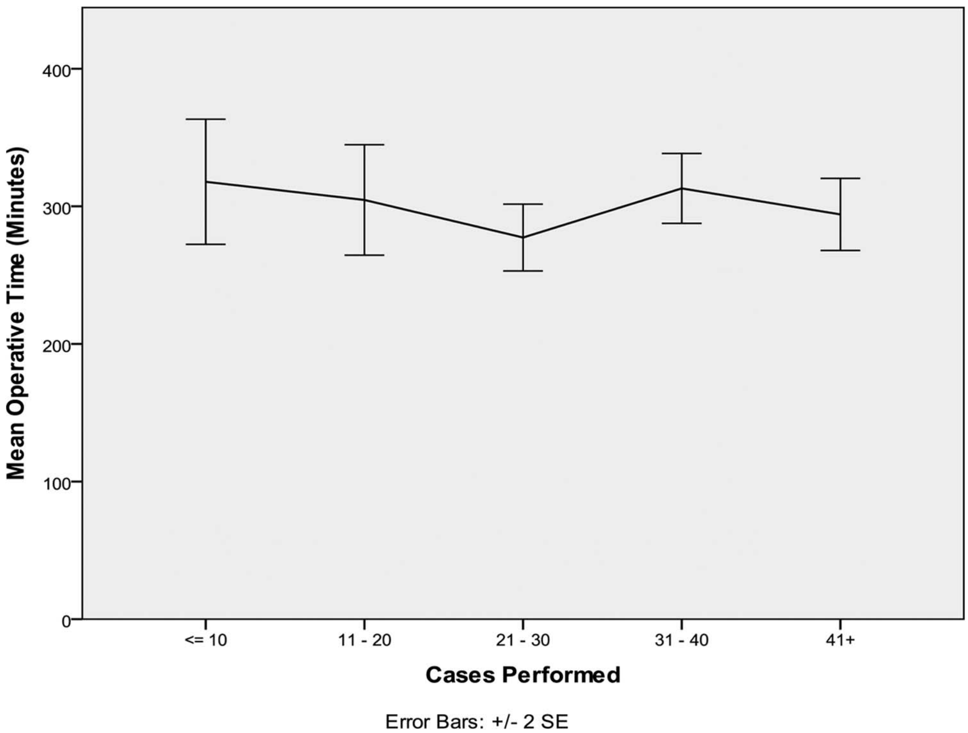

Figure 1. Operative time with increasing cases performed. SE, standard error.

Table 3.
Intraoperative and Postoperative Complications

Complication	*n* (%)	Diagnosis/Management
Bladder injury	2 (3.8)	Diagnosed and repaired intraoperatively
Bowel injury	0 (0.0)	N/A
Conversion to laparotomy[a]	9 (17.3)	Laparotomy
Clostridium difficile colitis	2 (3.8)	1 readmission, 1 outpatient management
Dehydration	1 (1.9)	Readmission for intravenous fluids
Post-operative bowel obstruction	2 (3.8)	Diagnosed and repaired surgically
Post-operative pneumomediastinum	1 (1.9)	Cardiothoracic surgical intervention
Urinary tract infection	8 (15.4)	Antibiotics
Urosepsis	1 (1.9)	Readmission for intravenous antibiotics

[a]Five of 9 conversions occurred in first 15 cases.
N/A, not applicable.

tion of this technique into an academic institution where previously no minimally invasive sacrocolpopexies were performed and where fellows are taught the technique. We must ensure safe delivery of care to patients in this setting.

In our study, surgical times remained relatively constant. There are 2 possible explanations for this lack of a demonstrable learning curve. First, trainee participation and operating room staff varied throughout the course of the study period. Additionally, the cases were performed at 3 different hospitals with surgical staff with varying levels of robotic experience. Finally, as attending and fellow competence improved with experience, the portion of the case performed by the fellow also increased. Therefore, the stable operative time may reflect the transition from a case predominantly performed by an attending to one predominantly performed by a fellow. Unfortunately, because this was a retrospective chart review, we are not able to definitively comment on this speculation, as there was not standard documentation in regard to extent of trainee participation. Additional research would be required to further delineate this possible association.

The second potential reason for no demonstrable learning curve may be due to the past surgical experience of the attending urogynecologist. The increased maneuverability and range of motion of robotic instruments is closer to open surgical technique than to laparoscopy, so these acquired skills from open surgery may be more readily transferable to robotics than to laparoscopy. If surgeons are already past their learning curve for the open surgical equivalent, it will likely decrease their learning curve with robotic surgery. Ultimately, even though we failed to demonstrate a learning curve with increasing case number, it is evident that the incorporation of this technique into a training program does not increase operative times above what is reported at other academic institutions.[5]

Furthermore, our data suggest that the adoption of RSC is a process with similar rates of bladder/bowel injuries and postoperative complications when compared with other published studies.[3,4,7,9,10] Thus, we believe it is safe to offer patients RSC while it is being incorporated into an academic institution.

In our series, 17.3% of cases were converted to laparotomy, which is higher than for previous reports demonstrating conversion rates of 0% to 7%.[3,5,11] Most of our conversions occurred in the first 15 cases, and afterwards, our rate was closer to published rates. In all cases, conversion was due to poor visualization of anatomy secondary to extensive adhesive disease or patient obesity rendering the presacral dissection difficult both robotically and open. Though not found in other studies, the conversion rate itself may be another marker of surgical learning, which improved after 15 cases. Regardless, we feel that this is an acceptable conversion rate as at the time, our institution was performing all sacrocolpopexies through a laparotomy approach and that would be equivalent to a 100% conversion rate. As other institutions move toward minimally invasive techniques, a conversion rate similar to ours in the short term may be preferable to the continued use of laparotomy on all cases.

A major strength of this study is that our analysis included only 1 attending surgeon. During the study period, he was the only robotic surgeon in the division of urogynecology. Thus, he was a constant variable while investigating operative times and complication rates. We feel this is reflective of most surgical techniques in which 1 member of the division learns a procedure and then teaches other colleagues.

The biggest weakness is the retrospective nature of this study. A prospective study could have better delineated which parts of the operation were performed by the attending and fellow. Further research is needed to confirm our speculation that trainee involvement affected our ability to detect a learning curve. In a teaching institution, simulation models were used to prepare both the attending urogynecologist and fellows. With data to demonstrate which steps were more difficult, the models could have been adjusted to better prepare for harder parts of the surgery.

Our goal was to describe our initial experience with RSC. We found that a urogynecologist with experience with open sacrocolpopexy can rapidly assimilate robotic skills and perform this surgery with similar efficiency and safety as that reported for more experienced surgeons. We found that a program where fellows perform a graduated portion of the case based on their competency level results in similar operative times and complication rates as those of published series as well. We ultimately found that RSC can be safely integrated into a teaching urogynecology service.

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