Int Urogynecol J (2014) 25:1201–1206
DOI 10.1007/s00192-014-2366-1

ORIGINAL ARTICLE

Is de novo stress incontinence after sacrocolpopexy related to anatomical changes and surgical approach?

Edgar L. LeClaire · Marium S. Mukati · Dianna Juarez · Dena White · Lieschen H. Quiroz

Received: 21 November 2013 / Accepted: 26 February 2014 / Published online: 20 March 2014

Abstract
Introduction and hypothesis The objective was to investigate the relationship between new onset postoperative stress urinary incontinence (SUI) after sacrocolpopexy (SCP) and anatomical change/surgical approach.
Methods We analyzed a retrospective cohort of patients with negative preoperative testing for SUI who underwent SCP from 2005 to 2012. Our primary outcome was new onset postoperative SUI. Logistic regression was used to examine the relationship among anatomical change, defined as ΔAa, ΔBa, ΔC, and ΔTVL, and surgical approach, categorized as abdominal (ASCP) for open cases and minimally invasive (MISCP) for laparoscopic and robot-assisted cases, and postoperative SUI.
Results Of 795 cases, 33 ASCP (43%) and 44 MISCP (57%) met the inclusion criteria for analysis. New onset SUI was demonstrated by 15 patients (45%) of the ASCP group and 7 patients (15%) of the MISCP group ($p=0.005$). New onset SUI was significantly associated with route of SCP and ΔAa ($p=0.006$ and $p=0.033$ respectively). Controlling for ΔAa, the odds of new onset SUI were 4.4 times higher in the ASCP group compared with the MISCP group (OR 4.37, 95% CI 1.42, 13.48). Controlling for route of SCP, the odds of new onset SUI were 2.2 times higher with moderate ΔAa compared with low ΔAa (OR 2.16 95% CI 1.07, 4.38). The odds of new onset SUI was 4.7 times higher in those with high ΔAa than in those with low ΔAa (OR 4.67 95% CI 1.14, 19.22). ΔBa, ΔC, and ΔTVL were not associated with new onset SUI.
Conclusions Greater reduction in point Aa and abdominal surgical route are risk factors for new onset postoperative SUI after SCP.

Keywords Sacrocolpopexy · Stress urinary incontinence · Point Aa

Abbreviations

ASCP	Abdominal sacrocolpopexy
MISCP	Minimally-invasive sacrocolpopexy
POPQ	Pelvic organ prolapse quantification
SCP	Sacrocolpopexy
SUI	Stress urinary incontinence
TVL	Total vaginal length
ΔTVL	Difference between preoperative & postoperative total vaginal length
ΔAa	Difference in preoperative & postoperative POPQ point Aa
ΔBa	Difference in preoperative & postoperative POPQ point Ba
ΔC	Difference in preoperative & postoperative POPQ point C

Introduction

Symptomatic pelvic organ prolapse (POP) is a frequent indication for surgery with an annual incidence of 10 to 30 per 10,000 women [1]. Each year approximately 200,000 women undergo inpatient procedures to treat POP in the United States [2]. POP and associated pelvic floor disorders are expected to have an increasing impact on public health as the aging population grows.

Sacrocolpopexy (SCP), suspension of the anterior and posterior vagina to the anterior longitudinal ligament of the

E. L. LeClaire (✉) · M. S. Mukati · D. Juarez · D. White · L. H. Quiroz
Division Female Pelvic Medicine and Reconstructive Surgery, University of Oklahoma Health Sciences Center, 920 S. L. Young, 2430, Oklahoma City, OK 73104, USA
e-mail: edgar.leclaire@gmail.com

sacrum using mesh, is a durable and effective treatment option for women with POP [3]. High anatomical success rates (78–100%) and patient satisfaction rates (85–100%) have established SCP as a 'gold standard' to which all other surgical treatments for POP are compared [4].

Stress urinary incontinence (SUI), involuntary leakage of urine with exertion, often occurs as a result of vaginal support defects and commonly coexists with POP [5, 6]. As the degree of POP increases, SUI is more likely to be "masked" by kinking of the urethra [7–9]. Anterior vaginal tensioning intended to reduce bladder prolapse during SCP can result in flattening of the urethrovesical angle and lead to new onset SUI [10]. De novo SUI is a disappointing outcome for previously continent women who opt for surgical treatment of bothersome POP. Thus, preoperative urinary stress testing with prolapse reduced is used to identify patients who may benefit from incontinence surgery at the time of SCP. Unfortunately, bothersome SUI occurs after POP surgery even with negative preoperative testing. Reported rates of postoperative SUI following abdominal and laparoscopic SCP vary widely and range from 1.9 to 44% and 24% respectively [11, 12].

In this retrospective cohort study, we set out to investigate the relationship between de novo SUI and anatomical outcomes among women undergoing abdominal sacrocolpopexy (ASCP) and minimally invasive sacrocolpopexy (MISCP).

Materials and methods

This study protocol was approved by the Institutional Review Board at the University of Oklahoma Health Sciences Center. A retrospective cohort was sampled from all patients who underwent SCP at this institution between 2005 and 2012. Patients who did not report SUI symptoms and had negative testing preoperatively were included for analysis. Patients who underwent a concomitant incontinence procedure at the time of SCP or had prior surgery for POP or incontinence mesh were excluded.

All patients underwent preoperative cough stress testing with prolapse reduction. Reduction was performed with an intravaginal polycarbonate plastic sphere (Colpexin™, Adamed, Warsaw, Poland). Cough stress test and Valsalva maneuvers were initiated when infused bladder volume reached 200 ml. If no leakage was observed, provocative maneuvers were repeated at 300 ml. No leakage indicated a negative test.

Our surgical technique for laparoscopic SCP is similar to that described by Frick and Paraiso for laparoscopic [13] and by Elliott et al. for robot-assisted SCP [14], with minor variations. Polytetrafluoroethylene suture (CV-2 GORE-TEX®, Flagstaff, AZ, USA) was used for suturing graft to the vagina and sacrum during MISCP. Abdominal SCP was performed using techniques described by Addison and Timmons [15]. Polypropylene suture (Prolene®; Ethicon, Somerville, NJ, USA) was used to suture graft in the vagina and sacrum during ASCP. A Y-shaped polypropylene mesh graft, 10 cm in standard length and tailored to each patient's anatomical specifications during surgery, was used with all SCP procedures. If the uterus was present, a supracervical hysterectomy was performed at the time of SCP. All surgeries were performed by three fellowship trained faculty surgeons who interchangeably perform abdominal and laparoscopic or robotic SCP.

Our primary outcome was bothersome postoperative SUI after negative preoperative screening for occult SUI. To capture this outcome we considered a composite outcome that included:

1. A response ≥2 on item 3 of the Urogenital Distress Inventory (UDI-6)
2. A complaint of bothersome urinary leakage with coughing, laughing, or sneezing after surgery
3. A positive stress test during postoperative UDS

Our secondary outcome was reoperation for the treatment of de novo SUI.

Anatomical outcomes of interest included the difference between preoperative and postoperative measurements of total vaginal length (ΔTVL) and urethrovesical prolapse (ΔAa) using the Pelvic Organ Prolapse Quantification (POPQ) system [16]. These outcomes were selected as surrogate markers for vaginal tensioning.

Eligible patients were identified through electronic medical record query of Current Procedural Terminology codes. All preoperative, operative, and postoperative documentation was reviewed. Only patients with postoperative follow-up and POPQ measurements were included in our final analysis.

Preoperative variables including age, race, parity, body mass index (kg/m^2), menopausal status, medical comorbidities, and presenting stage of anterior prolapse were compared in ASCP and MISCP patients. Concomitant procedures at the of SCP were also compared. Continuous variables were compared using Student *t* tests, categorical variables were compared using Fisher's exact test, and ordinal variables were compared using Wilcoxon rank sum tests.

Logistic regression modeling was used to analyze the relationship between our primary outcome with the following predictor variables; change in total vaginal length (ΔTVL), change in point Aa (ΔAa), change in point Ba (ΔBa), change in point C (ΔC), and route of SCP (abdominal vs minimally invasive). Interactions between variables were assessed and, if significant, included in the model. Confounding variables were included in the model if point estimates changed by more than 20% with their inclusion. Anatomical change variables were assessed for linearity and converted to categorical variables as indicated by model fit statistics (concordance index, Deviance, Pearson, Hosmer–Lemeshow). Cochran–Armitage and goodness of linear fit tests were also used to evaluate for linear trends between anatomical changes and de novo SUI.

The resulting ΔTVL, ΔBa, and ΔC variables were categorized as: increased ($\Delta>0$), or reduced/no change ($\Delta\leq0$). Aa reduction magnitude was categorized as low if less than or equal to 2 cm ($\Delta Aa\leq2$ cm), moderate if greater than 2 centimeters or less than or equal to 4 cm (4 cm$\geq\Delta Aa>$ 2 cm) , and high if greater than 4 cm and less than or equal to 6 cm (6 cm$\geq\Delta Aa>$4 cm). For example, a preoperative point Aa of +3, which was reduced to −3 postoperatively would be categorized as a high reduction magnitude.

Abdominal route (ASCP) and smallest anatomical change were used as reference groups during analysis. An α level of 0.05 was considered statistically significant. Odds ratios were reported with 95% confidence intervals. All analyses were carried out using SAS® version 9.3 (SAS Institute, Cary, NC, USA).

Results

An inclusion and exclusion diagram is shown in Fig. 1. During the study period, a total of 795 patients underwent SCP. Of these, 77 were eligible for inclusion in the final analysis: 33 ASCP and 44 MISCP patients.

Baseline characteristics and demographics of the study population are described in Table 1. The overall mean age of the population of interest was 62 (±7.4) years, and 91% were white. There was no difference in parity, BMI or comorbidities between the groups. There was no statistical difference in preoperative variables between the ASCP and MISCP groups including presenting stage of anterior prolapse, and concomitant procedures. Median follow-up was 15 weeks (range 7–99) for the ASCP group and 12 weeks (range 2–90) for the MISCP group (p=0.039). Although not statistically significant, there was a higher proportion of cystocele repairs in the MISCP group. We found no association between cystocele repair at the time of SCP and ΔAa reduction magnitude, or postoperative SUI.

The overall rate of de novo SUI was 28.6% (22 out of 77). Table 2 demonstrates the association between surgical approach and anatomical outcomes with postoperative SUI in this cohort. New onset postoperative SUI was noted in 45.5% (15 out of 33) of the ASCP group and 15.9% (7 out of 44) of the MISCP group (p=0.004). De novo SUI occurred more frequently in the ASCP group than in the MISCP group (p=0.004). ΔTVL was not associated with new onset SUI in this study population (p=0.37). De novo SUI was noted among 10% (3 out of 30) of the low ΔAa group, 44% (12 out of 27) of the moderate ΔAa group, and 35% (7 out of 20) of the high ΔAa group. This positive trend was statistically significant (Chi-squared: p=0.012, Cochran–Armitage: p=0.03); however, this relationship was not linear (goodness of linear fit Chi-squared: p=0.04). All patients demonstrated a positive ΔBa and no association with ΔC was noted (p=0.063). Overall and route-specific outcomes for the entire cohort are depicted in Fig. 2.

Postoperative anatomical outcomes themselves did not differ according to the route of SCP. Twenty-one ASCP patients (63.6%) and 27 MISCP patients (61.4%) had an increased TVL at postoperative follow-up (p=0.839). Average increase in TVL was 1.6±0.9 cm. Otherwise, patients showed reduced or no change in TVL. Among ASCP patients, 11 (33.3%) had a low ΔAa, 14 (42.4%) had a moderate ΔAa, and 8 (24.2%) had a high ΔAa. By comparison, of those who underwent MISCP, 19 (43.2%) had a low ΔAa, 13 (29.6%) had a moderate ΔAa, and 12 (27.3%) had a high ΔAa. The differences in these outcomes were not statistically significant (p=0.49).

Results of the logistic regression analysis are listed in Table 3. Controlling for ΔAa, the odds of new onset SUI were 4.7 times higher in the ASCP group than in the MISCP group (OR 4.73, 95% CI 1.56, 14.34). Controlling for route of SCP, the odds of new onset SUI were 2.2 times higher with moderate ΔAa than with low ΔAa (OR 2.16 95% CI 1.07, 4.38). The odds of new onset SUI were 4.7 times higher in those with high ΔAa than in those with low ΔAa (OR 4.67 95% CI 1.14, 19.22).

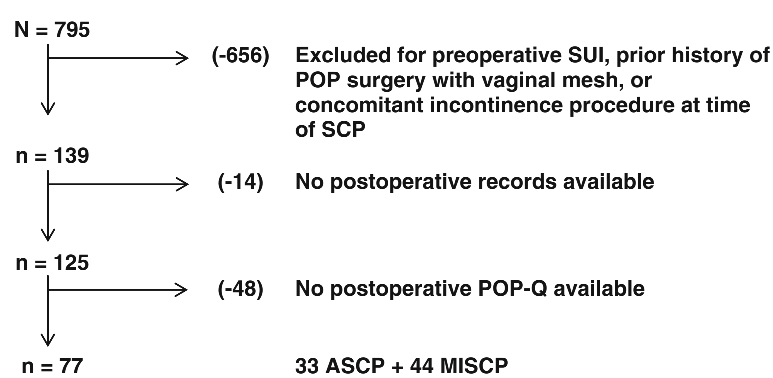

Fig. 1 Inclusion and exclusion diagram. Of 795 sacrocolpopexy (*SCP*) patients, 77 met the inclusion criteria. *POP* pelvic organ prolapse, *POPQ* pelvic organ prolapse quantification, *ASCP* abdominal sacrocolpopexy, *MISCP* minimally invasive sacrocolpopexy

Table 1 Comparison of baseline characteristics by surgical approach (n=77)

Variable	ASCP (n=33)	MISCP (n=44)	p value
Age, mean (SD)	62.12 (7.12)	62.80 (7.67)	0.332
BMI, mean (SD)	27.42 (4.19)	27.15 (4.48)	0.788
Parity, median (range)	2.5 (2, 8)	2.5 (1, 7)	0.392
Race, n (%)			0.597
Caucasian	31 (93.9)	39 (88.6)	
African–American	2 (6.1)	4 (9.1)	
Asian	0 (0.0)	1 (2.3)	
Menopausal, n (%)	31 (93.9)	40 (90.9)	0.695
Smoker, n (%)	3 (9.1)	2 (5.0)	0.653
Hypertension, n (%)	14 (42.4)	20 (45.5)	0.791
Diabetes, n (%)	1 (3.0)	4 (9.1)	0.385
COPD/chronic cough, n (%)	4 (12.1)	3 (6.8)	0.454
Presenting stage of anterior prolapse, n (%)			0.408
Stage 1	3 (9)	7 (16)	
Stage 2	11 (33)	19 (43)	
Stage 3	13 (40)	10 (23)	
Stage 4	6 (18)	8 (18)	
Concomitant procedures at SCP, n (%)			
Hysterectomy	11 (33.3)	16 (36.4)	0.783
Bilateral salpingo-oophorectomy	6 (18.2)	16 (36.4)	0.081
Cystocele repair	1 (3.0)	8 (18.2)	0.069
Rectocele repair	4 (12.1)	8 (18.2)	0.468
Perineorrhaphy	11 (33.3)	11 (25.0)	0.423
Weeks follow-up, median (range)	15 (7, 99)	12 (2, 90)	**0.039**

ASCP abdominal sacrocolpopexy, *MISCP* minimally invasive sacrocolpopexy, *COPD* chronic obstructive pulmonary disease

Statistically significant p-values are in bold

Variations in surgical route according to the primary surgeon were also evaluated for effect on the primary outcome. The proportions of ASCP among the three surgeons were 28%, 34%, and 38%. Statistical modeling showed no association or interaction between postoperative SUI and primary surgeon (p=0.24).

Postoperative SUI was diagnosed by report of bothersome symptoms at a postoperative office visit in 94% (n=71), by

Table 2 Association between surgical approach and anatomical outcomes with postoperative stress urinary incontinence (SUI) in patients undergoing sacrocolpopexy (SCP; %)

Variable	SUI present (n=22)	SUI absent (n=55)	Chi-squared
Surgical approach			**0.005**
Abdominal	15 (68.2)	18 (32.7)	
Minimally invasive	7 (31.8)	37 (67.3)	
Change in vaginal length (ΔTVL)			0.372
ΔTVL >0	12 (54.5)	36 (65.4)	
ΔTVL ≤0	10 (45.5)	19 (34.6)	
Point Aa reduction (ΔAa)*			**0.012**
Low (ΔAa≤2 cm)	3 (13.6)	27 (49.1)	
Moderate (4 cm≥ΔAa>2 cm)	12 (54.6)	15 (27.3)	
High (6 cm≥ΔAa>4 cm)	7 (31.8)	13 (23.6)	
Point Ba reduction (ΔBa)			
ΔBa >0	22 (100)	55 (100)	–
ΔBa≤0	0 (0)	0 (0)	
Point C reduction (ΔC)			
ΔC >0	19 (86.3)	54 (98.2)	0.063
ΔC ≤0	3 (13.6)	1 (1.8)	

*Cochran–Armitage trend test p=0.029 (significant for positive trend), goodness of linear fit Chi-squared p=0.042 (nonlinear relationship)

Statistically significant p-values are in bold

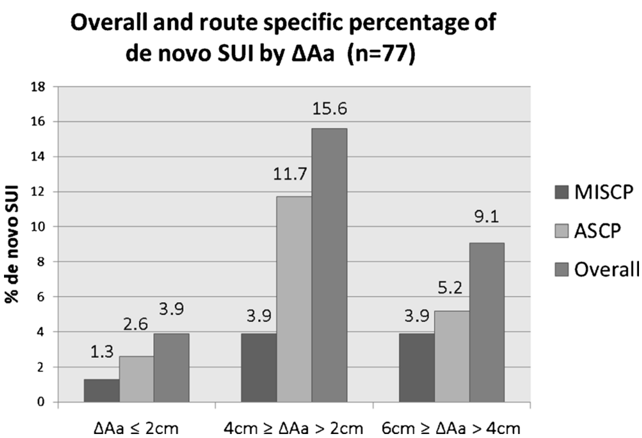

Fig. 2 Overall and route-specific percentage of de novo stress urinary incontinence (SUI) by ΔAa (n=77). The percentage of patients demonstrating de novo SUI after sacrocolpopexy (SCP) shows an increasing trend as ΔAa increases from ≤ 2 cm to > 2 cm. More women in the abdominal sacrocolpopexy (ASCP) group demonstrated de novo SUI

repeat stress testing in 4% (n=3), and by UDI-6 questionnaire in 3% (n=2). Overall, 7 patients (32%) were surgically treated for new onset SUI. Of these, 6 had undergone ASCP. Five patients underwent retropubic sling and 2 underwent urethral bulking. All patients had a satisfactory improvement in SUI symptoms.

Post hoc analysis revealed that our study had adequate power to detect a 34% difference in the proportions of de novo SUI between ASCP and MISCP groups. Most significantly, the 95% confidence interval for the difference in proportions did not include zero (0.29, 95% CI 0.09–0.49). Analysis of exclusion rates showed that 26 out of 59 (0.44) abdominal cases 18 out of 62 (0.29) minimally invasive cases had missing POPQs. The difference in the proportion of patients missing POPQ data between the two surgery types (0.15, 95% CI −0.03 to 0.32) was not statistically significant. Thus, there was no evidence to suggest that missing POPQ data might be related to surgery type.

Discussion

Our primary aim was to investigate the role of prolapse reduction in the development of de novo SUI after SCP in terms of surgical approach and anatomical change. We hypothesized that tensioning differences resulting from variations in tactile sensation between open and minimally invasive SCP might have an impact on SUI outcomes. Interestingly, postoperative SUI was observed more frequently after ASCP (45%), where tactile feedback is more accessible, compared with MISCP (16%).

We found no statistically significant difference in anatomical outcomes between ASCP and MISCP. This is consistent with findings from other studies comparing open and minimally invasive SCP [17, 18]. In a retrospective comparison, Siddiqui et al. found no significant difference in postoperative TVL between 70 robotic SCP patients and a cohort of 289 ASC patients from the CARE trial (median TVL=9 for both groups, p=0.06) [17]. In a randomized, non-inferiority trial comparing post-hysterectomy ASCP and laparoscopic SCP, Freeman et al. reported no statistically significant difference in point C at 1-year follow-up (−6.63 and −6.67 respectively) [18].

Total vaginal length, Aa, Ba, and C reduction magnitude were analyzed as surrogate markers for vaginal tensioning, which is thought to instigate de novo SUI [10]. In this study, only Aa reduction was associated with de novo SUI, regardless of surgical approach. Our analysis suggests that there might be a positive, nonlinear relationship between Aa reduction magnitude and postoperative SUI. Compared with women with low ΔAa, women with moderate ΔAa had double the odds of de novo SUI and women with high ΔAa had almost 5 times the odds of de novo SUI. Since ΔAa represents the anatomical repositioning of the urethrovesical junction, we feel that these findings provide empiric support to the theoretical mechanism of urethral “unkinking,” which is thought to contribute to postoperative SUI.

In this study, 32% of patients with new onset postoperative SUI underwent reoperation. All except one of these patients had undergone ASCP. Published reoperation rates for SUI after ASCP range from 1.2% to 30.9%, while rates after laparoscopic SCP range from 11% to 16.4% [10, 12, 19, 20]. Our findings corroborate these results.

Screening for occult SUI using prolapse-reduced urodynamic (UDS) stress testing is commonly performed to identify patients who may benefit from an incontinence procedure at the time of corrective surgery for POP. However, reported SUI rates after negative testing are substantial. In a retrospective study that included abdominal and laparoscopic cases, Elser et al. report that 13% of subjects without demonstrable SUI at preoperative UDS developed urinary incontinence “of any type” postoperatively [21]. By comparison, Leruth et al. report a 55% postoperative SUI rate in a retrospective cohort of laparoscopic SCP patients who had negative reduction testing [20]. Both studies, however, included women with preoperative symptoms of SUI.

Table 3 Point estimates and 95% confidence limits for significant predictors of new-onset SUI after SCP in the logistic regression model

Covariate	Odds ratio	95% confidence intervals
ASCP vs MISCP	4.73	(1.56, 14.34)
Moderate ΔAa vs low ΔAa	2.16	(1.07, 4.38)
High ΔAa vs low ΔAa	4.67	(1.14, 19.22)

Logistic regression model fit statistics: concordance index = 0.774, deviation p=0.865, Pearson p=0.865, Hosmer–Lemeshow p=0.99

The negative predictive value of reduction testing among continent women planning to SCP is limited. In the Colpopexy and Urinary Reduction Efforts (CARE) study, a randomized clinical trial to determine the effectiveness of routine colposuspension for the prevention of SUI among asymptomatic patients, Visco et al. report that 38% of control group subjects with negative testing developed new onset SUI after abdominal SCP [22]. Adequate counseling and optimal management of the continent, UDS-negative patient planning SCP requires further investigation of other risk factors for new-onset SUI. To this end, we focused on anatomical outcomes related to postoperative SUI.

Limitations of this study include its retrospective design and relatively small sample size. However, by analyzing a focused sample of asymptomatic patients, applying stringent inclusion criteria, and strictly defining relevant urinary outcomes we were able to mitigate confounders for postoperative urinary symptoms. The concordance index (c=0.774) indicates a strong, predictive fit between the data and our logistic regression model. To our knowledge, this is the first study to focus on analyzing specific anatomical outcomes as risk factors for postoperative SUI. Given our findings, a larger, randomized study can be planned to confirm the generalizability of our results, and to examine the predictive value of point Aa reduction magnitude in a urinary incontinence risk assessment model.

Based on this study, we conclude that a greater reduction in point Aa increases the risk of de novo SUI in previously continent patients undergoing SCP.

Acknowledgements We would like to acknowledge Sara Vesely PhD, Professor, Department of Biostatistics, University of Oklahoma Health Sciences Center for assistance with statistical analysis.

Conflict of Interest None.

References

1. Brubaker LBR, Jacquetin B, Schuessler B, Weidner A, Zimmern P et al (2002) Incontinence: 2nd International Consultation on Incontinence, 2nd edn. Health Publications, Plymouth
2. Boyles SHWA, Meyn L (2003) Procedures for pelvic organ prolapse in the United States, 1979–1997. Am J Obstet Gynecol 188:108–115
3. Nygaard I, Brubaker L, Zyczynski HM, Cundiff G, Richter H, Gantz M, Fine P, Menefee S, Ridgeway B, Visco A, Warren LK, Zhang M, Meikle S (2013) Long-term outcomes following abdominal sacrocolpopexy for pelvic organ prolapse. JAMA 309(19):2016–2024
4. Maher C, Feiner B, Baessler K, Schmid C (2013) Surgical management of pelvic organ prolapse in women. Cochrane Database Syst Rev 4:CD004014
5. Bump RC, Norton PA (1998) Epidemiology and natural history of pelvic floor dysfunction. Obstet Gynecol Clin North Am 25(4):723–746
6. Abrams P, Andersson KE, Birder L, Brubaker L, Cardozo L, Chapple C, Cottenden A, Davila W, de Ridder D, Dmochowski R, Drake M, Dubeau C, Fry C, Hanno P, Smith JH, Herschorn S, Hosker G, Kelleher C, Koelbl H, Khoury S, Madoff R, Milsom I, Moore K, Newman D, Nitti V, Norton C, Nygaard I, Payne C, Smith A, Staskin D, Tekgul S, Thuroff J, Tubaro A, Vodusek D, Wein A, Wyndaele JJ (2010) Fourth International Consultation on Incontinence Recommendations of the International Scientific Committee: evaluation and treatment of urinary incontinence, pelvic organ prolapse, and fecal incontinence. Neurourol Urodyn 29(1):213–240
7. Bergman A, Koonings PP, Ballard CA (1988) Predicting postoperative urinary incontinence development in women undergoing operation for genitourinary prolapse. Am J Obstet Gynecol 158(5):1171–1175
8. Richardson DA, Bent AE, Ostergard DR (1983) The effect of uterovaginal prolapse on urethrovesical pressure dynamics. Am J Obstet Gynecol 146(8):901–905
9. Rosenzweig BA, Pushkin S, Blumenfeld D, Bhatia NN (1992) Prevalence of abnormal urodynamic test results in continent women with severe genitourinary prolapse. Obstet Gynecol 79(4):539–542
10. Nygaard IE, McCreery R, Brubaker L, Connolly A, Cundiff G, Weber AM, Zyczynski H (2004) Abdominal sacrocolpopexy: a comprehensive review. Obstet Gynecol 104(4):805–823. doi:10.1097/01.AOG.0000139514.90897.07
11. Brubaker L, Cundiff GW, Fine P, Nygaard I, Richter HE, Visco AG, Zyczynski H, Brown MB, Weber AM (2006) Abdominal sacrocolpopexy with Burch colposuspension to reduce urinary stress incontinence. N Engl J Med 354(15):1557–1566
12. Sarlos D, Brandner S, Kots L, Gygax N, Schaer G (2008) Laparoscopic sacrocolpopexy for uterine and post-hysterectomy prolapse: anatomical results, quality of life and perioperative outcome-a prospective study with 101 cases. Int Urogynecol J Pelvic Floor Dysfunct 19(10):1415–1422. doi:10.1007/s00192-008-0657-0
13. Frick AC, Paraiso MF (2009) Laparoscopic management of incontinence and pelvic organ prolapse. Clin Obstet Gynecol 52(3):390–400
14. Elliott DS, Frank I, Dimarco DS, Chow GK (2004) Gynecologic use of robotically assisted laparoscopy: Sacrocolpopexy for the treatment of high-grade vaginal vault prolapse. Am J Surg 188(4A Suppl):52S–56S
15. Addison WA, Timmons MC (1993) Abdominal approach to vaginal eversion. Clin Obstet Gynecol 36(4):995–1004
16. Bump RC, Mattiasson A, Bo K, Brubaker LP, DeLancey JO, Klarskov P, Shull BL, Smith AR (1996) The standardization of terminology of female pelvic organ prolapse and pelvic floor dysfunction. Am J Obstet Gynecol 175(1):10–17
17. Siddiqui NY, Geller EJ, Visco AG (2012) Symptomatic and anatomic 1-year outcomes after robotic and abdominal sacrocolpopexy. Am J Obstet Gynecol 206(5):1
18. Freeman RM, Pantazis K, Thomson A, Frappell J, Bombieri L, Moran P, Slack M, Scott P, Waterfield M (2012) A randomised controlled trial of abdominal versus laparoscopic sacrocolpopexy for the treatment of post-hysterectomy vaginal vault prolapse: LAS study. Int Urogynecol J 3:3
19. Higgs PJ, Chua HL, Smith AR (2005) Long term review of laparoscopic sacrocolpopexy. BJOG 112(8):1134–1138
20. Leruth J, Fillet M, Waltregny D (2012) Incidence and risk factors of postoperative stress urinary incontinence following laparoscopic sacrocolpopexy in patients with negative preoperative prolapse reduction stress testing. Int Urogynecol J 24:24
21. Elser DM, Moen MD, Stanford EJ, Keil K, Matthews CA, Kohli N, Mattox F, Tomezsko J (2010) Abdominal sacrocolpopexy and urinary incontinence: surgical planning based on urodynamics. Am J Obstet Gynecol 202(4):371–375.e1–5
22. Visco AG, Brubaker L, Nygaard I, Richter HE, Cundiff G, Fine P, Zyczynski H, Brown MB, Weber AM (2008) The role of preoperative urodynamic testing in stress-continent women undergoing sacrocolpopexy: the Colpopexy and Urinary Reduction Efforts (CARE) randomized surgical trial. Int Urogynecol J Pelvic Floor Dysfunct 19(5):607–614