CASE SERIES JSLS

Robotic Single-Site Sacrocolpopexy with Retroperitoneal Tunneling

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ABSTRACT

Introduction: This series of cases was an investigation of the safety and feasibility of robotic laparoendoscopic single-site surgery (R-LESS) as a method of performing sacrocolpopexy.

Case Presentation: This is a retrospective series of 15 cases of R-LESS sacrocolpopexy with the V-Loc (Medtronic, Minneapolis, Minnesota, USA) suture and a retroperitoneal tunneling technique performed by a single surgeon, combined with a literature review. Patient demographic information and perioperative data were analyzed. The standard robotic sacrocolpopexy steps were followed, but the surgeon used a combined technique of V-Loc suture and retroperitoneal tunneling to simplify the procedure. No additional ports were necessary in any of the patients.

Management and Outcome: Using the pelvic organ prolapse quantification (POP–Q) scoring method, the mean preoperative C-point of the 15 patients was +1.16 compared to the mean immediate postoperative C-point, which was −5.5. The mean total sacrocolpopexy time was 74.7 (range, 50–99) minutes and mean mesh anchoring time was 22.60 ± 3.85 minutes. The mean sacral promontory fixation and tunneling and mesh position times were 11.87 ± 3.02 and 5.80 ± 2.14 minutes, respectively. All 15 cases were performed without perioperative or long-term complications.

Discussion: R-LESS in combination with the V-Loc suture and the retroperitoneal tunneling technique can be safely and feasibly performed, especially in sacrocolpopexy and, potentially, in other POP surgeries. With adequate and systematic training, surgeons can acquire the necessary skills to perform this complex surgical procedure.

Key Words: Pelvic organ prolapse; Retroperitoneal tunneling technique; Robotic laparoendoscopic single-site (R-LESS); Sacrocolpopexy; V-Loc suture

INTRODUCTION

Single-incision surgery is gaining popularity among surgeons and patients. It not only has an impressive cosmetic outcome,[1] but it also reduces intraoperative surgical trauma, which decreases postoperative surgical pain.[2,3] Evolving robotic instruments coupled with improving surgical techniques are making more complex single-site surgeries feasible for surgeons who perform advanced minimally invasive operations.

Sacrocolpopexy is considered the gold standard treatment for repairing apical pelvic defects (vaginal vault prolapse), with long-term cure rates reaching 90%.[4–6] The sacrocolpopexy operation can be divided into 2 approaches: laparotomy and laparoscopy. Once laparoscopy is chosen, additional decisions must be made, as the procedure can be completed with the "straight-stick" or robotically with a single-site or multisite approach.

In 2000, the U.S. Food and Drug Administration (FDA) approved the da Vinci robotic platform (Intuitive Surgical, Sunnyvale, California, USA) to be applied in clinical laparoscopic surgery. In 2014 the FDA gave clearance for the single-site wristed needle driver for use in single-incision surgery, which overcomes the challenges in single-site suturing. Currently, robotic laparoendoscopic single-site surgery (R-LESS) can be safely used in many gynecologic surgeries, including hysterectomy, subtotal hysterectomy,

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salpingo-oophorectomy, ovarian cyst excision, excision of endometriosis lesions, and even staging of low-risk surgeries for early endometrial cancer.[7–12] However, there are still some technical challenges associated with R-LESS when compared with multisite robotic surgery. The learning curve and thus the necessary training period to achieve proficiency and safety are longer for R-LESS. Compared with procedures such as simple oophorectomy, ovarian cystectomy, or simple hysterectomy, R-LESS sacrocolpopexy is a more technically complex surgery requiring thorough knowledge of pelvic floor anatomy and advanced surgical skill allowing for both efficient dissection of surgical planes and laparoscopic suturing.

The senior author (XG) has published a video article of a case report regarding V-Loc suturing coupled with the retroperitoneal tunneling technique while performing an R-LESS sacrocolpopexy.[13] However, there are limited reports of the safety and feasibility of this technique. In this retrospective case series, we used this combined technique to perform sacrocolpopexy and present our findings for 15 patients, including mean age, body mass index (BMI), gravidity, pre- and postoperative pelvic organ prolapse quantification (POP-Q) quantification,[14] operation time, and surgical complications.

CASE SERIES

Fifteen consecutive R-LESS sacrocolpopexies were successfully performed by a single surgeon using the V-Loc barbed suture and a retroperitoneal tunneling technique. No additional ports other than the primary umbilical single port were necessary in any of the cases. The research design involved patients who had undergone robotic single-site sacrocolpopexy with the principle investigator from January 2015 through January 2017. These patients were followed up in the clinic or by telephone for 3 months after surgery. Eligibility criteria for R-LESS sacrocolpopexy included patients who did not have any contraindication for surgery and symptomatic stage II–IV POP-Q.

The demographics and characteristics of the 15 patients are summarized in **Table 1**. **Table 2** describes operation-related variables for the 15 patients. The mean age of the patients was 63 (range, 39–80) years, and the mean BMI was 26.9 kg/m^2 (range, 18.37–31.79 kg/m^2). The main risk factors for POP were likely increasing age and elevated BMI. Multiparity may be another risk factor based on the gravidity and parity shown in these 15 cases. The history of a vaginal sacrospinous ligament fixation, total abdominal hysterectomy, bladder suspension, and transobturator tape sling are common surgeries within our patient population. Preoperative prolapse measurements most commonly showed stage 2–3 of POP-Q score apical prolapse. Using the POP-Q scoring method, the mean preoperative C-point of the 15 patients was +1.16 (one patient excluded, with a range from −1 to +4), compared to the mean immediate postoperative C-point, which was −5.5 (one patient excluded, with a range from −5 to −6). Three weeks after surgery, the mean C-point improved further, reaching−5.6 (range,−5 to −6, with 1 patient excluded). The mean total sacrocolpopexy time was 74.7 ± 14.02 minutes and mean mesh anchoring time was 22.60 ± 3.85 minutes. The mean sacral promontory fixation time was 11.87 ± 3.02 minutes and the mean tunneling and mesh positioning time was 5.80 ± 2.14 minutes. All 15 cases were performed without perioperative or long-term complications.

The surgical procedure is described in detail in our video article.[13] A vertical transumbilical skin incision was created, and the da Vinci Single-Site platform, with a specialized silicone port (Intuitive Surgical) and two curved cannula with flexible instruments, was inserted.

For patients who needed hysterectomy, either robotic single-port total or supracervical laparoendoscopic hysterectomy was completed, and, depending on the procedure, the vaginal cuff or cervical stump was then closed with V-Loc sutures in a running fashion. The vesicovaginal and rectovaginal planes were then dissected until the Aa point and Ap points were reached. The assistant was pivotal in this step as he placed his finger vaginally at the Aa point and Ap point to help delineate the plane of the dissection.

The peritoneum overlying the sacral promontory was incised vertically in the midline to expose the retroperitoneal space underneath. This incision was extended medially toward the sigmoid colon mesentery 2–3 cm above the sacral promontory, which allowed for adequate exposure of the anterior longitudinal ligament and middle sacral vessels. Two 2-0 Gore-tex interrupted sutures (Gore Medical, Flagstaff, Arizona, USA) were preplaced in the sacral promontory to facilitate fixation of the mesh. A retroperitoneal tunnel was then created by undermining the peritoneum with the articulated needle driver. The needle driver was placed in the peritoneal opening over the sacral promontory, and the tunnel was created just medial to the right uterosacral ligament in the direction of the vaginal vault. The tunnel was created by using forward pressure and a sweeping motion to create a space within the retroperitoneum. When completed, the tunnel was

Table 1.
Patient Characteristics

Case	Age	BMI (kg/m^2)	Gravidity	History	Length of Stay (hours)	Postop Satisfaction (No Prolapse Present)
1	39	28.9	G3P4	Vaginal SSF	23	Yes
2	69	24.85	G3P2	N/A	15	Yes
3	63	28.91	G3P3	N/A	17	Yes
4	56	18.37	G4P5	TAH, anterior repair	6	Yes
5	68	30.38	G3P3	Bladder suspension, sling, TAH	20	Yes
6	61	32.42	G2P2	LSH, TVT sling	13	Yes
						No incontinence
7	68	23.95	G3P3	N/A	14	Yes
8	67	23.31	G4P3	TAH	19	Yes
9	60	30.74	G2P2	Bladder suspension, hysterectomy	32	Yes
10	80	24.06	G2P2	Bladder suspension, laparotomy	29	Yes
				Hysterectomy		
11	73	31.79	G4P3	Open gall bladder surgery, tubal ligation	28	Yes
12	70	24.84	G1P1	N/A	21	Yes
13	65	28.27	G2P1	Hysterectomy, incontinence surgery, history of BSO, vaginal prolapse repair	25	Yes
14	58	26.72	G1P1	History of cryotherapy of cervix	35	Yes
						No incontinence
15	62	26.19	G7P6	N/A	96, due to fever from atelectasis	Yes

BMI, body mass index; BSO, bilateral salpingo-oophorectomy; G, gravida; LSH, laparoscopic supravaginal hysterectomy; op, operation; P, para; SSF, sacrospinous fixation; TAH, total abdominal hysterectomy; TVT sling, tension-free vaginal tape sling.

situated between the right side of rectum and the right ureter. To prevent a ureteral injury, the right ureter was located and kept within the visual field during this dissection. Care was taken to identify the hypogastric nerves as they passed through this space to minimize nerve damage that could lead to visceral dysfunction and pain.

A sterile measuring tape was inserted into the abdomen via the single port to measure the distance from the Aa point and Ap point to the apex of the vaginal cuff. One centimeter was then added so that the bifurcation of the mesh would not lie flush to the apex. The Alyte Y-mesh (June Medical, Marlow, United Kingdom) was then cut according to these previously measured specifications. The anterior and posterior portions of the mesh were cut differently with either a straight or rounded end, to differentiate between them. The V-Loc 180-day delayed absorbable suture (Medtronic) was then placed through the lateral corner of the posterior edge of the mesh and threaded through the eye of the suture. This method saves time, so that when the mesh was inserted, the first stitch would be placed through vaginal tissue, as the V-Loc was already anchored to the mesh. The long arm of the mesh was then folded in an accordion fashion and loosely sutured together so that it would stay out of the surgical field.

The Alyte Y-shaped mesh was inserted through the assistant port and anchored to the anterior and posterior surfaces of the vaginal pelvic fascia. The mesh was anchored to the vagina via a continuous layer of single 2-0 V-Loc sutures. The long arm of the mesh was then passed through the retroperitoneal tunnel.

The tension of the mesh was adjusted based on the assistant's previous measurement, to minimize the overtension, and anchored to the sacral promontory with the 2 previously placed Gortex sutures. Finally, the peritoneum overlying the mesh was closed using a running V-Loc suture.

Table 2.
Operative Related Variables

Case	Preop Stage	Preop POP-Q	Postop POP-Q	Postop POPQ 3weeks	Concomitant Surgery	Total Sacrocolpopexy Time (minutes)	Mesh Anchoring Time (minutes)	Sacral-promontory Fixation Time (minutes)
1	Uterine stage III, cystocele stage II	C+3, Aa-1	C-5	C-5	LSH, TOT sling	89	29	19
2	Vaginal cuff III, retocele II	C+1, Ba-1	C-6	C-6	TOT sling	86	25	15
3	Uterine stage II, cystocele III	C 0, Aa+2	C 6	C-6	TLH, BSO	72	25	14
4	Vaginal cuff II, cystocele III	C 0, Aa+1	C 5	C5	N/A	50	15	10
5	Vaginal cuff II, cystocele III	C-1, Aa+2	C 6	C-6	N/A	68	20	12
6	Vaginal cuff I, cystocele III	C-5, Aa+1	C-7	C-7	N/A	69	19	10
7	Uterine stage III, cystocele stage III	C+4, Aa+2	C5	C-6	TLH, BSO	99	22	13
8	Cystocele III, vaginal cuff II, rectocele II	C-5, Aa+2	C-5	C-7	Burch	71	23	15
9	Cystocele stage III	C-5, Aa+2	c-7	C-7	BSO, perineoplasty, LOA	75	24	12
10	Stage II cystocele, Stage II rectocele	C 0, Aa+1	C-6	C-6.5	LOA	97	25	11
11	Stage II cysocele, Stage II rectocele	C-6, Aa+1	C-8	C-8	Supracervical hysterectomy, BSO, LOA	86	26	12
12	Stage II cystocele, stage II rectocele	C-7, Aa+1	C-6	C-7	TLH, BSO	68	19	9
13	Stage II cystocele, stage II rectocele	C-6, Aa+1	C-8	C-8	N/A	67	24	9
14	Stage II cystocele, stage II rectocele	C-4, Aa 0	C-8	C-8	TLH RSO, TOT sling	56.5	17	7
15	Stage II cystocele	C-5, Aa−1	c-6	C-6	TLH, BS, TOT sling, LOA	67	26	10

BS, bilateral salpingectomy; BSO, bilateral salpingo-oophorectomy; LOA, lysis of adhesions; LSH, laparoscopic supravaginal hysterectomy; N/A, data not available; TLH, total laparoscopic hysterectomy; TOT sling, transobturator tape sling.

Choosing the appropriate instrument is crucial for completing surgical tasks in a safe and efficient manner. In these cases, the bladder flap was dissected with the Monopolar Hook (Intuitive Surgical, Sunnyvale, CA). A Single-Site Wristed Needle Driver (Intuitive Surgical, Sunnyvale, CA) was used to create the peritoneal tunnel and to anchor the mesh to the sacral promontory (**Figure 1**).

Prophylactic intravenous cefazolin 1–2 g (Ancef, SmithKline Beecham, London, United Kingdom) was given before the start of surgery. Patients were discharged from the hospital with pain medication (600–800 mg; ibuprofen; Tylenol with codeine #3 or Motrin; Johnson & Johnson, New Brunswick, New Jersey, USA) and an abdominal binding was placed for reducing postoperative pain,[15] when they tolerated an oral diet, were ambulatory with well-controlled pain, and resumed normal urinary function. For 6 weeks after surgery, the patients were counseled to avoid vaginal intercourse and not to lift anything heavier than 10 pounds. All patients were reassessed by measuring vaginal length 3 weeks after surgery.

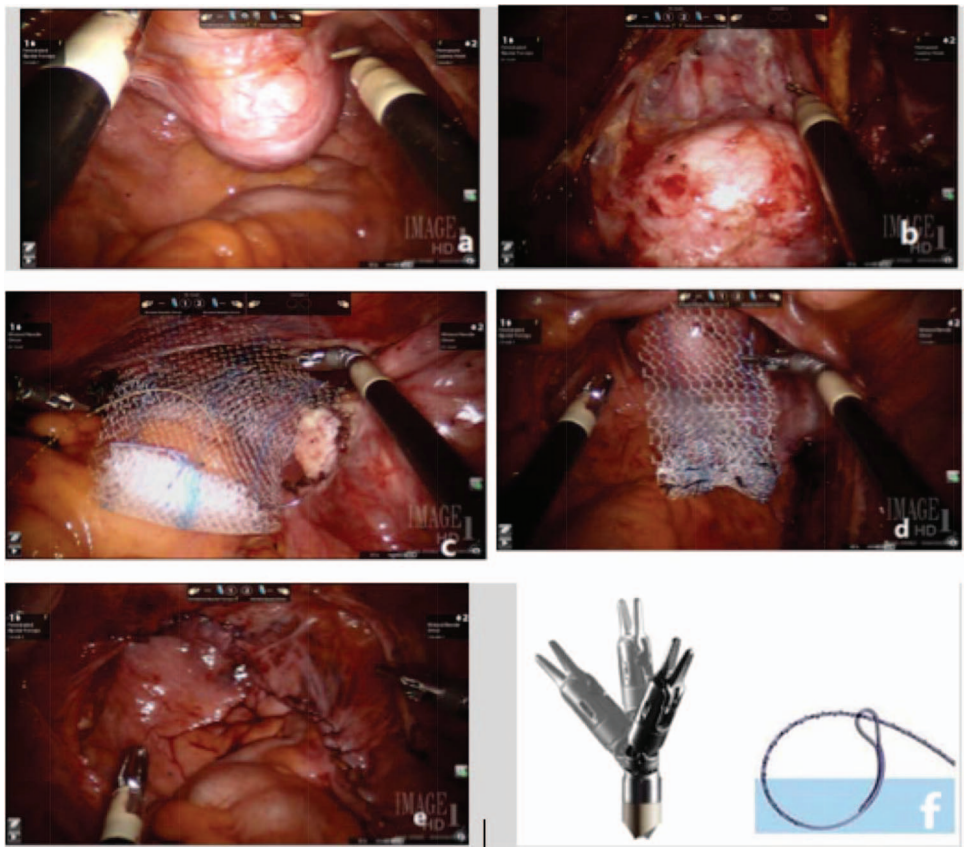

Figure 1. (**A**) Before dissection. (**B**) Opening bladder flap and rectouterine peritoneal fold to expose the anterior and posterior vaginal wall. (**C**, **D**) Anchoring of mesh to the anterior and posterior surfaces of the vagina. (**E**) Closing the peritoneum. (**F**) Single-site Wristed Needle Driver and V-Loc suture.

DISCUSSION

With the evolution of minimally invasive surgery and the introduction of the idea of a "scarless" surgery, single-site surgery has seen a large increase in interest and promotion. In 2009, Lee and Kim[16] first reported on laparoendoscopic single-site gynecologic surgery and recognized its applicability for hysterectomy. After that, more and more gynecologic surgeries were reported to be feasible, including sacrocolpopexy.[13,17–19]

There are characteristics of laparoscopic single-site technology that make it more technically difficult to perform when compared with R-LESS. The main problem of traditional LESS is something known as the "chopstick effect." Because all instruments must enter the abdominal cavity via the same incision, triangulation is markedly limited, and the instruments often collide, thus increasing the difficulty of the surgery. However, as is true of any novel surgical technique, the surgeon must become familiar with the technology and develop new surgical skills, even with the robotic single-site platform. Song et al[20] reported that the learning curve for traditional LESS may be long, and suggested that the surgeon must operate on between 25 and 75 patients to become sufficiently skilled. The learning curve for LESS is lengthy for various reasons. The surgical instruments and the light source are aligned on almost the same axis, a necessity that violates the efficacy of triangulation of the instruments. This configuration in turn limits the range of motion of the instruments, which is evidenced by decreased dexterity, especially in tasks requiring fine motor movements such as suturing.

R-LESS surgery is more feasible than LESS for complex gynecologic surgeries for several reasons. The robotic software allows for the surgeon's right hand to manipulate the instrument to be placed through the left trocar port that crosses the midline and ends up on the patient's right internally. The same is true of the surgeon's left hand. Thus, the robotic software eliminates the spatial problems in LESS where the instruments cross over each other. The

other major benefit of R-LESS over LESS is that a Single-Site Wristed Needle Driver (Intuitive Surgical) has been developed that makes suturing much easier. Ease of suturing is extremely important when planning sacrocolpopexy.

In 2016, Lee[21] reported 6 cases in which the wristed needle driver was used in traditional sacrocolpopexy and concluded that this instrument is both easy and safe to use. Recently, a similar report of 25 cases of robotic single-site sacrocolpopexy demonstrated that the single-port robotic-assisted approach feasible. with low complication rates, minimal blood loss and postsurgical pain, fast recovery, short hospitalization, and virtually scar-free cosmesis.[22] In our case series, the previous research results were echoed; however, our description of the feasibility of combination of V-Loc and peritoneal tunneling in robotic single site surgery adds to the literature regarding approaches to sacrocolpopexy.

V-Loc suturing allows for a unique beneficial approach to laparoscopic suturing, especially in single-site surgery. It has several benefits, including a preformed loop at the distal end of the suture that allows the first suture to be thrown without the need of tying a knot, which is very time consuming and challenging, even in R-LESS. It is self-anchoring within the tissue by the barbs that prevent reverse motion of the suture, and it can be easily cinched to the tissue, which can maintain even tissue–mesh tension during suturing. The sutures hold the incisional edges together firmly thus facilitating healing at the incision while minimizing the potential for an occult hematoma. The general absorption time for the suture is roughly 180 days, which allows enough time for both tissue healing and scar formation. Walgenbach and Shestak,[23] described how use of the V-Loc suture can shorten the healing time of an incision. Mostafa and Borahay[24] reported on 20 patients who underwent robotic sacrocolpopexy with barbed delayed absorbable sutures and noted that it was safe and effective during a 1-year follow-up. Furthermore, a randomized trial of vaginal mesh attachment techniques for sacrocolpopexy demonstrated that the barbed suture technique was 11–16 minutes faster for attaching mesh to the vagina than the nonbarbed suture method.[25] This study also showed comparable anatomic outcomes at 12 months after surgery. Because suturing with knot tying using robotic single site surgery is very challenging, even with a wristed needle driver, we adopted this safe and effective technique to simplify the procedure.[13] Lee and Zimmern[26] used 2 running 2-0 V-Loc-180-day absorbable sutures placed on the mesh tail in abdominal sacrocolpopexies, demonstrating satisfactory anatomic outcomes. We found that self-anchoring barbed suturing can quickly anchor the mesh to the vaginal endopelvic fascia while keeping it flush against the vaginal tissue. This technique should reduce the formation of mesh erosion, even if there is vaginal wall penetration by the suture. V-Loc suturing may also reduce mesh erosion because it is a delayed absorbable suture. There have not been any mesh erosions in our 15 cases during the course of the study, but more studies over longer periods are needed to answer this clinical question.

The retroperitoneal tunneling technique provides a more natural curvature to attach the mesh from the vaginal apex to the sacral promontory. It also allows for easier adjustment and maintenance of mesh tension during the placement of sutures in the anterior longitudinal ligament of the sacral promontory when compared with opening the entire retroperitoneal space. The use of peritoneal tunneling simplifies the adjustment of mesh tension, because the tunnel acts as an extra arm to hold the mesh in place. This feature of the technique is particularly important in single-site surgery because of the limited number of ports available. The assistant plays an important role in mesh adjustment by measuring the tension-free vaginal length and by assuring that the goal vaginal length is achieved when the mesh is anchored. Attention to the vaginal length decreases the chance of overtightening the mesh and failing to account for the natural postoperative shrinkage of both the mesh and the tissues. In addition to causing erosion, mesh that is too tight can cause the patient pain, which can necessitate its removal. Last year, we[13] first reported this retroperitoneal tunneling technique for laparoscopic sacrocolpopexy. The tunneling technique may reduce the operative time and adhesion formation. Further studies are needed to assess whether the technique reduces intraoperative blood loss. All of our patients have been satisfied with their outcomes in terms of improvement of the prolapse and the cosmesis of the umbilicus. The major limitations of our study were that we had no comparison group and the sample of patients was small.

The clinical application of R-LESS has brought great changes to the field of minimally invasive gynecologic surgery. Because the learning curve of R-LESS is long, the surgeon must be skilled in traditional laparoscopy or robotic surgery before attempting to master the new technique. V-Loc suturing and retroperitoneal tunneling can make sacrocolpopexy an effective, feasible surgical option. R-LESS can be safely used for POP surgery especially for sacrocolpopexy.

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