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ORIGINAL ARTICLE

Laparoscopic sacral hysteropexy versus laparoscopic sacral colpopexy plus supracervical hysterectomy in patients with pelvic organ prolapse

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Abstract

Introduction and hypothesis The choice of whether or not to preserve the uterus in the case of patients with urogenital prolapse who undergo sacral colpopexy is still debated. We compared objective and subjective outcomes of laparoscopic sacral hysteropexy (LSHP) and laparoscopic sacral colpopexy with concomitant supracervical hysterectomy (LSCP/SCH) in patients with symptomatic pelvic organ prolapse.

Methods This is a multicenter retrospective cohort study conducted at the Urogynecology Department of the Fondazione Policlinico Universitario A. Gemelli IRCCS of Rome and at the Diaconesses Croix Saint Simon Hospital of Paris. We collected data of 136 patients; 78 underwent LSHP and 58 underwent LSCP/SCH for pelvic organ prolapse between January 2016 and December 2017.

Results Patients of the two groups had similar preoperative characteristics. All patients completed 24-month follow-up evaluation. Overall, anatomical cure rate was 84.6% and 87.9% in the LSHP group and LSCP/SCH group, respectively, without statistically significant differences. In particular, in the LSHP group the anatomical success rate was 94.9%, 92.3% and 92.3% for the apical, anterior and posterior vaginal compartment whereas in the LSHP group LSCP/SCH was 100%, 91.4% and 94.8%, respectively. Subjective success rate was 89.7% among patients who underwent LSHP and 93.1% among women who underwent LSCP/SCH ($p = 0.494$). The median operative time (OT) was significantly shorter in LSHP. There were no significant differences between the groups in terms of estimated blood loss, conversion to laparotomy and intra- and postoperative complications. Patients' satisfaction was high in both groups without statistical differences.

Conclusions Both laparoscopic procedures are safe and effective in the treatment of pelvic organ prolapse. LSHP can be offered as an alternative in women who are strongly motivated to preserve the uterus in the absence of abnormal uterine findings.

Keywords Prolapse · Sacropexy · Hysteropexy · Sacrohysteropexy laparoscopy · Subtotal hysterectomy

Introduction

Pelvic organ prolapse (POP) is a multifactorial pathology extremely common in middle-aged and elderly women in developed countries. It is characterized by an anatomical change caused by the downward displacement of pelvic organs from their normal position in the pelvis with a consequent bulge into the vagina [1, 2].

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Traditionally, in native tissue vaginal surgery, vaginal hysterectomy has been considered standard practice for correction of uterovaginal prolapse with the general purpose of gaining access to tissues used for apical suspension. Moreover, the choice of performing hysterectomy was motivated by the fact that most patients were perimenopausal. However, the known high rate of recurrence after transvaginal surgery with native tissue [3] led to the introduction of prosthetic transvaginal surgery, with the aim of reducing the high recurrence rate of native tissue surgery.

Parallel to the development of prosthetic surgery, there was an increasing tendency toward the preservation of the uterus to reduce erosive complications. However, despite this precaution, the increasingly frequent reports on transvaginal mesh-related complications and the several FDA alerts published from 2011 to 2019 [4, 5] have caused a decrease in transvaginal mesh surgeries for POP in favor of abdominal sacrocolpopexy. Laparoscopic sacral colpopexy (LSCP) can be actually considered the gold standard for apical prolapse correction [6, 7]. This technique has been described with uterine preservation and associated with total or subtotal hysterectomy. There is still debate regarding which type of technique guarantees the best results in terms of anatomical outcomes and improvement of the quality of life.

The choice of whether or not to preserve the uterus in the case of patients with urogenital prolapse who must undergo sacral colpopexy is complex [8]. On the one hand, we must consider the women's growing desire to preserve fertility and their sense of femininity or identity conferred by a uterus [9] and on the other the possibility of carrying out adequate prevention for the future development of possible malignant or benign diseases at the time of prolapse surgery. Furthermore, in the case of uterus removal, in recent years there has been the tendency to prefer the preservation of the cervix rather than performing a total hysterectomy during sacral colpopexy to reduce the risk of mesh exposure [10, 11].

Despite this state of affairs, however, there is a lack of data comparing laparoscopic sacral hysteropexy (LSHP) to laparoscopic sacral colpopexy with concomitant supracervical hysterectomy (LSCP/SCH). In this context, the aim of this study was to evaluate and compare the anatomic and functional outcomes of LSHP and LSCP/SCH in a large series of patients. In particular, the primary objective of the study was to analyze the anatomical recurrence rates in the two groups. Secondary outcomes included the analysis of functional outcomes and perioperative data.

Materials and methods

This is a multicenter study including patients with Pelvic Organ Prolapse Quantification (POP-Q) System stage ≥ 2 [1] who underwent laparoscopic promontofixation with a retrospective analysis of prospectively collected data. The study was conducted at the Urogynecology Referral Center of the Diaconesses Croix Saint Simon Hospital of Paris and at the Female Pelvic Medicine and Reconstructive Surgery Center of the Fondazione Policlinico Universitario Agostino Gemelli IRCCS of Rome.

After Institutional Review Board approval of both hospitals, patients were selected from the two hospitals' databases among women who underwent the described surgical procedures for POP-Q stage ≥ 2 between January 2016 and December 2017. Women with age > 80 years, uterine cervix dysplasia or endometrial disorders, uterine size > 12 weeks of gestation and who had previously undergone > 2 major abdominal surgeries were excluded from the study. In the final analysis, patients who did not complete the 1-, 3-, 12- and 24-month follow-up visits were not considered. We then investigated two groups of LSCP populations, according to the subtype of surgical procedure: the laparoscopic sacral hysteropexy group (LSHP) and laparoscopic sacral colpopexy with supracervical hysterectomy group (LSCP/SCH).

All the procedures were performed by four expert urogynecological surgeons (GP, AE, GC, PG) with a minimum of 30 LSCP per year prior to this study. The surgical selection was based on prolapse type and grade, surgeon preference, risk factors, women's history of previous surgery and preference. Additional procedures performed when indicated included bilateral salpingo-oophorectomy and placement of a suburethral sling. All patients received an upfront explanation of the surgical approach. Women signed written consent to undergo the described procedure and to permit data use. The study has been carried out in accordance with the Code of Ethics of the World Medical Association (Declaration of Helsinki) for experiments involving humans.

Preoperative evaluation included detailed history, physical examination, urodynamic and ultrasound evaluation and was performed by an urogynecologist of the two surgical teams. Registered comorbidities included: hypertension, diabetes, chronic obstructive pulmonary disease, thyroid disease, cardiovascular and neurological diseases. Patients were requested to have a negative Pap smear not older than a year. In case of suspected urogenital or ano-rectal malignant pathologies, additional tests and/or imaging were performed. Prolapse was classified in accordance with the Pelvic Organ Prolapse Quantification (POP-Q) System published by the International Continence Society [1]. During urogynecological evaluation, patients were questioned about urinary and bowel dysfunction.

We defined operative time (OT) as the interval between the skin incision and its closure. Intraoperative complications were defined as bowel, bladder, ureteral or vascular injuries. A hemoglobin level < 8 g/dl was considered anemia and body temperature of at least 38 °C in two consecutive measurements, at least 6 h apart, excluding the first day after surgery,

was considered fever. Postoperative complications were evaluated during the first 30 days after surgery according to Clavien-Dindo's (CD grade) classification [12]. Surgical results were described in accordance with the ICS/IUGA joint report on the terminology for pelvic floor dysfunction [13].

Follow-up visits were performed at 1, 3 and 12 months after the intervention and then yearly. A urogynecologist performed the postoperative evaluation of the patients during the routine outpatient follow-up. Anatomical surgical failure was described as POP stage ≥ 2 in any compartment. Subjective success was defined by the absence of bulge symptoms. Urodynamic evaluation was repeated 1 year after the surgical procedure in all patients. Patients were questioned about the improvement or worsening of urinary and/or bowel symptoms after the treatment at each follow-up visit. During medical interview sexually active patients were asked if they were affected by dyspareunia, defined as a perceived pain or discomfort during sexual intercourse. Patients' satisfaction rate after surgery was measured using the Patient Global Impression of Improvement (PGI-I) [14].

Results were summarized as follows: median and range for continuous variables and percentages for categorical variables. The $\chi 2$ analysis or Fisher's exact test was used, when appropriate, for categorical variables and Wilcoxon signed ranks test and Mann-Whitney U-test, when appropriate, for continuous variables. Statistical significance was set at $p < 0.05$ (95% confidence interval). Univariate and multivariate analyses were conducted to identify risk factors for prolapse recurrence. The Kaplan-Meier method was used to analyze the cumulative proportion of relapse-free patients in time, and the two groups were compared using the log-rank test. Statistical analysis was performed using SPSS version 26.0 for Windows (SPSS Statistics, SPSS Inc., Chicago, IL, USA).

Surgical technique

The surgical team performed all procedures using a standard technique in accordance with what we previously published [15–17]. The first step of LSCP was exposing the longitudinal vertebral ligament by opening the parietal peritoneum covering the sacral promontory and performing blunt dissection of retroperitoneal tissue. Median sacral vessels were pushed back inward during dissection and coagulated if necessary. The peritoneal incision was prolonged along the right pelvic wall up to the uterine isthmus. The Douglas pouch was incised between the left and right uterosacral ligaments, and the rectovaginal space was fully dissected. At its caudal edge, represented by the perineal body, the dissection was carried out lateral to the rectum upward to identify the pelvic parietal fascia covering the levator ani muscle. An adequately shaped polypropylene type 1 mesh (Restorelle XL, Coloplast Corp., Minneapolis, MN, USA) was placed and fixed to the vaginal wall by four 3–0 non-absorbable sutures (Ethibond, Ethicon Inc., Somerville, NJ, USA) to cover the entire dissection space without tension. The first two sutures were on the levator ani muscles. Two sutures for each side were applied on the upper portions of the posterolateral vaginal walls. The vesico-uterine peritoneum was opened, and vesico-uterine as well as vesicovaginal spaces were dissected. This created a triangular-shaped vesicovaginal space with the apex at the dorsal end of the bladder trigone and the lateral limits represented by the bladder pillars. At this point, in the hysteropexy group the right broad ligament was fenestrated (unilateral fenestration) at the level of the cervico-uterine junction in an avascular space lateral to the uterine artery to thread the cephalad portion of the anterior mesh. Differently, in the supracervical hysterectomy group, a standard subtotal hysterectomy was then carried out. Adequately shaped polypropylene type 1 mesh (Restorelle XL) covering the entire dissection space without creating tension was inserted and fixed to the anterior vaginal wall with five 3–0 non absorbable sutures (Ethibond): the first suture in the midline at the apex of the dissected space and two sutures for each side on the middle and upper anterolateral vaginal wall portions. Two to three 2–0 non-absorbable sutures (Ethibond) were placed on the anterior and posterior aspects of the cervix. The anterior mesh was threaded up toward the promontory from the vagina under visual control to lift the vagina. Anterior mesh was fixed to the longitudinal vertebral ligament anterior to the L5–S1 intervertebral space with 1–0 non-absorbable suture (Ethibond) on a noncutting needle. The last step was the peritonealization of the meshes with a 2/0 barbed suture (Stratafix spiral monocryl plus knotless tissue control device, Ethicon Inc. Somerville, NJ, USA). When subtotal hysterectomy is performed, the specimen is put into an endobag and extracted through the umbilicus with extracorporeal morcellation using a cold knife.

All patients received antibiotic prophylaxis with cefazoline administered intravenously 1 hour before surgery and antithrombotic prophylaxis consisting of enoxaparin from the day of surgery to the 10th day after the discharge. Voiding trials began on the first postoperative day. Bladder drainage was discontinued after resumption of spontaneous and adequate voiding, defined as residual urine volume < 100 ml at two consecutive post-void determinations when the volume voided was ≥ 200 ml.

Results

From the originally 201 selected patients who fulfilled the inclusion criteria, 21 patients were initially eliminated according to the exclusion criteria (15 for age > 80 years, 6 for having performed > 2 major abdominal surgeries). After that, 44 (24.4%) additional women who did not complete all the indicated follow-up were excluded from the study. Among them,

30 patients (68.2%) were lost after the 3-month postoperative visit. The remaining 14 women completed only the 1-month follow-up. Despite the absence of anatomical and subjective recurrences in this particular subgroup, we did not include the related data in the final analysis.

A total of 136 patients were eligible for the analysis, including 78 subjects who underwent LSHP and 58 subjects who underwent LSCP/SCH. Follow-up time was 24 months for all women of both groups.

Clinical baseline characteristics of the recruited patients were comparable between the groups. More women who underwent LSHP had previous operations for pelvic floor dysfunction (7.7% vs. 0%, $p = 0.038$). No difference was found in terms of age, menopausal status, BMI, comorbidities, parity, hormone replacement therapy and prolapse stage at presentation (Table 1). A severe preoperative POP-Q stage (≥ stage 3) was present in 35.9% and 36.2% of the patients for the anterior compartment, in 23.1% and 31% of the subjects for the apex and in 3.9% and 0% for the posterior compartment in LSHP and LSCP/SCH groups respectively.

Perioperative outcomes are shown in Table 2. No differences were seen regarding hospital stay, estimated blood loss (EBL), conversions to laparotomy, intraoperative complications, re-operations and association with urinary incontinence procedures. Median OT was significantly longer in subjects who underwent LSCP/SCH (150 vs. 120 min; $p < 0.001$). Specifically, all intraoperative complications were represented by bladder lesions that were resolved during surgery. There was no statistical difference between the two groups in terms of postoperative complications (2.5% in LSHP vs. 8.6% in LSCP/SCH, $p = 0.136$). Specifically, in the LSCP/SCH cohort we observed one rectovaginal hematoma and one vesical-vaginal hematoma, which were both drained on the 2nd postoperative day, one abdominal wall hematoma caused by a lesion of the inferior epigastric vessels, one phlebitis and one urinary retention after concomitant TVT, which resolved spontaneously. Conversely, in the LSHP cohort, we observed one rectovaginal hematoma and one bowel occlusion due to post-surgical adherences.

No mesh exposure occurred in either group. All procedures were completed laparoscopically, with no need for conversion to laparotomy. The subjects in both groups showed statistically significant changes in individual prolapse stage after surgery: no differences were registered between the two groups regarding the postoperative prolapse stage anteriorly, apically and posteriorly (Table 3).

The percentage of patients affected by SUI decreased significatively in both groups after the treatment at every follow-up time ($p = 0.000$): at 24-month follow-up SUI incidence compared to the preoperative-one decreased from 65.4% to 15.4% in the LSHP group ($p = 0.000$) and from 60.3% to 17.2% in the LSCP/SCH group ($p = 0.000$). However, the differences among the two cohorts did not reach statistical significance (Table 4).

Compared to the baseline, overall postoperative constipation (including de novo cases) did not change in a significative manner after the surgical procedures during the 24-month follow-up in both groups. At 2-year follow-up the rate of dyspareunia (including the new cases) decreased in both groups without statistically significative differences (24.6% vs. 14.5%, $p = 0.139$ in the LSHP group; 23.4% vs. 13.8%, $p = 0.384$ in the LSCP/SCH group; Table 4). Recurrent prolapse rate (defined as ≥ stage 2 of any compartment) was similar between the two groups at every follow-up visit with higher incidence of anterior and posterior prolapse compared to apical (Table 5).

After 24 months, subjective success rate was 89.7% among patients who underwent LSHP and 93.1% among women who underwent LSCP/SCH ($p = 0.494$). Likewise, the distribution of relapses over time was comparable in the two groups as shown in the Kaplan-Meier curve in Fig. 1. At 1 month's follow-up none of the patients showed prolapse recurrence. At 3 months we observed only one case of tricompartmental prolapse in the LSHP group: this was the only subject in the LSHP group who underwent reoperation for symptomatic prolapse.

Among the factors possibly implicated in POP recurrence, we investigated age ≥ 65 years, BMI ≥ 25 kg/m^2, previous POP surgery, uterus preservation, a POP-Q stage ≥ 3 in the anterior, apical or posterior compartment and the presence of postoperative constipation through the logistic regression. In the univariate and multivariate analysis, having a severe preoperative cystocele (stage ≥ 3) was the only independent risk factor for POP recurrence (OR 3.39; IC 1.216–9.464, $p = 0.020$; Table 6).

Subjective satisfaction rates as measured by the PGI-I questionnaire were high in both groups as shown in Table 3.

De novo constipation and de novo stress urinary incontinence (SUI) were slightly more frequent in LSCP/SCH without however reaching statistical significance.

There were no cases of abnormal uterine pathology at the histological examination in the LSCP/SCH cohort.

Discussion

Uterine preservation at the time of POP surgery is still debated in the scientific community. Most of the previous published studies involved open abdominal techniques (ASCP) or procedures with concomitant total hysterectomy. The present study is one of the largest series among the current literature comparing LSCP/SCH with LSHP. In our practice, women with POP for which hysterectomy is indicated undergo a laparoscopic procedure that provides a subtotal hysterectomy in consideration of the reduced risk of mesh exposure with this

Table 1 Baseline patient characteristics

	LSHP (n =78)	LSCP/SCH (n =58)	P value
Age (years), median (range)	57 (34–79)	61 (47–75)	0.207
BMI, median (range)	24.02 (18.3–35.3)	24.87 (18–32)	0.252
Parity, median (range)	2 (0–10)	2 (1–4)	0.414
Cesarean section, n (%)	1 (0–1)	1 (0–1)	0.656
Weight of heaviest baby (g), median (range)	3500 (2600–4620)	3600 (2230–5200)	0.118
Menopausal, n (%)	69 (87)	52 (89.7)	0.826
Hormonal replacement, n (%)	2 (2.6)	4 (6.9)	0.401
Comorbidities, n (%)	20 (25.6)	19 (32.8)	0.444
Prolapse at presentation (POP-Q stage)			
Anterior			
Median (range)	2 (0–4)	2 (0–4)	0.886
3–4, n (%)	28 (35.9)	21 (36.2)	0.970
Apical			
Median (range)	2 (2–4)	2 (2–4)	0.330
3–4, n (%)	18 (23.1)	18 (31.0)	0.298
Posterior			
Median (range)	1 (0–3)	1 (0–2)	0.051
3–4, n (%)	3 (3.9)	0 (0)	0.261
SUI, n (%)	51 (65.4)	35 (60.3)	0.547
Constipation, n (%)	14 (17.9)	8 (12.8)	0.639
Sexually active patients, n (%)	65 (83)	47 (81)	0.728
Preoperative dyspareunia, n(%)	16 (24.6)	11 (2.4)	0.882
Previous operations for pelvic floor dysfunction, n (%)	6 (7.7)	0 (0)	**0.038**

technique compared to total hysterectomy [10, 11]. To avoid potential spread of malignant cells by seeding on the peritoneum during power morcellation [18], we decided to morcellate the specimen in an endobag with a cold knife.

Concerning our results, at 24 months' follow-up anatomical outcomes were highly satisfactory in both cohorts, confirming the efficacy of these procedures. In the LSCP/SCH group, apical prolapse was restored in 100% of patients,

Table 2 Perioperative data

	LSHP (n=78)	LSCP/SCH (n=58)	P value
Operative time (min), median (range)	120 (60–240)	150 (80–305)	**0.001**
Estimated blood loss (ml), median (range)	30 (0–100)	30 (0–150)	0.326
Hospital stay (days), median (range)	2 (1–8)	2 (1–11)	0.062
Concomitant incontinence procedure, n (%)	48 (61.5)	32 (55.2)	0.456
TOT	39 (50)	25 (43.1)	0.426
TVT	9 (11.5)	5 (8.6)	0.580
Intraoperative complications[1], n (%)	2 (2.5)	1 (1.7)	0.610
Conversion to laparotomy, n (%)	0 (0)	0 (0)	n/a
Postoperative complications, n (%)	2 (2.5)	5 (8.6)	0.136
CD1, n (%)	0 (0)	2 (3.4)	0.426
CD2, n (%)	0 (0)	1 (1.7)	0.342
CD3, n (%)	2 (2.5)	2 (3.4)	0.763
Re-operations[2], n (%)	2 (2.5)	2 (3.4)	0.572

[1] All intraoperative complications were represented by bladder lesions

[2] Re-operations were caused by one rectovaginal hematoma and one vesical-vaginal hematoma in the LSHP group and by one rectovaginal hematoma and one bowel occlusion in the LSCP/SCH group

Bold results are statistically significant: $p < 0.05$

Table 3 Pre- and postoperative anatomical data

	Preoperative			12-month FUP			24-month FUP			Preoperative VS 24 month FUP LSHP	Preoperative VS 24 month FUP LSCP/SCH
	LSHP (n=78)	LSCP/SCH (n=58)	*P* value	LSHP (n=78)	LSCP/SCH (n=58)	*P* value	LSHP (n=78)	LSCP/SCH (n=58)	*P* value	*P* value	*P* value
Anterior stage											
0	2 (2.5)	1 (1.7)	0.610	41 (52.6)	39 (67.2)	0.085	34 (43.6)	34 (58.6)	0.083	**0.000**	**0.000**
1	4 (5.1)	1 (1.7)	0.289	32 (41.0)	17 (29.3)	0.159	38 (48.7)	19 (32.8)	0.062	**0.000**	**0.000**
2	44 (56.4)	35 (60.4)	0.646	4 (5.1)	2 (3.4)	0.637	5 (6.4)	5 (8.6)	0.433	**0.000**	**0.000**
3	21 (26.9)	17 (29.3)	0.759	0 (0)	0 (0)	N/A	0 (0)	0 (0)	N/A	**0.000**	**0.000**
4	7 (9.1)	4 (6.9)	0.457	0 (0)	0 (0)	N/A	1 (1.3)	0 (0)	0.574	**0.032**	0.059
Apical stage											
0	0 (0)	0 (0)	N/A	73 (93.6)	57 (98.3)	0.239	71(91)	57 (98.3)	0.075	**0.000**	**0.000**
1	0 (0)	0 (0)	0.771	2 (2.6)	1 (1.7)	0.742	3 (3.9)	1 (1.7)	0.428	**0.013**	**0.004**
2	60 (76.9)	40 (69)	0.298	1 (1.3)	0 (0)	0.574	2 (2.5)	0 (0)	0.327	**0.000**	**0.000**
3	12 (15.4)	13 (22.4)	0.295	1 (1.3)	0 (0)	0.574	1 (1.3)	0 (0)	0.574	**0.001**	**0.000**
4	6 (7.7)	5 (8.6)	0.543	1 (1.3)	0 (0)	0.574	1 (1.3)	0 (0)	0.574	0.058	**0.029**
Posterior stage											
0	16 (20.5)	14 (24.1)	0.614	64 (82)	52 (89.6)	0.234	59 (75.6)	48 (82.8)	0.316	**0.000**	**0.000**
1	25 (32)	27(46.6)	0.085	8 (10.2)	3 (5.2)	0.353	13 (16.7)	7 (12.0)	0.454	**0.020**	**0.004**
2	34 (43.6)	17(29.3)	0.089	6 (7.7)	3 (5.2)	0.413	6 (7.7)	3 (5.2)	0.413	**0.000**	**0.000**
3	3 (3.9)	0 (0)	0.186	0 (0)	0 (0)	N/A	0 (0)	0 (0)	N/A	0.123	N/A
4	0 (0)	0 (0)	N/A	0 (0)	0 (0)	N/A	0 (0)	0 (0)	N/A	N/A	N/A

Bold results are statistically significant: $p < 0.05$

whereas the success rates for the anterior and posterior vaginal compartments were 91.4% and 94.8%, respectively. In the LSHP group, the success rates were 94.9%, 92.3% and 92.3% for the apical, anterior and posterior vaginal compartments, respectively. These results were not statistically different between the groups.

These outcomes differ from those already published by Gracia et al. [19] in their prospective observational pilot study in which they compared the same two surgical procedures. This series revealed a significantly better anterior and apical cure rate in the LSCP/SCH group than in the LSHP one at 12 months' follow-up (90% and 66.7% vs. 46.7% and 27.6%). Despite the prospective design of the study, the small sample size of the LSHP cohort compared to that investigated in our report (15 patients vs. 78 patients) may justify the worse results, possibly related to less experience of the authors in this procedure compared to the one in which supracervical hysterectomy was involved. In another small retrospective report by Li et al. [20], the first on the Asian population, 23 women with POP (12 receiving LSHP and 11 LSCP/SCH) did not present any recurrence at 6 months' follow-up, demonstrating similar outcomes among the groups.

Among the advantages of uterus-preserving surgery, many authors have reported reduced OT, EBL and hospital stay [21, 22]. In our study we noticed only a longer OT for LSCP/SCH (150 vs. 120 min, $p < 0.001$), in line with current literature, whereas no differences in terms of EBL and hospital stay were shown. Regarding EBL, it has to be noted that in our SCH technique we close the uterine artery at its origin, and this precaution could justify the reduced blood loss during the hysterectomy, making it similar to that seen during hysteropexy [23].

Considering perioperative complications, which were similar between the two cohorts of women, no major postoperative complications or cases of mesh exposure were registered. This is in accordance with data already published by Gracia et al. and Bojahr et al. (0%) [19, 24]. Gutman et al. performed a meta-analysis of all available comparative studies demonstrating that the risk of mesh exposure is approximately four times greater if a total hysterectomy is performed at the time of sacral colpopexy (8.6%) compared with 2.2% without a hysterectomy and 1.7% if subtotal hysterectomy is performed [25]. Cervix preservation prevents the communication between the vaginal and abdominal cavities, avoiding exposure of the surgical bed to the vaginal microbiota. This fact, in combination with the devascularization of the vaginal cuff caused by total hysterectomy, might play a significant role in the genesis of future mesh-related complications. Moreover, the use of type 1 macroporous monofilament lightweight polypropylene meshes and the dissection of the vesicovaginal and rectovaginal spaces without disrupting the vaginal muscularis are other precautions we think are of utmost importance in reducing this risk.

Concerning the functional outcomes, there was a similar statistically significative improvement in stress urinary incontinence (passing from 65.4% to 12.2% and from 60.3% to 15.5% for LSHP and LSCP/SCH, respectively). This is related to the concomitant use of a mid-urethral sling during POP

Table 4 Subjective outcomes at 3-, 12- and 24-month follow-up

Variables	1-month FUP			3-month FUP			12-month FUP			24-month FUP		
	LSHP (n=78)	LSCP/SCH (n=58)	*P* value	LSHP (n=78)	LSCP/SCH (n=58)	*P* value	LSHP (n=78)	LSCP/SCH (n=58)	*P* value	LSHP (n=78)	LSCP/SCH (n=58)	*P* value
Subjective success rate, n (%)	78 (100)	58 (100)	N/A	77 (98.7)	58 (100)	0.387	71 (91)	56 (96.5)	0.300	70 (89.7)	54 (93.1)	0.494
PGI-I												
1, n (%)	70 (89.7)	50 (86.3)	0.595	70 (89.7)	50 (86.3)	0.595	70 (89.7)	50 (86.3)	0.595	62 (79.6)	47 (81)	0.969
2, n (%)	8 (10.3)	8 (13.7)	0.527	7 (9)	8 (13.7)	0.416	2 (2.6)	4 (6.9)	0.401	10 (12.8)	5 (8.7)	0.439
3, n (%)	0 (0)	0 (0)0	N/A	0 (0)	0 (0)	N/A	2 (2.6)	2 (3.4)	0.763	3 (3.8)	4 (6.9)	0.459
4, n (%)	0 (0)	0 (0)	N/A	1 (1.3)	0 (0)	0.574	4 (5.1)	2 (3.4)	0.637	3 (3.8)	2 (3.4)	0.903
Postoperative SUI, n (%)	10 (12.2)	9 (15.5)	0.654	11 (14.1)	10 (17.2)	0.616	12 (15.4)	10 (17.2)	0.771	12 (15.4)	10 (17.2)	0.771
De novo SUI, n (%)	4 (5.1)	6 (10.3)	0.324	5 (6.4)	7 (12.1)	0.198	6 (7.7)	7 (12.1)	0.391	6 (7.7)	7 (12.1)	0.391
Postoperative constipation, n (%)	9 (11.5)	10 (17.2)	0.454	9 (11.5)	10 (17.2)	0.454	8 (10.2)	9 (15.5)	0.359	8 (10.2)	9 (15.5)	0.359
De novo constipation n (%)	5 (6.4)	7 (12.1)	0.198	5 (6.4)	7 (12.1)	0.198	4 (5.1)	6 (10.3)	0.324	4 (5.1)	6 (10.3)	0.324
Sexually active patients, n (%)	0 (0)	0 (0)	N/A	60 (76.9)	42 (72.4)	0.548	69 (88.5)	49 (84.5)	0.498	69 (88.5)	49 (84.5)	0.498
Postoperative dyspareunia, n (%)	0 (0)	0 (0)	N/A	11 (18.3)	9 (15.5)	0.698	10 (14.5)	8 (13.8)	0.785	10 (14.5)	8 (13.8)	0.785
De novo dyspareunia, n (%)	0 (0)	0 (0)	N/A	0 (0)	0 (0)	N/A	0 (0)	0 (0)	N/A	0 (0)	0 (0)	N/A

Table 5 Anatomical outcomes at 3-, 12- and 24-month follow-up

Recurrence	1-months FUP			3-months FUP			12-month FUP			24-month FUP		
	LSHP (n=78)	LSCP/SCH (n=58)	*P* value	LSHP (n=78)	LSCP/SCH (n=58)	*P* value	LSHP (n=78)	LSCP/SCH (n=58)	*P* value	LSHP (n=78)	LSCP/SCH (n=58)	*P* value
Total, n (%)	0 (0)	0 (0)	N/A	1 (1.3)	0 (0)	0.574	10 (15.4)	4 (6.9)	0.261	12 (15.4)	7 (12.1)	0.581
ISOLATED												
Anterior, n (%)	0 (0)	0 (0)	N/A	0 (0)	0 (0)	N/A	2 (2.6)	1 (1.7)	0.742	3 (3.8)	4 (6.9)	0.459
Apical, n (%)	0 (0)	0 (0)	N/A	0 (0)	0 (0)	N/A	1 (1.3)	0 (0)	0.387	2 (2.6)	0 (0)	0.507
Posterior, n (%)	0 (0)	0 (0)	N/A	0 (0)	0 (0)	N/A	4 (5.1)	2 (3.4)	0.637	4 (5.1)	2 (3.4)	0.489
COMBINED												
Anterior+apical, n (%)	0 (0)	0 (0)	N/A	0 (0)	0 (0)	N/A	1 (1,3)	0 (0)	N/A	1 (1.3)	0 (0)	0.574
Apical+posterior, n (%)	0 (0)	0 (0)	N/A	0 (0)	0 (0)	N/A	0 (0)	0 (0)	N/A	0 (0)	0 (0)	N/A
Anterior+posterior, n (%)	0 (0)	0 (0)	N/A	0 (0)	0 (0)	N/A	1 (1.3)	1 (1.7)	0.673	1 (1.3)	1 (1.7)	0.673
Anterior+apical+posterior, n (%)	0 (0)	0 (0)	N/A	1 (1.3)	0 (0)	0.574	1 (1.3)	0 (0)	0.574	1 (1.3)	0 (0)	0.574
OVERALL												
Anterior, n (%)	0 (0)	0 (0)	N/A	1 (1.3)	0 (0)	0.574	5(7.7)	2 (3.4)	0.698	6 (7.7)	5 (8.6)	0.844
Apical, n (%)	0 (0)	0 (0)	N/A	1 (1.3)	0 (0)	0.574	3(5.1)	0 (0)	0.261	4 (5.1)	0 (0)	0.136
Posterior, n (%)	0 (0)	0 (0)	N/A	1 (1.3)	0 (0)	0.574	6 (7.7)	3 (5.2)	0.732	6 (7.7)	3 (5.2)	0.732

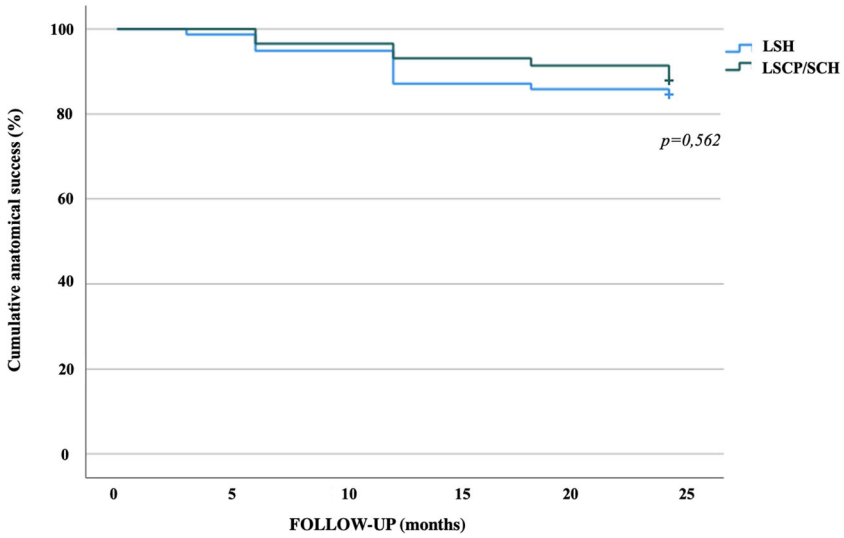

Fig. 1 Kaplan-Meier curve: proportion of relapse-free patients at 24-month follow-up

surgery to correct SUI. Only four (5.1%) and six (10.3%) women were affected by de novo stress incontinence who underwent LSHP and LSCP/SCH, respectively. There was only one case of urinary retention after LSCP/SCH plus TVT, which resolved spontaneously within 1 month. On the contrary, patients reported no changes in terms of pre- and postoperative constipation. De novo dyspareunia was not observed in the two cohorts.

Table 6 Risk factors for prolapse recurrence at 24-month follow-up

	Univariate analysis		Multivariate analysis*	
	Odds ratio (95% CI)	*P* value**	Odds ratio (95% CI)	*P* value**
Age				
< 65§	0.816	0.704		
≥ 65	(0.286–2.329)			
Body mass index (BMI)				
< 25 kg/m^2	2.743	**0.049**	2.660	0.062
≥ 25 kg/m^2§	(1.005–7.484)		(0.950–7.444)	
First POP surgery				
No	1.244	0.846		
Yes§	(0.137–11.276)			
Surgical technique				
Sacral hysteropexy§	1.325	0.582		
Sacral colposacropexy	(0.487–3.605)			
POP-Q stage anterior≥3				
No	3.568	**0.014**	3.392	**0.020**
Yes§	(1.298–9.807)		(1.216–9.464)	
POP-Q stage apical≥3				
No	2.312	0.102	–	–
Yes§	(0.846–6.314)			
POP-Q stage posterior≥3				
No	3.194	0.353		
Yes§	(0.275–37.068)			
Postoperative constipation				
No§	3.937	0.194	–	–
Yes	(0.498–31.151)			

*Multivariate analysis with backward stepwise method was performed for variables with $p < 0.2$ at univariate analysis

**Bold cases are statistically significant: $p < 0.05$

A PGI-I score 1–2 was obtained in 92.4% and 89.7% of subjects who underwent LSHP and LSCP/SCH respectively. Despite the cases of de novo SUI and relapses of descensus, the grade of patients' satisfaction remained high: this may be explained by the fact that all women without preoperative clinical SUI received accurate counseling about the possibility of developing urinary leakage after the surgery and several therapeutical options to correct it. Second, the grade of prolapse recurrence was mild in most cases (81.2% and 100% of all recurrences were stage 2 for LSHP and LSCP/SCH patients) and often asymptomatic.

To better investigate possible clinical risk factors influencing the rate of recurrence of the two surgical procedures, we performed a univariate and multivariate analysis. What emerged was that independently of the removal or not of the uterus, a preoperative grade of cystocele > 2 may triple the probability of having a recurrence (OR 3.39; IC 1.216–9.464, $p = 0.020$). In this state of affairs, it might be useful for the surgeon to inform women with advanced preoperative cystoceles about the major risk of POP surgery failure. This aspect mainly concerns central cystoceles in which the weakening of the endopelvic fascia is more severe. In this respect, alternative techniques [26] were proposed to improve the success rate of the surgical treatment. A recent series published by Gagyor et al. [27] observed a higher incidence of anterior anatomical failures in association with LSH compared to LSCP (21.1% vs. 8.8%) probably due to the relative technical difficulty of inserting the mesh in the LSH group. Gaygor et al.'s data differ from our results, which revealed a superimposable anatomical recurrence rate regardless of the type of compartment considered. These results might be explained by the fact that the feasibility of our standardized technique does not appear to be affected by the choice of preserving the uterus in either mesh placement or suture positioning.

In our series obese women appear to have a double probability of recurrence almost reached statistical significance (OR 2.66; IC 0.950–7.444, $p = 0.062$). Obesity might influence the failure of surgery both indirectly and directly, by making the surgical procedure much more complex and sometimes less effective since it is associated with increased blood loss, longer operative times and more intraoperative complications [28].

Lastly, it has to be considered that uterine conservation during prolapse surgery places the patient at risk of future intervention due to new uterine or ovarian abnormalities. The risk of premalignant and malignant gynecological pathology at the time of surgery for uterovaginal prolapse has been estimated at around 1–3% in asymptomatic postmenopausal women [29, 30]. Moreover, the family history of the patients must be carefully investigated as family history regarding cancer pathologies or hereditary cancer syndromes (e.g., Lynch syndrome, BRCA 1–2 mutations, etc.) may promote the choice for a non-conservative intervention. Furthermore, it has to be considered that a second surgical procedure on an organ with a previously implanted mesh could be more technically challenging for the surgeon. Although the potential for future pathological conditions should not dictate the need for the removal of a healthy organ, patients who choose to preserve the uterus must be counseled about the need for ongoing oncological surveillance consistent with best practice guidelines.

Before surgery our patients undergo a thorough preoperative screening with an up-to-date negative Pap smear and a pelvic sonography in addition to an accurate medical and family history together with clinical examination. In light of the above, since the majority of patients are postmenopausal, we tend to offer a subtotal hysterectomy with a bilateral salpingoophorectomy to prevent the development of future malignancies. However, based on the similar anatomical and functional outcomes of the LSHP group, we feel confident about proposing the uterus-sparing technique for patients in the phase of perimenopausal transition who are motivated to preserve the organ or in young women affected by POP.

Our results must be read in light of some limitations such as the retrospective nature of the study, the lack of specific questionnaires and significant loss to follow-up rate. However, strengths of our study include the large sample size, the multicentric setting in high-volume hospitals, the use of a standardized surgical procedure and all participating surgeons performing both techniques.

Conclusion

In conclusion, our findings demonstrate that both laparoscopic procedures are safe and effective in the treatment of POP. Menopausal patients and perimenopausal patients who no longer desire uterine preservation will be encouraged to consider LSCP/SCH. LSHP can be offered as an alternative in premenopausal patients and perimenopausal women who are strongly motivated to preserve the uterus in the absence of abnormal uterine findings at the preoperative evaluation.

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Statistical analysis: L. Vacca.

Declarations

Conflict of interest The authors certify that there is no conflict of interest with any financial organization.

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