Original Article – Female Urology

Grand J Urol 2021;1(3):83-8
DOI: 10.5222/GJU.2021.03511

Our Minimally Invasive Sacrocolpopexy Experiences in Pelvic Organ Prolapse Treatment

Pelvik Organ Prolapsusu Tedavisinde Minimal İnvaziv Sakrokolpopeksi Deneyimlerimiz

Kamil Gokhan Seker[1], Emre Sam[2], Yusuf Arikan[3], Ahmet Haciislamoglu[3], Abdulmuttalip Simsek[4], Volkan Tugcu[5]

[1]Department of Urology, Mus State Hospital, Mus, Turkey
[2]Department of Urology, University of Health Sciences, Regional Training and Research Hospital, Erzurum, Turkey
[3]Department of Urology, University of Health Sciences, Dr. Said Konuk Training and Research Hospital, Istanbul, Turkey
[4]Department of Urology, University of Health Sciences, Basaksehir Cam ve Sakura City Hospital, Istanbul, Turkey
[5]Department of Urology, Memorial Bahcelievler Hospital, Istanbul, Turkey

Cite as: Seker KG, Sam E, Arikan Y, Haciislamoglu A, Simsek A, Tugcu V. Our minimally invasive sacrocolpopexy experiences in pelvic organ prolapse treatment. Grand J Urol 2021;1(3):83-8.

Submission date: 17 April 2021 **Acceptance date:** 26 May 2021 **Online First:** 07 June 2021 **Publication date:** 20 September 2021

Corresponding Author: Yusuf Arikan / University of Health Sciences, Dr. Said Konuk Training and Research Hospital, Department of Urology, Istanbul, Turkey / dryusufarikan@gmail.com ORCID ID: 0000-0003-0823-7400

Abstract

Objective: We aimed to evaluate the results of our minimally invasive (laparoscopic and robotic) sacrocolpopexy operations in patients with pelvic organ prolapse (POP).
Materials and Methods: Demographic characteristics, intraoperative and postoperative data of 15 patients for whom we applied laparoscopic or robotic sacrocolpopexy due to symptomatic Grade 2 or higher apical POP based on POP-Q classification between September 2014 and September 2018. Treatment success was defined as Grade 0 or 1 POP in POP examination in the final surveillance.
Results: Mean age of the patients was 60.4 ± 8.3 (49-82) years. Four patients (26.7%) were operated using robotic and eleven patients (73.3%) using laparoscopic methods. Uterus conservative surgery was applied in all patients excluding one. Mean operative time was 183.3 ± 21.4 (145-220) minutes and mean hospital stay of the patients was 2.8 ± 0.7 (2-4) days. Intraoperative and postoperative complications developed in a total of two patients (13.3%). Mean duration of follow-up was calculated as 12.1 ± 4.8 (8-24) months. De novo urgency urinary incontinence developed in two patients and stress incontinence in one patient. Based on the physical examination in the follow-ups, 14 patients (93.3%) had Grade 0 and one patient had (6.7%) asymptomatic Grade 2 anterior POP.
Conclusion: Minimally invasive sacrocolpopexy is an efficient and safe surgical option for prolapse repair in symptomatic advanced stage POP cases.

Keywords: pelvic organ prolapse, minimally invasive surgery, sacrocolpopexy, laparoscopy, robotic surgery

Öz

Amaç: Pelvik organ prolapsusu (POP) olan hastalarda minimal invaziv (laparoskopik ve robotik) sakrokolpopeksi operasyon sonuçlarımızı değerlendirmeyi amaçladık.
Gereçler ve Yöntemler: Eylül 2014- Eylül 2018 tarihleri arasında POP-Q sınıflamasına göre semptomatik evre 2 veya daha büyük, apikal POP nedeniyle laparoskopik veya robotik sakrokolpopeksi operasyonu uyguladığımız 15 hastanın demografik özellikleri, intraoperatif ve postoperatif verileri analiz edildi. Tedavi başarısı, nihai izlemde POP muayenesinde grade 0 veya 1 POP olarak tanımlandı.
Bulgular: Hastaların ortalama yaşları 60,4 ± 8,3 (49-82) idi. 4 hasta (%26,7) robotik, 11 hasta (%73,3) ise laparoskopik yöntemle opere edildi. Bir hasta hariç tüm hastalara uterus koruyucu cerrahi yapıldı. Ortalama operasyon süresi 183,3 ± 21,4 (145-220) dakika ve hastaların ortalama hastanede kalış süresi 2,8 ± 0,7 (2-4) gün idi. Toplamda 2 hastada (%13,3) intraoperatif ve postoperatif komplikasyon gelişti. Ortalama takip süresi 12,1 ± 4,8 (8-24) ay olarak hesaplandı. İki hastada de-novo urgency inkontinans, bir hastada ise stres inkontinans gelişti. Takiplerde fizik muayenede 14 hastada (%93,3) grade 0, bir hastada (%6,7) non-semptomatik grade 2 anterior POP mevcuttu.
Sonuç: Minimal invaziv sakrokolpopeksi semptomatik ileri evre POP olgularında prolapsus onarımı için etkin ve güvenli bir cerrahi seçenektir.

Anahtar kelimeler: pelvik organ prolapsusu, minimal invaziv cerrahi, sakrokolpopeksi, laparoskopi, robotik cerrahi

ORCID ID: **K.G. Seker** 0000-0003-4449-9037 **A. Haciislamoglu** 0000-0002-6117-2098 **V. Tugcu** 0000-0002-4136-7584
E. Sam 0000-0001-7706-465X **A. Simsek** 0000-0001-8003-4654

Introduction

Pelvic organ prolapse (POP) affects nearly half of the female population [1]. Approximately 12.6% of women have a lifelong POP operation risk and this rate is considered to increase over years with aging, while importance was attached to quality life and the increasing awareness for pelvic base diseases [2]. Corrective restorative operations can be applied vaginally or abdominally in POP surgery. Higher rates of strength, and endurance of anatomic strcuctures are achieved using abdominal approach [3-5]. Thus abdominal sacrocolpopexy is regarded as the golden standard treatment method in the treatment of apical prolapse [6,7]. On the other hand, abdominal sacrocolpopexy is also associated with relatively longer operative times, delayed return to daily activities, higher morbidity, longer hospital stay and increased hospital costs compared to the vaginal approach [4].

Laparoscopic sacrocolpopexy was first defined by Nezhat et al in 1994 to overcome the present disadvantages of abdominal sacrocolpopexy [8]. With the developments in robotic surgery, robotic sacrocolpopexy was first applied by Di Marco et al in 2004 [9]. The studies showed that minimally invasive sacrocolpopexy had an equivalent efficiency compared to abdominal sacrocolpopexy [10-12]. Additionally, speeding up patient recovery and minimizing surgical morbidity have caused extensive use of minimally invasive sacrocolpopexy in recent years [13,14]. The objective of this study was to review our minimally invasive sacrocolpopexy experiences and present our results.

Materials and Methods

Fifteen patients who underwent minimally invasive sacrocolpopexy (laparoscopic sacrocolpopexy in 11 and robotic sacrocolpopexy in 4 patients) with symptomatic ≥ Grade 2 apical POP diagnosis based on POP-Q classification were retrospectively analyzed after obtaining local ethics committee approval (Dr. Sadi Konuk Training and Research Hospital Ethical Committee approval number: 2020/530) and also informed consent from all the patients for research.

Demographic data of all study patients such as age, parity, menopausal status, body mass index (BMI), previous pelvic operations (hysterectomy, pelvic base repair, etc.), comorbidities and ASA score were retrieved from medical records. Same preoperative protocol covering urogynecological history, physical examination, urinalysis, urination diary, stress test, measurement of postvoid residual urine volume was applied in all patients. Degree of prolapsus was evaluated using POP-Q quantification system in all patients [15]. Preoperative gynecological evaluation was performed in all patients who had conservative uterine-sparing surgery.

Perioperative period, estimated blood loss and duration of hospitalization were recorded. Low-molecular weight heparin and antithrombotic prophylaxis were given to risky patients. Antibiotic prophylaxis was applied in all patients. The difference between estimated blood loss and postoperative hemoglobin levels was calculated. Intraoperative and postoperative complications were recorded. The results were evaluated within postoperative 12 months. Surgical success was defined as POP-Q Grade 0 or 1 in the final follow-up examination.

Surgical Technique

Robotic Sacrocolpopexy: The patients were laid in dorsal lithotomy and 30° Trendelenburg position under general anesthesia. A 16 F Foley catheter was inserted. Pneumoperitoneum was created through umbilicus using a Veress needle and four robotic ports and one 12 mm assistant port were inserted through the same plane. Docking was performed using robotic system Da-Vinci-Xi (Intuitive Surgical Inc., Sunnyvale, CA, USA). Interchangeable 0° or 30° robotic optics were used. Vaginal retractor was used to push forward vaginal wall. Peritoneum was incised and dissected to reach first vesicouterine and then rectouterine space. Peritoneal incision was performed on sacral promontorium in aortal bifurcation and sacral dissection was performed up to the anterior longitudinal ligament and incision line was combined with vaginal stump posterior incision. Y shaped mesh prepared in advance was located in the abdomen. Starting from the most distal part, it was fastened using 2/0 vicryl in rectovaginal area starting from the most distal part towards proximal. The same procedure was performed also on the vesicovaginal dissection line. Peritoneal dissection was performed between the posterior region of uterus and vagina to form peritoneal tunneling at the lateral level of broad ligament of the uterus. Anterior and posterior meshes were sutured together at the anterior aspect of the uterus. T shaped mesh was used. One end of the mesh was stabilized on the promontorium using two no 0 prolene sutures after ensuring the suitable tension. The mesh covered with peritoneum, and was completely retroperitonized. One drain was inserted in the region.

Laparoscopic Sacrocolpopexy: 10 mm camera port was inserted through the umbilicus with the patient in robotic sacrocolpopexy position. 5 mm operation ports and one 5 mm suprapubic port were inserted in 4 cm lateral on both sides of this port. Surgical technique which was applied in robotic sacrocolpopexy was used. Laparoscopic tapper was used in some cases for mesh fixation.

Results

Mean age of the patients was 60.4 ± 8.3 years and mean BMI was 32.8 ± 2.5 kg/m2. Eight patients (53.3%) had previously undergone histerectomy. According to POP-Q, 10 patients (66.7%) had stage 2 and 5 patients (33.3%) had Grade 3 prolapse. None of the patients had a history of incontinence or urinary incontinence surgery. Occult stress urinary incontinence wasn't detected in any patient in the stress test performed through prolapse reduction. Demographic characteristics of the patients are summarized in **Table 1**.

Mean operative time was 183.3 ± 21.4 min (laparoscopic 190 min, and robotic 165 min). Mean estimated blood loss was 62 ± 30.6 mL. Mean hospital stay was 2.8 ± 0.7 days. Intraoperatively, serious intestinal injury occurred in a patient in laparoscopic sacrocolpopexy group which was repaired with laparoscopic suture and one patient had wound drainage and infection in postoperative early period which was treated using conservative methods. Mean follow-up period was 12.1 ± 4.8 months. Based on the POP-Q quantification in the physical examination during the follow-ups, 14 patients (93.3%)

Table 1. Preoperative and postoperative characteristics of the cases

	Age	Abdominal surgery history	POP-Q classification	Operative time (min)	Hospital stay (days)	Combined operation	Postoperative grade	Follow-up period (month)
1	57	Peptic ulcus perforation	Grade 2 cystocele	190	3	none	Grade 0	24
2	82	TAH	Grade 3 cystocele	205	4	Rectocele repair	Grade 0	21
3	57	None	Grade 2 cystocele	175	2	Hysterectomy	Grade 0	16
4	69	TAH, cholecystectomy	Grade 2 cystocele	210	4	None	Grade 0	14
5	68	TAH, cholecystectomy	Grade 2 cystocele	180	3	None	Grade 0	12
6	52	None	Grade 2 cystocele	170	3	None	Grade 0	11
7	59	TAH/BSO	Grade 3 cystocele	200	3	Rectocele repair	Grade 0	11
8	61	None	Grade 3 cystocele	185	2	Rectocele repair	Grade 2	10
9	62	TAH	Grade 2 cystocele	195	2	None	Grade 0	10
10	59	None	Grade 2 cystocele	220	3	none	Grade 0	10
11	61	TAH	Grade 3 cystocele	160	3	None	Grade 0	9
12	63	TAH	Grade 3 cystocele	150	3	None	Grade 0	9
13	57	TAH	Grade 3 cystocele	185	3	Rectocele repair	Grade 0	9
14	50	None	Grade 3 cystocele	180	2	None	Grade 0	8
15	49	None	Grade 2 cystocele	145	2	None	Grade 0	8

POP-Q: pelvic organ prolapse-quantification system; TAH: total abdominohysterectomy; BSO: bilateral salpingo-oophorectomy

had grade 0 and one patient had (6.7%) asymptomatic grade 2 POP. Postoperative de novo urgency urinary incontinence was detected in two patients in laparoscopic sacrocolpopexy group (13.3%) and stress urinary incontinence was detected in one patient in robotic sacrocolpopexy group (6.7%). Stress urinary incontinence was treated with midurethral sling surgery while urgency urinary incontinence was treated with lifestyle changes and pharmacotherapy. Intraoperative and postoperative data are summarized in **Table 2**.

Discussion

Abdominal and minimally invasive sacrocolpopexy were compared for many aspects in literature. Considering all data, it was observed that minimally invasive sacrocolpopexy had similar short term efficiency with abdominal sacrocolpopexy and with additional advantages of shorter hospital stays, and recovery period, llower postoperative pain, bleeding and transfusion rate [16-19]. Therefore minimally invasive sacrocolpopexy stand out and be preferred more often today due to all these favourable characteristics. We also prefer minimally invasive sacrocolpopexy in our clinic and minimally invasive sacrocolpopexy success rate was also high in our series in line with literature (93.3%).

Apart from the advantages provided by minimally invasive surgery, laparoscopic sacrocolpopexy provides better visualization of the surgical field, more effective access to operation area and more accurate dissection. On the other hand, laparoscopic sacrocolpopexy has a vertical learning curve and longer operative times in addition to the classical disadvantages of laparoscopy such as limited degree of freedom and two-dimensional imaging [20]. Laparoscopic surgery is also related to more static head and neck posture, requirement for higher concentration and more mental stress for the surgeons compared to open surgery [21,22]. In the study by Tarr et al., comparing the ergonomic effects of laparoscopic sacrocolpopexy and robotic sacrocolpopexy, robotic sacrocolpopexy was reported to be related to lower neck, shoulder and back discomfort score [23]. Robotic surgery that overcomes the disadvantages of laparoscopy provides three-dimensional image through increased magnification, eliminates tremor of surgeon's hands, enables delicate and intuitional movements and provides more ergonomic surgery by improving manual skills thanks to wristed instruments [24].

Despite all these advantages, robotic surgery significantly limits buying, maintenance and repeated consumable price use. It especially results in low case volume and increased costs

Table 2. Intraoperative and postoperative data

	Laparoscopic sacrocolpopexy (n=11)	Robotic sacrocolpopexy (n:4)	Total (n:15)
Operative Time (min)	190 ± 18.2	165 ± 20.4	183.3 ± 21.4
Estimated Blood loss (ml)	70 ± 31.6	40 ± 12.9	62 ± 30.6
Perioperative Complication	1*	0	6.7%
Hospital stay (days)	2.9 ± 0.7	2.5 ± 0.6	
Follow-up period (months)	13.5 ± 4.9	8.5 ± 0.6	12.1 ± 4.8
Early complication	1**	0	6.7%
Late complication	2***	1****	20%
Postoperative POP-Q grade	10 (Grade 0) 1 (Grade 2)	4 (Grade 0)	14 (Grade 0) 1 (Grade 2)
Failure Rate	9.1%	0	6.7%

*Intestine serious injury; ** Wound drainage and infection; *** De novo urgency incontinence; **** Stress urinary incontinence

per case [24]. Two prospective randomized studies comparing laparoscopic and robotic sacrocolpopexy determined that robotic sacrocolpopexy was related to significantly higher costs [13,14]. While Anger et al., [13] reported purchase and maintenance cost of the robot as the cause of the higher cost of the procedure, Paraiso et al. [14] reported that robotic sacrocolpopexy was related to higher cost even if the purchase and maintenance cost of the robot is excluded. Cost of the robot is again an important limitation in our country and oncological surgeries are applied more frequently using the robotic approach. Thus, robotic sacrocolpopexy hasn't become popular in our country.

Prospective studies comparing laparoscopic sacrocolpopexy and robotic sacrocolpopexy have show that the success rates are comparable [13,14,25]. In the meta-analysis of the results of robotic sacrocolpopexy, Hudson et al. reported that this procedure has a success rate of 98.6% (defined as apical prolapse Grade ≤ 1) [26]. In our series high success rates were also achieved in both groups (robotic approach, 100%, and laparoscopic approach, 90.9% through). While Paraiso et al. [14] reported that robotic sacrocolpopexy was related to statistically significantly longer operative times (199 vs 265 min, p< .001), any statistically significant difference was not detected between two groups in terms of operative times [13,25]. Interestingly, in our series operative time was longer in the laparoscopic group (190 ± 18.2 versus 165 ± 20.4 min) compared to the robotic group which can be explained by high robotic surgery volume of our clinic. Oncology surgeries are extensively performed in our clinic and most of them (especially radical prostatectomy) are robotic surgeries. On the other hand, our sacrocolpopexy experience is limited and as anticipated, thanks to our accumulated experience, we perform faster surgeries using the robotic approach. In addition, while Seror et al., [25] reported robotic sacrocolpopexy to be related to statistically significantly lower amounts of bleeding (55 vs 280 mL, p= .03), Anger et al. [13] didn't detect any significant difference among the two groups. In our series, the average blood loss was found comparable between both groups.

Although sacrocolpopexy is the most effective procedure in apical POP treatment, the complications related to this operation constitute a significant problem. Although defecating disorders and stress urinary incontinence are the most common complications, presacral hemorrhage is the most life-threatening intraoperative complication. Also, dissection should be performed carefully to avoid the injury of sigmoid, presacral veins and right urethra during the leftward retraction of sigmoid and operating on sacral area [27]. Prospective studies comparing robotic sacrocolpopexy with laparoscopic sacrocolpopexy reported similar complication rates for both groups [13,14,25]. A retrospective study by Nosti et al., showed that the general complication rates in laparoscopic sacrocolpopexy are higher than robotic sacrocolpopexy (4.0% vs 0.4%, p < .01) [28]. On the contrary, another study reported that the robotic sacrocolpopexy was related to a higher rate of bladder injury [29]. Any serious early-term complication was not detected in our series apart from intraoperative small bowel injury in one patient (9.1%) and postoperative port site infection (9.1%) in one patient.

The main limitations of this study were its retrospective nature, limited number of patients especially in robotic sacrocolpopexy group, and relatively shorter patient follow-up.

Conclusion

Minimally invasive sacrocolpopexy is an efficient and safe surgical option for prolapse repair in symptomatic advanced grade POP cases. Prospective randomized studies with larger patient series are required.

Ethics Committee Approval: The study was approved by University of Health Sciences, Dr. Sadi Konuk Training and Research Hospital Ethical Committee, Bakirkoy, Istanbul, Turkey (Approval Number: 2020/530).
Informed Consent: An informed consent was obtained from all the patients for research.
Publication: The results of the study were not published in full or in part in form of abstracts.
Peer-review: Externally peer-reviewed.
Authorship Contributions: There is not any contributions who may not be listed as authors. Concept – K.G.S., E.S., Y.A., Design

– K.G.S., E.S., Y.A., Supervision – A.S., V.T., Resources – E.S., Y.A., A.H., Materials – E.S., Y.A., A.H., Data Collection and/or Processing – E.S., Y.A., A.H., Analysis and/or Interpretation – K.G.S., E.S., Y.A., Literature Search – E.S., Y.A., A.H., Writing– K.G.S., E.S., Y.A., Critical Review – A.S., V.T.

Conflict of Interest: The authors declare that they have no conflict of interest.

Financial Disclosure: The authors declare that this study received no financial support.

References

[1] Lee W, Tam J, Kobashi K. Surgery for Apical Vaginal Prolapse After Hysterectomy: Abdominal Sacrocolpopexy. Urol Clin North Am 2019;46:113-21. https://doi.org/10.1016/j.ucl.2018.08.006.

[2] Wu JM, Matthews CA, Conover MM, Pate V, Funk MJ. Lifetime risk of stress urinary incontinence or pelvic organ prolapse surgery. Obstet Gynecol 2014;123:1201–6. https://doi.org/10.1097/AOG.0000000000000286.

[3] Maher CF, Feiner B, Decuyper EM, Nichlos CJ, Hickey KV, O'Rourke P. Laparoscopic sacral colpopexy versus total vaginal mesh for vaginal vault prolapse: A randomized trial. Am J Obstet Gynecol 2011;204:360.e1-360.e7. https://doi.org/10.1016/j.ajog.2010.11.016.

[4] Maher C, Feiner B, Baessler K, Schmid C. Surgical management of pelvic organ prolapse in women. Cochrane Database Syst Rev 2013:CD004014. https://doi.org/10.1002/14651858.CD004014.pub5.

[5] Rondini C, Braun H, Alvarez J, Urzúa MJ, Villegas R, Wenzel C, et al. High uterosacral vault suspension vs Sacrocolpopexy for treating apical defects: a randomized controlled trial with twelve months follow-up. Int Urogynecol J 2015;26:1131–8. https://doi.org/10.1007/s00192-015-2666-0.

[6] Nygaard IE, McCreery R, Brubaker L, Connolly AM, Cundiff G, Weber AM, et al. Abdominal sacrocolpopexy: A comprehensive review. Obstet Gynecol 2004;104:805–23. https://doi.org/10.1097/01.AOG.0000139514.90897.07.

[7] Serati M, Bogani G, Sorice P, Braga A, Torella M, Salvatore S, et al. Robot-assisted sacrocolpopexy for pelvic organ prolapse: A systematic review and meta-analysis of comparative studies. Eur Urol 2014;66:303-18. https://doi.org/10.1016/j.eururo.2014.02.053.

[8] Nezhat CH, Nezhat F, Nezhat C. Laparoscopic sacral colpopexy for vaginal vault prolapse. Obstet Gynecol 1994;84:885–8. https://pubmed.ncbi.nlm.nih.gov/7936532/.

[9] DiMarco DS, Chow GK, Gettman MT, Elliott DS. Robotic-assisted laparoscopic sacrocolpopexy for treatment of vaginal vault prolapse. Urology 2004;63:373-6. https://doi.org/10.1016/j.urology.2003.09.033.

[10] Oliver JL, Kim JH. Robotic Sacrocolpopexy—Is It the Treatment of Choice for Advanced Apical Pelvic Organ Prolapse? Curr Urol Rep 2017;18. https://doi.org/10.1007/s11934-017-0715-6.

[11] Wang LC, Al Hussein Al Awamlh B, Hu JC, Laudano MA, Davison WL, Schulster ML, et al. Trends in Mesh Use for Pelvic Organ Prolapse Repair From the Medicare Database. Urology 2015;86:885-91. https://doi.org/10.1016/j.urology.2015.08.022.

[12] Freeman RM, Pantazis K, Thomson A, Frappell J, Bombieri L, Moran P, et al. A randomised controlled trial of abdominal versus laparoscopic sacrocolpopexy for the treatment of post-hysterectomy vaginal vault prolapse: LAS study. Int Urogynecol J Pelvic Floor Dysfunct 2013;24:377–84. https://doi.org/10.1007/s00192-012-1885-x.

[13] Anger JT, Mueller ER, Tarnay C, Smith B, Stroupe K, Rosenman A, et al. Robotic compared with laparoscopic sacrocolpopexy: A randomized controlled trial. Obstet Gynecol 2014;123:5–12. https://doi.org/10.1097/AOG.0000000000000006.

[14] Paraiso MFR, Jelovsek JE, Frick A, Chen CCG, Barber MD. Laparoscopic compared with robotic sacrocolpopexy for vaginal prolapse: A randomized controlled trial. Obstet Gynecol 2011;118:1005-13. https://doi.org/10.1097/AOG.0b013e318231537c.

[15] Bump RC, Mattiasson A, Bo K, Brubaker LP, DeLancey JOL, Klarskov P, et al. The standardization of terminology of female pelvic organ prolapse and pelvic floor dysfunction. Am J Obstet Gynecol 1996;175:10-7. https://doi.org/10.1016/S0002-9378(96)70243-0.

[16] Paraiso MFR, Walters MD, Rackley RR, Melek S, Hugney C. Laparoscopic and abdominal sacral colpopexies: A comparative cohort study. Am J Obstet Gynecol 2005;192:1752-8. https://doi.org/10.1016/j.ajog.2004.11.051.

[17] De Gouveia De Sa M, Claydon LS, Whitlow B, Dolcet Artahona MA. Laparoscopic versus open sacrocolpopexy for treatment of prolapse of the apical segment of the vagina: a systematic review and meta-analysis. Int Urogynecol J 2016;27:3–17. https://doi.org/10.1007/s00192-015-2765-y.

[18] Geller EJ, Siddiqui NY, Wu JM, Visco AG. Short-term outcomes of robotic sacrocolpopexy compared with abdominal sacrocolpopexy. Obstet Gynecol 2008;112:1201–6. https://doi.org/10.1097/AOG.0b013e31818ce394.

[19] Klauschie JL, Suozzi BA, O'Brien MM, McBride AW. A comparison of laparoscopic and abdominal sacral colpopexy: Objective outcome and perioperative differences. Int Urogynecol J 2009;20:273–9. https://doi.org/10.1007/s00192-008-0768-7.

[20] Deprest J, Krofta L, Van Der Aa F, Milani AL, Den Boon J, Claerhout F, et al. The challenge of implementing laparoscopic sacrocolpopexy. Int Urogynecol J Pelvic Floor Dysfunct 2014;25:1153–60. https://doi.org/10.1007/s00192-014-2398-6.

[21] Nguyen NT, Ho HS, Smith WD, Philipps C, Lewis C, De

Vera RM, et al. An ergonomic evaluation of surgeons' axial skeletal and upper extremity movements during laparoscopic and open surgery. Am. J. Surg 2001;182:720-4. https://doi.org/10.1016/S0002-9610(01)00801-7.

[22] Berguer R, Smith WD, Chung YH. Performing laparoscopic surgery is significantly more stressful for the surgeon than open surgery. Surg Endosc 2001;15:1204–7. https://doi.org/10.1007/s004640080030.

[23] Tarr ME, Brancato SJ, Cunkelman JA, Polcari A, Nutter B, Kenton K. Comparison of Postural Ergonomics Between Laparoscopic and Robotic Sacrocolpopexy: A Pilot Study. J Minim Invasive Gynecol 2015;22:234–8. https://doi.org/10.1016/j.jmig.2014.10.004.

[24] Callewaert G, Bosteels J, Housmans S, Verguts J, Van Cleynenbreugel B, Van der Aa F, et al. Laparoscopic versus robotic-assisted sacrocolpopexy for pelvic organ prolapse: a systematic review. Gynecol Surg 2016;13:115–23. https://doi.org/10.1007/s10397-016-0930-z.

[25] Seror J, Yates DR, Seringe E, Vaessen C, Bitker MO, Chartier-Kastler E, et al. Prospective comparison of short-term functional outcomes obtained after pure laparoscopic and robot-assisted laparoscopic sacrocolpopexy. World J Urol 2012;30:393–8. https://doi.org/10.1007/s00345-011-0748-2.

[26] Hudson CO, Northington GM, Lyles RH, Karp DR. Outcomes of robotic sacrocolpopexy: A systematic review and meta-analysis. Female Pelvic Med Reconstr Surg 2014;20:252–60. https://doi.org/10.1097/SPV.0000000000000070.

[27] Kale A, Biler A, Terzi H, Usta T, Kale E. Laparoscopic pectopexy: Initial experience of single center with a new technique for apical prolapse surgery. Int Braz J Urol 2017;43:903–9. https://doi.org/10.1590/S1677-5538.IBJU.2017.0070.

[28] Nosti PA, Andy UU, Kane S, White DE, Harvie HS, Lowenstein L, et al. Outcomes of abdominal and minimally invasive sacrocolpopexy: A retrospective cohort study. Female Pelvic Med Reconstr Surg 2014;20:33–7. https://doi.org/10.1097/SPV.0000000000000036.

[29] Unger CA, Paraiso MFR, Jelovsek JE, Barber MD, Ridgeway B. Perioperative adverse events after minimally invasive abdominal sacrocolpopexy. Am J Obstet Gynecol. 2014;211:547.e1-8. https://doi.org/10.1016/j.ajog.2014.07.054.