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ORIGINAL ARTICLE

Urodynamic findings and functional outcomes after laparoscopic sacrocolpopexy for symptomatic pelvic organ prolapse

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Abstract

Introduction and hypothesis The aim of this study was to evaluate the functional outcomes and urodynamic findings after laparoscopic sacrocolpopexy (LSC) in patients with stages II–IV pelvic organ prolapse (POP).

Methods In this single-center prospective study, we evaluated 63 women (mean age 62.5 ± 7.5 years) women with symptomatic and advanced POP (stage II–IV) who underwent LSC without concomitant anti-incontinence surgery. The preoperative evaluation incuded history, clinical examination, and urodynamic testing. Women were followed up at 1, 3, 6, and 12 months after surgery and then annually using history, examination, and uroflowmetry. At 6 months, we performed urodynamic testing. To evaluate urinary symptoms, we used the Urogenital Distress Inventory (UDI)-6 questionnaire before and 6 months after surgery.

Results Median follow- up was 22 months (range 8–48). After surgery, maximum flow (Q_{max}) significantly improved compared with baseline (14.17 ± 2.3 vs 27 ± 8.4 ml/s; $p = 0.02$), and the percentage of patients with elevated postvoid residual (PVR) significantly decreased (33.3% vs 11.1%; $p = 0.001$). Detrusor overactivity and bladder outlet obstruction disappeared in 73.6% and 85.7% of patients, respectively, while detrusor underactivity persisted in 66.6% of women. Twenty women (31.7%) reported stress urinary incontinence (SUI) before surgery (14 clinically evident and 6 as occult form), which persisted in only 7/20 (11%) patients following LSC, with no de novo cases. The most common preoperative symptoms were voiding symptoms, present in 42/63 (66.6%) patients, which resolved in 36 (85.7%). The overactive bladder syndrome disappeared in 60% of women, with no de novo cases. Results were reflected by a significant decrease in UDI-6 score from a median of 16 (0–45) at baseline to 5.5 (0–17) at the final follow-up ($p = 0.001$). The domain on storage symptoms (median 3 vs 1) and voiding symptoms (median 3 vs 1) of UDI-6 showed an improvement after surgery ($p = 0.001$).

Conclusions The urodynamic finding showed that LSC in women with advanced POP provides good functional outcomes.

Keywords Laparoscopic sacrocolpopexy · Advanced pelvic organ prolapse · Urodynamic testing · Functional outcomes · Stress urinary incontinence · Overactive bladder

Introduction

Pelvic organ prolapse (POP) is often associated with lower urinary tract symptoms (LUTS), including storage symptoms/overactive baldder (OAB), urinary incontinence (UI), and voiding symptoms [1–3]. Urinary dysfunction often improves after surgical prolapse repair [2]. Nevertheless, in some cases, de novo symptoms appear [4, 5]. In the literature, the reported rate of symptomatic improvement and de novo cases varies due to different repair techniques and various subjective and objective outcome measures used for assessment. Evaluation of functional outcomes after POP surgery has been becoming increasingly important, as they have stronger associations to quality of life improvements compared with anatomic outcomes. Few studies have objectified the functional outcomes of POP surgery by improving urodynamic parameters [2, 6]. The primary aim of this study was to evaluate the functional outcomes of laparoscopic

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sacrocolpopexy (LSC) by comparing preoperative with postopertive urodynamic findings in patients with stages II–IV POP.

Material and methods

This was a single-center prospective study in consecutive patients with symptomatic stage II–IV POP according to the Pelvic Organ Prolapse Quantification system (POP-Q) [7] who underwent laparoscopic sacrocolpopexy (LSC) and in whom functional outcomes were evaluated using pre- and postoperative urodynamic tests. Preoperative evaluation included medical history, clinical examination, multichannel urodynamics, and transperineal ultrasound (TUS). Stress testing during clinical examination was performed with and without prolapse reduction and with a naturally comfortably full bladder. Diagnosis of urinary symptoms was made by means of clinical history according to the International Urogynecological Association (IUGA)/International Continence Society (ICS) Joint Report on Terminology [7]. Urinary symptoms were quantified using the short forms of the Urogenital Distress Inventory (UDI-6) [8]. Patients were followed up at 1, 3, 6, and 12 months postoperatively and annually thereafter, with history, clinical examination, uroflowmetry, and postvoid residual (PVR) volume measurement. Six months after surgery, all patients performed a urodynamic re-evaluation and completed the UDI-6 questionnaire. The study was approved by the local ethics committee (CEAS N 2827/16). Informed consent was obtained from all study participants.

Surgical procedure

All surgical procedures were performed by two senior surgeons (EC, AZ). A previously described [9, 10] standardized approach using four trocars was used: a subumbilical 12-mm trocar for the 0° scope, a 10-mm trocar medial to the superior–anterior iliac spine, another 5-mm trocar medial to the superior–anterior iliac spine on the other side, and a 5-mm trocar halfway between the symphysis and umbilicus. A rectangular polypropylene mesh was attached to the anterior vaginal wall with four polyglycolic 1–0 sutures after dissection from the bladder down to the bladder neck. Another rectangular polypropylene mesh was attached to the posterior vaginal wall with four polyglycolic 1–0 sutures after dissection down to the levator ani plane. Both meshes were fixed to the sacral periosteum with one or two nonabsorbable 2.0 sutures, avoiding tension. No concomitant anti-incontinence surgery was performed.

Multichannel urodynamic evaluation

Multichannel urodynamic evaluation was performed using the Mediwatch EBN system©, in accordance with ICS Good Urodynamic Practice (GUP) 2002 [11] and ICS-GUP 2016 updates [12]. ICS standard cystometry and pressure-flow study were done with the patient comfortably seated. During cystometry, the bladder was filled with room-temperature saline solution at 50 ml/min with the patient in a supine position. No prolapse reduction was performed during evaluation. A urodynamic report was completed according to ICS-GUP 2016. Detrusor overactivity (DO) was defined according to current recommendations [7] as involuntary detrusor contractions during filling cystometry, spontaneous or provoked, phasic or terminal, that produce a wave form on the cystometrogram of variable duration and amplitude. Bladder outlet obstruction (BOO) was defined according to Defreitas nomogram [maximum flow (Q_{max}) at uroflowmetry ≤12 ml/s and a detrusor pressure at Q_{max} during pressure-flow study ≥25 cm H_2O defining BOO] [13]. Detrusor underactivity (DU) was defined according to the Projected Isovolumetric Pressure (PIP) index and calculated as Q_{max} + maximum detrusor pressure (Pdet) Q_{max} (normal range 30–75 cmH_2O) [14]. All urodynamic tests were performed by an independent urologist (AG). Bladder compliance was calculated by dividing the volume change by the change in detrusor pressure. Two standard points were used: the start of filling and cystometric capacity, or immediately before any detrusor contractions that would end the test by, for example, significant leakage [7].

Statistical analysis

All calculations were performed using IBM-SPSS® version 22.0 (IBM Corp., Armonk, NY, USA). Categorical data are presented in the form of absolute numbers and their corresponding percentage values. McNemar test was used to compare pre- and postoperative prevalence of clinical and urodynamic diagnoses; $\chi 2$ test was used for unpaired categorical data. Wilcoxon signed-rank test was used to compare pre- and postoperative urodynamic parameters and uroflowmetry parameters. Statistical significance was set at $p < 0.05$.

Results

Sixty-three women who underwent LSC for urogenital prolapse stage II–IV between May 2014 and July 2017 were included in this study. Table 1 shows their demographic and clinical characteristics at baseline. median follow-up study was 22 months (range 8–48).

Table 2 shows pre- and postoperative urodynamic parameters. At 6 months after surgery, free uroflowmetry data

Table 1 Baseline characteristics of the study population

	Study group ($n = 63$)
Age (years, mean ± SD)	62.5 ± 7.5
Body mass index (kg/m^2, mean ± SD)	26.1 ± 3.2
Parity (median, range)	2 (1–5)
Weight of a baby at its birth (kg median, range)	3.7 (2.7–4)
Menopause *n* (%)	50 (79.3)
Voiding symptoms *n* (%)	42 (66.6)
Storage symptoms *n* (%)	32 (50.8)
Urodynamic stress urinary incontinence *n* (%)	20 (32)
Clinical evident stress urinary incontinence (%) (without POP reduction)	14(22.2)
No clinical evident stress urinary incontinence (%) (with POP reduction)	6(9.5)
Urgency urinary incontinence *n* (%)	6 (9.5)
Overactive bladder syndrome *n* (%)	15 (23.8)
Dry *n* (%)	9 (14.3)
Wet *n* (%)	6 (9.5)
Detrusor overactivity *n* (%)	19 (30.2)
Dry *n* (%)	16 (25.4)
Wet *n* (%)	3 (4.7)
Anterior compartment prolapse stage *n* (%)	
<III	16 (25.3)
≥III	47 (74.6)
Apical compartment prolapse stage *n* (%)	
<III	31 (49.2)
≥III	32 (51)
Posterior compartment prolapse stage *n* (%)	
<III	59 (93.6)
≥III	4 (6.3)

SD standard deviation, *POP* pelvic organ prolapse

showed that Q_{max} significantly improved compared with baseline (14.17 ± 2.3 vs 27 ± 8.4 ml/s; $p = 0.02$), and the percentage of patients with PVR >30% of voided volume significantly decreased (33.3% vs 11.1%; $p = 0.001$). Bladder compliance also significantly improved, with only 19.4% presenting with low compliance compared with 32.2% preoperatively. Maximum cystometric capacity did not significantly change.

At baseline, 19 (30.2%) women had involuntary detrusor contractions during the filling phase of the urodynamic evaluation as typical phasic DO. Sixteen women presented dry DO, eight of whom also reported symptoms of dry OAB. Three patients had wet DO, two of whom complained of symptoms of wet OAB, while the third had a clinically dry OAB. Fifteen of 19 women with DO also presented mild BOO.

Six months after surgery, DO was detected in only five women ($p < 0.0001$); none had urodynamic incontinence; all had normal bladder compliance and lower pressure of involuntary detrusor contractions compared with baseline. At 6 months, four of these five patients complained of some urgency episodes or increased daytime frequency but were not bothered by these symptoms. One of the five women had mild obstruction, persistent but not bothersome voiding symptoms, and stage II anterior-compartment prolapse at urogynecological examination.

BOO, which was the most frequent urodynamic dysfunction at baseline, was observed in only six (9.5%) patients postoperatively compared with 42 (66.6%) at baseline ($p < 0.0001$). Pre- and postoperative pressure-flow studies showed significant improvements in Q_{max} (from 12.3 ± 7.1 ml/s to 21.1 ± 7.3 ml/s; $p = 0.005$) in the percentage of patients with PVR >30% of voided volume ($p = 0.001$) and in total voiding time ($p = 0.02$), while there was no change in the time to Q_{max} ($p = 0.09$). As shown in Table 2, baseline mean detrusor opening pressure, maximum pressure, and pressure at maximum flow significantly decreased at 6 months after surgery. The most common preoperative symptoms, in according to urodynamic data, were voiding symptoms (one or more of these symptoms: slow stream, splitting or spraying of the stream, intermittent stream, hesitancy, straining), which were present in 42 of 63 patients (66.6%). They resolved in 36 patients (85.7%). Six patients had

Table 2 Pre- and postoperative urodynamic parameters

Parameters	Preoperative	Postoperative	*P* value
Uroflowmetry			
Q_{max} (mean ± SD; ml/s)	14.17 ± 2.3	27 ± 8.4	0.022
Elevated PVR *n* (%)	21 (33.3)	7 (11.1)	0.001*
Cystometry			
Low bladder compliance *n* (%)	20 (32.2%)	12 (19.4%)	0.008*
Maximum cystometric capacity (mean ± SD, ml)	369.4 ± 92.36	381.6 ± 86.79	0.369
IDC *n* (%)	19 (30.2)	5 (7.9)	< 0.0001*
Detrusor pressure IDC (mean ± SD,cmH_2O)	25 ± 21.2	11 ± 1.4	<0.0001
Positive VLPP *n* (%)	14 (22.2)	7 (11.1)	0.001
Abdominal VLPP positive (mean ± SD,cmH_2O)	32.5 ± 13.4	35 ± 1.2	0.126
Pressure-flow study			
Q_{max} (mean ± SD; ml/s)	12.3 ± 7.1	21.1 ± 7.3	0.005
PVR *n* (%)	22 (35)	7 (11.1)	0.001
Opening pressure (mean ± SD, cmH_2O)	32.3 ± 22.2	16.9 ± 10.7	<0.0001
Pdet Q_{max} (mean ± SD, cmH_2O)	43.2 ± 25.6	24.3 ± 13.04	<0.0001
Pdet Q_{max} (mean ± SD, cmH_2O)	33.6 ± 22.2	18.64 ± 10.33	<0.0001
Time to maximum flow (mean ± SD, s)	32.4 ± 38.7	20.8 ± 16.4	0.09
Voiding time (mean ± SD, s)	71.3 ± 60.5	47.8 ± 14.5	0.022
PIP <35 cmH_2O	12 (19)	8 (12.6)	0.125*
BOO according to Defreitas nomogram	42 (66.6)	6 (9.5)	<0.0001*
UDI-6 score (median, range)	16 (0–45)	5.5 (0–17)	0.001

Q_{max} maximum flow, *PVR* postvoid residual, *PVR* >30% of voided volume, *IDC* involuntary detrusor contractions, *VLPP* Valsalva (vesical) leak-point pressure, *$Pdet_{max}$* detrusor maximum pressure, *Pdet Q_{max}* detrusor pressure at maximum flow, *PIP* projected isovolumetric pressure, *BOO* bladder outlet obstruction, *UDI* Urogenital Distress Inventory

*McNemar test

persistent voiding symptoms, which were not bothersome, and one patient had stage II cystocele, mild BOO, and persistent DO; she refused treatment. Voiding-symptom domain of the UDI-6 showed an improvement of median (range) score after 6 months [3 (0–3) vs 1 (0–3); $p = 0.001$)] There were no de novo cases of voiding symptoms.

Preoperatively, 12 women had DU according to their PIP index, and seven of 12 also had BOO. After surgery, four of these 12 women had no urodynamic DU (PIP >35 cmH_2O, range 36.5–54.2), and eight had persistent asymptomatic DU with a PIP score slightly below the standard (range 29–33.5). Twenty (31.7%) women reported SUI before surgery. Fourteen had evident SUI and positive Valsalva leak-point pressure (VLPP), with a mean abdominal pressure of 32.5 ± 13.4 cmH_2O; six patients had SUI on stress testing during clinical examination after POP reduction. It persisted in 7/20 patients (11.1%) after LSC: four were offered pelvic floor muscle training (PFMT) (positive VLPP >60 cmH_2O), and three (positive VLPP <60 cmH_2O) underwent anti-incontinence surgery. These results were also confirmed by the median score (range) in the SUI domain of the UDI-6 [baseline 3 (0–3) vs 6 months after surgery 0 (0–3); $p < 0.0001$]. There were no de novo cases.

Of 15 patients with preoperative OAB, six had persistent symptoms 1 month after surgery (2 OAB wet without DO at baseline urodynamic evaluation; 4 dry OAB but demonstrable DO at baseline urodynamics). At 6 months, OAB symptoms resolved spontaneously in four of the six patients, while in the remaining two, wet OAB persisted despite the absence of DO at cystometry and they were treated with anticholinergic drugs. Their symptoms improved significantly. No cases of de novo OAB or urgency urinary incontinence (UUI) were noted. The storage symptoms domain of the UDI-6 showed symptom improvement after surgery [3 (0–3) vs 1 (0–3); $p = 0.001$].

Apical prolapse was corrected to stage 0–I in all (100%) cases with LSC. Anatomical correction success rates (prolapse stage 0 or I) for the anterior and posterior vaginal compartments were 92% and 95%, respectively. At the last follow-up visit, there was one case of recurrent and three cases of persistent anterior compartment prolapse. All cases of persistent or recurrent prolapse were stage II and were treated with PFMT. Only one patient refused treatment.

Discussion

In this study, the urodynamic test confirmed objectively the improvement in or disappearance of preoperative urological dysfunctions in patients with POP treated with laparoscopic sacrocolpopexy. These results were shown in our previous studies by subjective parameters (history, questionnaires) [9, 10]. Unlike Kummeling's study [2], several urodynamic parameters improved significantly following LSC, including Q_{max}, Pdet $_{max}$, Pdet Q_{max}, and PVR. Results were related to significant improvement in clinical conditions. Women with high-grade POP often had preoperative voiding symptoms (66.6%), with low Q_{max} (14.17 ± 2.3 ml/s) and high Pdet Q_{max} (33.6 ± 22.2 cm H_2O) at pressure-flow studies, in accordance with findings of several other studies [15, 16]. Within 6 months after surgery, voiding symptoms disappeared in 88% women, with an improvement of voiding parameters on urodynamics and no demonstrable BOO. The preoperative rate of BOO diagnosis appeared to be higher in women with (79%) than without (21%) DO, suggesting that some degree of obstruction during voiding may play a role in DO pathogenesis [16]. Nineteen (30.2%) women had preoperative DO, and after surgery it disappeared in 74% of them. These results are supported by data from other studies after vaginal or abdominal POP repair [17–20]. In contrast, Kummeling [2] and Abdullah [6] showed no statistically significant decrease in DO after LSC. These different results could be due to different surgical techniques used in these studies; in fact, the authors avoid extensive dissection of the bladder base, which could lead to different postoperative compartment corrections.

We can hypothesize that the decrease in DO could be explained by the reduction of BOO in cases where DO was secondary to BOO, or to anatomic changes in the bladder neck following POP correction. In previous studies, BOO was shown to contribute to alterations in detrusor function that leads to persistent OAB symptoms [21], including UUI. Clinically, 86.6% of women had OAB symptom resolution, supporting the pathophysiologic relation between OAB and prolapse [1]. Two women in our population had persistent wet OAB. Araki [22] reported that DO at baseline was a strong predictor of postoperative persistence of UUI. We did not observe this correlation, and DO disappeared possibly as a result of BOO alleviation, as previously mentioned in our previous study [23].

With regard to DU, evidence is not clear. In the literature, there are no studies evaluating DU after LSC. Twelve women in our series had preoperative DU, and 7/12 had concomitant BOO (BOO is recognized as a possible cause of mechanical DU in animal models [24]). After LSC, DU was not evident in four patients and persisted in eight. DU improvement could be explained by removal of the obstruction, while persistence could be related to several factors: time of obstruction due to POP, aging, denervation, ischemia, and inflammation [25].

In this study, after surgery, SUI disappeared in 65% of women, in contrast to 30% in Kummeling's study [2] . We did not performed concomitant anti-incontinence surgery, in according to our previous experience [26]. In fact, in our prevoius trial, not only did prophylactic procedures fail to improve continence outcomes but were associated with a higher postoperative incontinence rate. Again, this difference could be attributed to the differences in surgical techniques. In particular, in our technique, dissection of the anterior vaginal wall down to the bladder neck may allow us to stabilize the urethra [26]; Kummeling avoided extensive dissection, and periurethral and pubocervical fascia laxity was not corrected, which may be a reason for postoperative UI or UUI [2].

Bladder compliance of our patients improved after surgery. Probably, bladder compliance was weaker in women with high voiding pressures and BOO. The mechanism leading to reduced bladder compliance may be a result of detrusor structural alterations and changes in detrusor innervation. After surgery, this issue may improve in women with a shorter duration of prolapse and whose detrusor has not yet undergone morphological changes.

The strength of our study is the use of urodynamic evaluation to objectify functional outcomes after LSC in women with severe POP in a relatively large sample compared with other studies in the literature. Limitations include lack of a comparison group and urodynamic evaluation at last visit; data are relative to the first 6 months after surgery. Another limitation is that urodynamic evaluation was done without prolapse reduction. Furthermore, it seems evident that even if urodynamic testing might be useful to diagnose occult SUI by some methods (pessary, large cotton swab, Sims speculum, vaginal packing, ring forceps, manual reduction), such methods are not standardized [27]. Furthermore, Hwang, in a recent study [28], showed that clinical examination (by stress test with and without prolapse reduction) and urodynamic testing are equivalent and concordant when demonstrating occult SUI. The International Consultation on Incontinence, however, recommends that women with POP be informed about the relatively unpredictable chance of developing SUI after surgery for POP,, regardless of the presence of occult incontinence [29].

In conclusion, LSC in women with POP stage II–IV provides good anatomical and functional outcomes, as demonstrated by the urodynamic findings before and after surgery.

Compliance with ethical standards

Conflicts of interest None.

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