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How does office assessment of prolapse compare to what is seen in the operating room?

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Abstract

Introduction and hypothesis It is not known whether the measurements of pelvic organ assessment under anesthesia accurately estimate prolapse severity. We compared Pelvic Organ Prolapse Quantification (POP-Q) measurements in the office to exams under anesthesia.

Methods We prospectively enrolled patients undergoing prolapse surgery between February 2020 and July 2020. POP-Qs at rest and with Valsalva were performed at pre- and postoperative visits. POP-Q under anesthesia was performed, without traction, at the start of case (pre-surgical), following apical suspension, and at the end of case (post-surgical). Primary outcome was change in POP-Q between the office and operating room. Due to the COVID-19 pandemic, additional patients were recruited to maintain the follow-up time frame.

Results Out of 66 patients, 63 underwent surgery and 33 had postoperative exams within 6 weeks. Mean age was 61.3 ± 11.9 years, and mean BMI was 28.4 ± 6.5 kg/m^2. Preoperative Aa, Ba, C, Ap, Bp, and D with Valsalva had greater descent than pre-surgical measurements. However, preoperative Gh with Valsalva (4.1 ± 1.3 cm) was not different from pre-surgical Gh (4.0 ± 1.0 cm) ($P = 0.60$). Postoperative Aa, Ba, Ap, Bp, and D were not different from post-surgical measurements. In contrast, postoperative Gh at rest (2.3 ± 0.7 cm) and with Valsalva (2.4 ± 0.8 cm) were both narrower than post-surgical Gh (2.8 ± 0.6 cm) ($P < 0.05$). Gh was also narrowed after apical suspension (3.6 ± 1.0 cm, $P = 0.005$) prior to posterior repair.

Conclusions Surgeons should rely on preoperative POP-Q for surgical decisions. Gh should be reassessed after apical suspension, and further correction should consider that Gh may be exaggerated compared to the measurement postoperatively when the patient is awake.

Keywords Exam under anesthesia · Intraoperative decision-making · Pelvic organ prolapse surgery · Preoperative decision-making · Genital hiatus

Introduction

Pelvic organ prolapse (POP) is a common condition with > 500,000 pelvic reconstructive surgeries performed annually in the US [1, 2]. POP is assessed using Pelvic Organ Prolapse Quantification (POP-Q) [3–5], which is the standard of care before treatment of POP to objectively evaluate the extent of prolapse [6]. POP-Q measurements guide surgeons in their preoperative counseling regarding surgical options and in their postoperative evaluation of surgical outcome. However, despite no standard practice to perform measurements of prolapse in the operating room, the ultimate decisions are often made in the operating room. Although not well studied, many pelvic reconstruction surgeons would agree that the exam in the operating room, with the patient under anesthesia, is different from that in the office [7]. What is not known is whether the exam under anesthesia under- or overestimates prolapse severity. The patient is unable to perform the Valsalva maneuver when anesthetized; therefore, one may suspect that the degree of descent would be underestimated. On the other hand, with the perineal and levator ani muscles paralyzed, it is plausible that the prolapse is more pronounced. Assessing POP-Q measurements at rest and with Valsalva maneuver in the office helps assess whether the Valsalva maneuver makes a significant difference to the assessment.

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There are several studies suggesting that intraoperative assessment and modifications affect the risk of prolapse recurrence—normalizing the genital hiatus and the addition of a posterior colporrhaphy have been shown to decrease the recurrence of prolapse [8–10]. Yet, it is not known how the pelvic floor repair and specifically the size of the genital hiatus at the conclusion of the surgery in the operating room compare to the exam in the office.

More information about the correlation between the exam under anesthesia to that of the awake patient could help guide the intraoperative decisions for pelvic reconstructive surgeons. The objective of this study was to compare POP-Q measurements, and specifically Gh, in the office with the patient at rest and while performing the Valsalva maneuver versus under anesthesia. We hypothesized that the office evaluation would differ from the intraoperative evaluation.

Materials and methods

This was a prospective cohort study where we enrolled patients undergoing prolapse surgery at a single institution between February 2020 and July 2020. Patients were enrolled at their preoperative appointment. This study was approved by the Institutional Review Board.

All office POP-Q measurements were recorded both at rest and with the Valsalva maneuver. The preoperative POP-Q measurements were collected from the patient's most recent POP-Q examination prior to surgery. The postoperative measurements were collected from the first follow-up visit within 6 weeks after surgery. Intraoperatively, POP-Q measurements under anesthesia were performed at the start of case (pre-surgical), following apical suspension, and at the end of case (post-surgical). Since patients under anesthesia were unable to perform the Valsalva maneuver, these were "modified" POP-Q measurements, without any traction on the vagina or cervix. The pre-surgical measurements were taken after induction of general anesthesia, and the post-surgical measurements were taken prior to the reversal of anesthesia. All POP-Q measurements were performed by either board-certified urogynecologists or urogynecology fellows using a wooden POP-Q "popsicle stick" with centimeter markings.

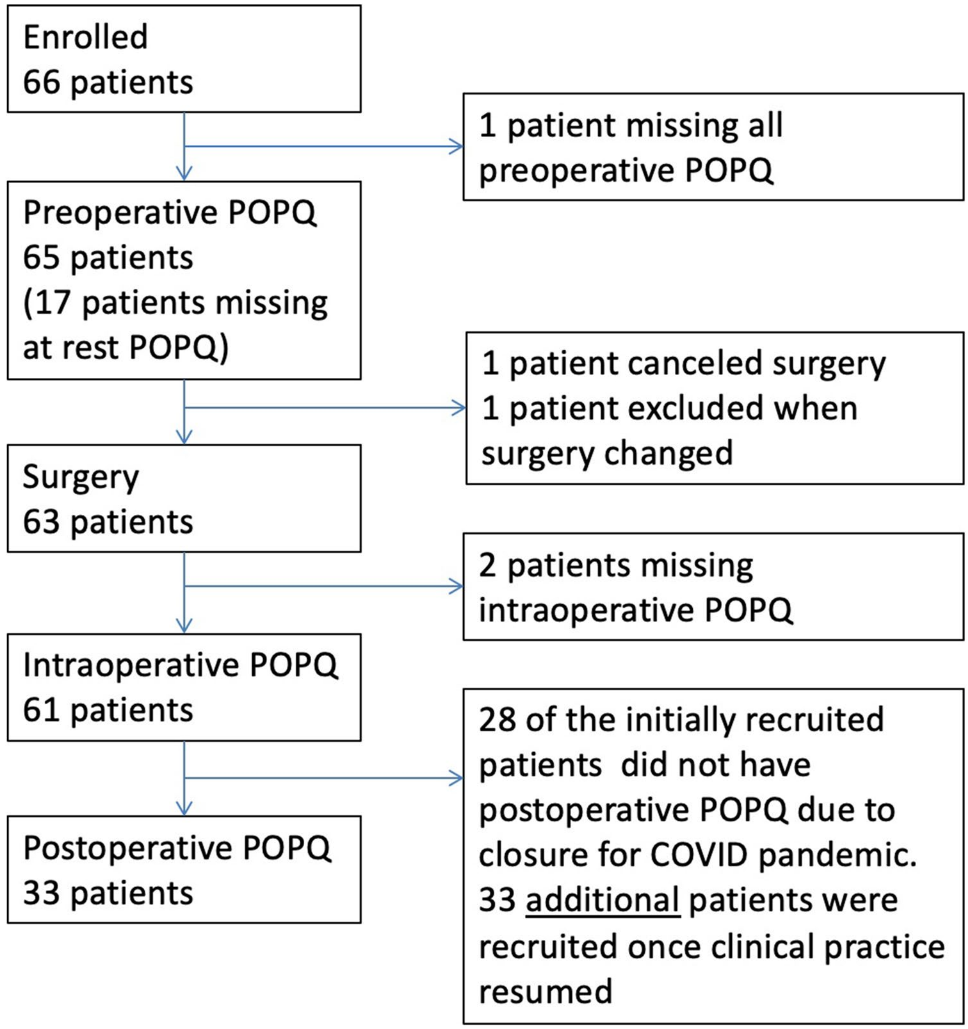
Primary outcome was change in POP-Q measurements between office and operating room evaluations. Demographic and clinical characteristics included age, race, body mass index, smoking status, parity, and sexual activity. Patients were eligible if they were female, 18 years or older, with planned procedure for apical prolapse repair and/or posterior compartment prolapse repair under general anesthesia. Patients were excluded if they were undergoing planned obliterative procedures, having a procedure in the anterior compartment only, or not undergoing general anesthesia with muscle paralysis. Patients who underwent anterior compartment prolapse repair were included if they also underwent apical and/or posterior compartment repair.

Based on prior literature, the normative value of the genital hiatus (Gh) is approximately 3.4 cm, and postoperative Gh after posterior colporrhaphy and/or perineorrhaphy is approximately 2.8 cm, with standard deviation of approximately 1 cm [11]. A sample size of 24 would afford 80% power to detect a mean of paired differences of 0.6, with an estimated standard deviation of differences of 1.0, using an alpha level of 0.05 with a paired *t*-test. To account for an attrition rate of 15%, we aimed to enroll 29 participants. Due to the COVID pandemic, a portion of initially enrolled patients was not able to present for in-person postoperative exams. Therefore, the decision was made to extend the study, and an additional 30 patients were enrolled to meet adequate sample size for paired comparison. Descriptive statistics were calculated with the use of standard methods for means, medians, and proportions. Continuous variables were analyzed using paired *t*-tests. Statistical analysis was performed with Stata software (version 12; StataCorp, College Station, TX). All analyses were considered statistically significant at $p < 0.05$.

Results

A total of 66 patients were enrolled at their preoperative visit, 63 patients underwent surgery, 65 patients had preoperative exams, 61 patients had intraoperative exams, and 33 patients had postoperative exams within 6 weeks (range 11–41 days). As mentioned in the above, based on the power calculation initially 33 patients were recruited for the study and underwent surgery; however, due to the beginning of the COVID-19 pandemic our clinics were closed and these patients were not seen for their 6-week postoperative visit. Given that the timing of the postoperative visit was critical for us to make meaningful comparisons, once our clinical practice resumed we made a decision to recruit 30 additional subjects. Therefore we had 65 subjects with preoperative evaluations available, but only 33 of them had a postoperative evaluations (Fig. 1). Mean age was 61.3 ± 11.9 years, and mean BMI was 28.4 ± 6.5 kg/m^2. About half of the patients were sexually active, and 20% had a prior hysterectomy (Table 1). The majority of patients (81%) had apical suspension procedures performed at the time of their prolapse repair. Apical suspension procedures included sacrospinous ligament suspension (21%), uterosacral ligament suspension (30%), minimally invasive sacrocolpopexy (24%), and open sacrocolpopexy (6%). Hysterectomy was performed in 56% of patients. Most patients also had a posterior colporrhaphy (89%), and 51% had an anterior

Fig. 1 Study recruitment



colporrhaphy. Concomitant anti-incontinence surgery was performed in 38% of patients.

Pre-surgical intraoperative POP-Q measurements were significantly different from preoperative POP-Q measurements with the Valsalva maneuver and similar to preoperative POP-Q measurements at rest (Table 2). Preoperative points Aa, Ba, C, Ap, Bp, and D with the Valsalva maneuver had significantly lower descent than pre-surgical intraoperative measurements. Gh was the only POP-Q measurement that had the opposite correlation. Preoperative Gh with the Valsalva maneuver was similar to the pre-surgical Gh under anesthesia, whereas preoperative Gh at rest was significantly narrower than Gh under anesthesia.

Intraoperatively, Gh narrowed from 4.1 ± 1.1 cm to 3.6 ± 1.0 cm ($P = 0.005$) following the apical suspension portion of the surgery. Gh then further narrowed to 2.8 ± 0.5 cm ($P < 0.001$) at the conclusion of surgery, in most cases following the posterior repair, with or without perineorrhaphy.

Post-surgical intraoperative POP-Q measurements, on the other hand, generally did not differ from postoperative POP-Q measurement in the office. Postoperative points Aa, Ba, Ap, Bp, and D were not significantly different from post-surgical intraoperative measurements (Table 3). In contrast, postoperative office measurements of Gh at rest and with the Valsalva maneuver, were both significantly narrower than post-surgical intraoperative Gh under anesthesia. Figure 2 illustrates the changes in Gh from the preoperative office exam to intraoperative measurements to the postoperative office exam. Figure 3 shows a similar timeline for the changes in point C.

Discussion

The findings of this study highlight that most POP-Q measurements with the Valsalva maneuver in the office are more representative of the degree of prolapse than what is seen under anesthesia in the operating room.

Surgeons may question whether office evaluation underestimates the degree of apical descent, points C and D, and

Table 1 Patient characteristics ($N = 64$)*

Age (mean, SD)	61.3 (11.9)
BMI (mean, SD)	28.4 (6.5)
Race	
White	50 (78.1)
Black	4 (6.2)
Other	10 (15.6)
Smoking	15 (23.4)
Diabetes	6 (9.4)
Sexually active	32 (50.8)
Defecatory dysfunction	33 (52.4)
Prior hysterectomy	13 (20.3)
Surgical repair	
Anterior colporrhaphy	32 (50.8)
Posterior colporrhaphy	56 (88.9)
Hysterectomy	35 (55.6)
Hysteropexy	6 (9.5)
Sacrospinous ligament suspension	13 (20.6)
Uterosacral ligament suspension	19 (30.2)
Laparoscopic/robotic sacrocolpopexy	15 (23.8)
Abdominal sacrocolpopexy	4 (6.3)
Anti-incontinence surgery	24 (38.1)

**n* (%) unless otherwise specified

may even counsel the patient that the final decision may be made based on the intraoperative findings. In a survey of gynecologists, 75% of surgeons indicated that they consider the cervical location on the intraoperative exam with traction when deciding whether or not to perform a hysterectomy [7]. Our study showed that preoperative office assessment with the patient performing the Valsalva maneuver is reliable when making the decisions regarding surgical approaches in planning pelvic reconstructive surgery. In fact, exams in the office more accurately represented maximal descent than exam under anesthesia.

It is important to note that in our study the evaluation in the operating room was done without traction on the apex. This may explain why our findings differ from previous literature. Krissi et al. compares preoperative office POP-Q with Valsalva to the intraoperative POP-Q assessment with "gentle traction" on the cervix or vaginal apex [12]. In contrast to our findings, the authors demonstrated greater descent in the operating room, concluding that the surgical plan may be altered according to the intraoperative findings [12]. Swenson et al. also compared the effect of traction on the exam of women without prolapse to those with prolapse, both with and without apical descent [13]. They found that all women with prolapse but with normal apical support in the office, and half of women with no prolapse, had cervix located at or below the hymen when examined with traction [13]. It is not surprising that traction on the apex exaggerates the apical descent, as vaginal hysterectomy for women without prolapse is feasible by applying traction on the cervix. Office procedures such as endometrial biopsy and IUD placement also rely on traction to bring the cervix into view. However, applying traction on the cervix may not represent "real-life" prolapse. Hence, Swenson et al. in the above-mentioned study suggested identifying a "normal range" of cervical/apical descent as opposed to using an absolute location when deciding whether or not to perform an apical supporting procedure. Without traction, we found that the exam under anesthesia approximates the office exam at rest, both demonstrating lesser prolapse than observed during the office examination with Valsalva. Thus, surgical decision should be based on the office preoperative evaluation with the Valsalva maneuver and there is no utility of evaluating prolapse at rest.

Table 2 Changes in POP-Q measurements between preoperative office and pre-surgical intraoperative evaluation*

	POP-Q measurements ($N = 43$)				POP-Q measurements ($N = 60$)			
	Preoperative office at rest	Intraoperative pre-surgical†	Difference	*P* value	Preoperative office with Valsalva	Intraoperative pre-surgical†	Difference	*P* value
Aa	-0.5 (1.8)	-0.7 (1.3)	-0.1 (1.4)	0.54	1.2 (2.0)	-0.5 (1.4)	-1.6 (1.5)	**< 0.001**
Ba	-0.4 (2.0)	-0.5 (1.7)	-0.1 (1.7)	0.69	1.6 (2.7)	-0.2 (2.2)	-1.9 (1.9)	**< 0.001**
C	-3.3 (3.6)	-3.3 (3.3)	0 (3.0)	1.00	-1.1 (4.4)	-3.0 (3.5)	-2.0 (3.6)	**< 0.001**
Gh	3.1 (0.9)	3.9 (1.0)	0.8 (1.0)	**< 0.001**	4.1 (1.3)	4.0 (1.0)	-0.1 (1.1)	0.60
Ap	-1.4 (1.5)	-1.5 (1.1)	-0.1 (1.6)	0.66	-0.6 (1.7)	-1.5 (1.2)	-0.9 (1.5)	**< 0.001**
Bp	-1.2 (1.9)	-1.3 (1.7)	-0.2 (1.9)	0.61	-0.2 (2.6)	-1.1 (2.3)	-0.9 (2.1)	**0.001**
D	-5.8 (4.4)	-5.4 (3.8)	0.3 (4.1)	0.64	-3.6 (4.6)	-5.0 (4.6)	-1.4 (4.8)	**0.04**

Significant findings in bold

*Data shown as mean (SD)

†Intraoperative pre-surgical POP-Q measurements were all made under anesthesia. Numbers differ in the two columns because of fewer patients having preoperative POP-Q measured at rest than with the Valsalva maneuver such that only a subset of patients could be included in the comparison between preoperative at rest and intraoperative POP-Q measurements

Table 3 Changes in POP-Q measurements between post-surgical intraoperative and postoperative office*

POP-Q measurements (*N* = 32)					POP-Q measurements (*N* = 32)			
	Postoperative at rest	Intraoperative post-surgical	Difference	*P* value	Postoperative with Valsalva	Intraoperative post-surgical	Difference	*P* value
Aa	-2.7 (0.4)	-2.6 (0.5)	0.1 (0.6)	0.34	-2.6 (0.5)	-2.6 (0.5)	0.02 (0.7)	0.90
Ba	-2.7 (0.4)	-2.6 (0.5)	0.1 (0.6)	0.34	-2.6 (0.5)	-2.6 (0.5)	0.02 (0.7)	0.90
C	-8.6 (0.9)	-7.7 (1.5)	0.8 (1.3)	**0.002**	-8.1 (1.4)	-7.7 (1.5)	0.4 (1.3)	0.08
Gh	2.3 (0.7)	2.8 (0.6)	0.6 (0.8)	**0.001**	2.4 (0.8)	2.8 (0.6)	0.4 (0.8)	**0.01**
Ap	-2.9 (0.3)	-2.9 (0.4)	0.02 (0.5)	0.86	-2.8 (0.4)	-2.9 (0.4)	-0.05 (0.6)	0.64
Bp	-2.9 (0.3)	-2.9 (0.4)	0.02 (0.5)	0.86	-2.8 (0.4)	-2.9 (0.4)	-0.05 (0.6)	0.64
D	-9.1 (0.6)	-9.4 (1.5)	-0.2 (1.2)	0.65	-8.9 (1.3)	-9.4 (1.5)	-0.5 (1.1)	0.27

Significant findings in bold

*Data shown as mean (SD)

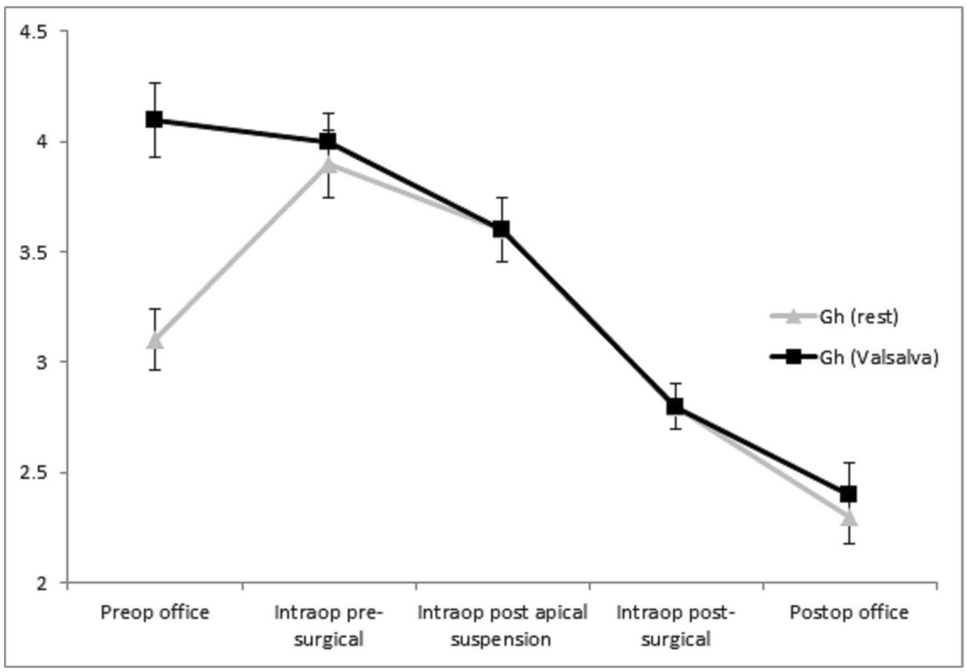


Fig. 2 Change in genital hiatus (Gh) from preoperative, intraoperative, to postoperative exam. Darker line denotes Gh measured with the Valsalva maneuver when patient is awake. Lighter line denotes Gh measured at rest when patient is awake.* Error bars show standard errors. *The intraoperative pre-surgical point differs between the Valsalva group (darker line) and the at rest group (lighter line) because of fewer patients having preoperative POP-Q measured at rest than with the Valsalva maneuver such that only a subset of patients could be included in the comparison between preoperative at rest and intraoperative POP-Q measurements

In contrast to the preoperative POP-Q points evaluating anterior, posterior, and apical compartments, the measurement for the Gh with the Valsalva maneuver was similar to that of the intraoperative Gh measurement. Intraoperative Gh measurement was greater than the Gh measured in the office at rest. Muscle paralytic agents that are administered as part of anesthesia affect skeletal muscle relaxation, including the muscles of the perineal body and the levator ani muscles, making the genital hiatus wider and more similar to the office exam with Valsalva. However, anesthesia appears to have minimal to no effect on the connective tissue that makes up the supporting structures such as uterosacral ligaments and fibromuscularis layer of the vagina. Therefore, it is not surprising that muscle relaxation under anesthesia results in a wider genital hiatus but no change in vaginal/uterine support.

We evaluated the change in the genital hiatus intraoperatively at the conclusion of the apical suspension and after a posterior colporrhaphy and/or perineorrhaphy. Consistent with the previous literature, we demonstrated a significant decrease in the genital hiatus after an apical suspension and further decrease after posterior compartment surgery [9, 14]. Wide genital hiatus is a surrogate indicator for the severity of levator muscle laxity or avulsion and the consequent apical descent, as supported by multiple studies that have found that genital hiatus size is associated with prolapse severity [15, 16]. Pelvic floor imaging studies have further confirmed this association between the genital hiatus and the levator ani muscle attenuation [17–19]. As a marker of prolapse severity, it is not surprising that the size of genital hiatus has also been associated with prolapse recurrence [9,

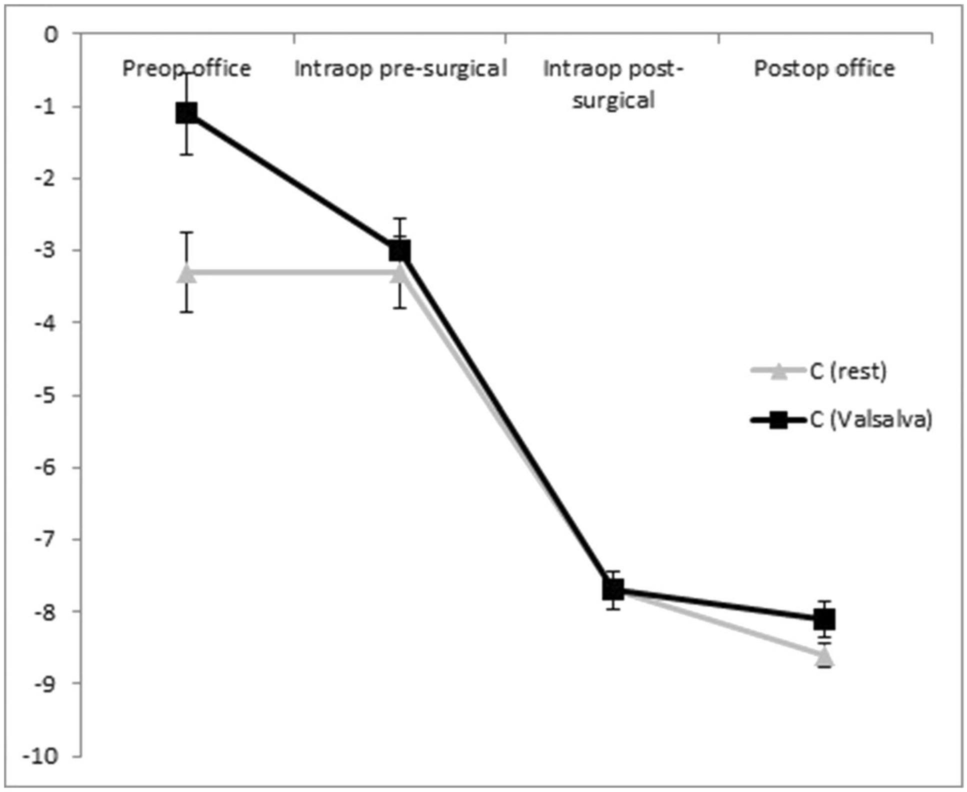


Fig. 3 Change in point C (cervix/vaginal cuff) from preoperative, intraoperative, to postoperative exam. Darker line denotes C measured with the Valsalva maneuver when patient is awake. Lighter line denotes C measured at rest when patient is awake.* Error bars show standard errors. *The intraoperative pre-surgical point differs between the Valsalva group (darker line) and the at rest group (lighter line) because of fewer patients having preoperative POP-Q measured at rest than with the Valsalva maneuver such that only a subset of patients could be included in the comparison between preoperative at rest and intraoperative POP-Q measurements

10, 14, 20]. When evaluating this association, most studies compared postoperative genital hiatus remote from surgery; the unique approach in our study has allowed us to assess immediate intraoperative change in the size of the genital hiatus before and after the addition of posterior repair. The genital hiatus decreased to an average of 3.6 cm after apical suspension alone. This is consistent with several other studies demonstrating that genital hiatus decreases after apical suspension alone, especially sacrocolpopexy [9, 11, 21, 22]. After a posterior compartment repair, the genital hiatus further decreased to 2.8 cm.

Most POP-Q parameters measured within 6 weeks postoperatively in the office were similar to what was seen in the operating room. Interestingly, the genital hiatus was found to be wider post-surgically under anesthesia than in the office. Our study highlights that the surgeons must be cognizant not to overcorrect the genital hiatus, as what they see in the operating room may be wider because of the effects of the anesthesia paralytic agents on the perineal muscles. Given the intraoperative narrowing of the genital hiatus and the fact that the measurement intraoperatively overestimates the actual genital hiatus postoperatively, the surgeon may consider re-evaluating the size of the genital hiatus after the apical suspension when deciding on the posterior compartment repair. This may be especially true for the patients who are sexually active, as overcorrection of posterior compartment can carry a significant risk of de novo dyspareunia, reported between 9–19% [23, 24]. In our study, 50% of women were not sexually active, yet we did not find a difference in the genital hiatus size when comparing sexually active and inactive women. We were not powered to detect this difference, and there may be other subtle factors that played into the surgeon's decision that were not captured. The discussion between the surgeon and the patient should guide the surgical planning, carefully weighing the risk of recurrence, defecatory symptoms, and patient's desire for sexual activity.

The strengths of our study include the prospective collection of outcome measurements and follow-up. We included both POP-Q measurements at rest and with the Valsalva maneuver to identify the relationship between intraoperative and pre- and postoperative prolapse severity. We did not use traction intraoperatively on the vagina or cervix because it is difficult to standardize and control for the degree of force exerted, and the routine practice of intraoperative assessment does not necessarily involve traction. For our primary outcome, we were able to meet our pre-determined sample size despite initial set-back due to practice changes during a global pandemic. By comparing the post-surgical measurements under anesthesia with postoperative measurements within 6 weeks, we were able to mostly isolate the effects of general anesthesia instead of surgical healing and tissue remodeling. It is however possible that the patients were not able to adequately perform the Valsalva maneuver to the same extent as preoperatively probably because of guarding secondary to pain or discomfort.

Our results are limited by the fact that types of surgery performed were not randomized so selection bias may play a part. However, because our primary interest was the effect of general anesthesia on prolapse severity measures and all patients underwent general anesthesia, the effects of mode of surgery likely played a limited role. In addition, we were able to enroll women who underwent a range of procedures, including vaginal, laparoscopic/robotic, and open prolapse repairs. We were also not powered for some of our secondary analyses, and further research with larger cohorts may be able to add to our findings. While all cases, regardless of the approach, were done with muscle paralysis and the anesthesiology team was asked not to reverse the paralysis until the end of the case, it is possible that there was a different amount of paralysis at the conclusion of the vaginal versus a laparoscopic surgery. Because this study was conducted at a single institution, our patient population may not be generalizable to other regions or countries.

In conclusion, pelvic reconstructive surgeons can rely on their preoperative POP-Q assessment when making surgical decisions. Office preoperative POP-Q measurements of apical, anterior, and posterior vaginal prolapse represent the prolapse more accurately than under anesthesia in the operating room. When it comes to the genital hiatus, measurement under anesthesia is similar to the office measurement with Valsalva. Therefore, the decision to narrow the genital hiatus can be made based on the initial intraoperative assessment. Surgeons however should reassess the genital hiatus after the apical suspension and be cognizant when narrowing the genital hiatus that, due to the muscle relaxation, the measurements under anesthesia may exaggerate the size of the genital hiatus as compared to what is seen when the patient is awake.

Author contributions Rui Wang: Study design, data collection, data analysis, manuscript writing

Elena Tunitsky-Bitton: Study design, data collection, study supervision, manuscript writing

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Declarations

Conflict of interest The authors report no conflict of interest.

References

1. US Food and Drug Administration. Urogynecologic Surgical Mesh: Update on the Safety and Effectiveness of Transvaginal Placement for Pelvic Organ Prolapse; 2011. https://www.fda.gov/media/81123/download.
2. Kirby AC, Luber KM, Menefee SA. An update on the current and future demand for care of pelvic floor disorders in the United States. Am J Obstet Gynecol. 2013;209(6):584.e1–5.
3. Bump RC, Mattiasson A, Bo K, et al. The standardization of terminology of female pelvic organ prolapse and pelvic floor dysfunction. Am J Obstet Gynecol. 1996;175(1):10–7. https://doi.org/10.1016/S0002-9378(96)70243-0.
4. Hall AF, Theofrastous JP, Cundiff GW, et al. Interobserver and intraobserver reliability of the proposed International Continence Society, Society of Gynecologic Surgeons, and American Urogynecologic Society pelvic organ prolapse classification system. Am J Obstet Gynecol. 1996;175. Mosby Inc:1467–71. https://doi.org/10.1016/S0002-9378(96)70091-1.
5. Kobak WH, Rosenberger K, Walters MD. Interobserver variation in the assessment of pelvic organ prolapse. Int Urogynecol J. 1996;7(3):121–4. https://doi.org/10.1007/BF01894199.
6. ACOG practice bulletin no. 85: Pelvic organ prolapse. Obstet Gynecol. 2007;110(3):717–29. https://doi.org/10.1097/01.AOG.0000263925.97887.72.
7. Coats E, Agur W, Smith P. When is concomitant vaginal hysterectomy performed during anterior colporrhaphy? A survey of current practice amongst gynaecologists. Int Urogynecol J. 2010;21:S158–9.
8. Siff LN, Barber MD, Zyczynski HM, et al. Immediate postoperative pelvic organ prolapse quantification measures and 2-year risk of prolapse recurrence. Obstet Gynecol. 2020;136(4):792–801. https://doi.org/10.1097/AOG.0000000000004043.
9. Vaughan MH, Siddiqui NY, Newcomb LK, et al. Surgical alteration of genital hiatus size and anatomic failure after vaginal vault suspension. Obstet Gynecol. 2018;131(6):1137–44. https://doi.org/10.1097/AOG.0000000000002593.
10. Chang OH, Davidson ERW, Thomas TN, Paraiso MFR, Ferrando CA. Predictors for pelvic organ prolapse recurrence after sacrocolpopexy: a matched case-control study. Female Pelvic Med Reconstr Surg. 2021;27(1):e165–70. https://doi.org/10.1097/SPV.0000000000000874.
11. Carter-Brooks CM, Lowder JL, Du AL, Lavelle ES, Giugale LE, Shepherd JP. Restoring genital hiatus to normative values after apical suspension alone versus with level 3 support procedures. Female Pelvic Med Reconstr Surg. 2019;25(3):226–30. https://doi.org/10.1097/SPV.0000000000000528.
12. Krissi H, Eitan R, Ram E, Peled Y. How accurate is preoperative evaluation of pelvic organ prolapse in women undergoing vaginal reconstruction surgery? PLoS One. 2012;7(10):2–4. https://doi.org/10.1371/journal.pone.0047027.
13. Swenson CW, Smith TM, Luo J, Kolenic GE, Ashton-Miller JA, DeLancey JO. Intraoperative cervix location and apical support stiffness in women with and without pelvic organ prolapse. Am J Obstet Gynecol. 2017;216(2):155.e1–8. https://doi.org/10.1016/j.ajog.2016.09.074.
14. Bradley MS, Askew AL, Vaughan MH, Kawasaki A, Visco AG. Robotic-assisted sacrocolpopexy: early postoperative outcomes after surgical reduction of enlarged genital hiatus. Am J Obstet Gynecol. 2018;218(5):514.e1–8. https://doi.org/10.1016/j.ajog.2018.01.046.
15. Dunivan GC, Lyons KE, Jeppson PC, et al. Pelvic organ prolapse stage and the relationship to genital hiatus and perineal body measurements. Female Pelvic Med Reconstr Surg. 2016;22(6):497–500. https://doi.org/10.1097/SPV.0000000000000323.
16. Lowder JL, Oliphant SS, Shepherd JP, Ghetti C, Sutkin G. Genital hiatus size is associated with and predictive of apical vaginal support loss. Am J Obstet Gynecol. 2016;214(6):718.e1–8. https://doi.org/10.1016/j.ajog.2015.12.027.
17. Delancey JOL, Hurd WW. Size of the urogenital hiatus in the levator ani muscles in normal women and women with pelvic organ

prolapse. Obstet Gynecol. 1998;91(3):364–8. https://doi.org/10.1016/S0029-7844(97)00682-0.

18. Rostaminia G, White DE, Quiroz LH, Shobeiri SA. Levator plate descent correlates with levator ani muscle deficiency. Neurourol Urodyn. 2015;34(1). https://doi.org/10.1002/nau.22509.
19. Volloyhaug I, Wong V, Shek KL, Dietz HP. Does levator avulsion cause distension of the genital hiatus and perineal body? Int Urogynecol J. 2013;24(7):1161–5. https://doi.org/10.1007/s00192-012-1993-7.
20. Medina CA, Candiotti K, Takacs P. Wide genital hiatus is a risk factor for recurrence following anterior vaginal repair. Int J Gynecol Obstet. 2008;101(2):184–7. https://doi.org/10.1016/j.ijgo.2007.11.008.
21. Geynisman-Tan J, Kenton KS, Brown O, et al. Mind the Gap: Changes in gap: changes in levator dimensions after sacrocolpopexy. Female Pelvic Med Reconstr Surg. 2021;27(1):e184–6. https://doi.org/10.1097/SPV.0000000000000881.
22. Guiahi M, Kenton K, Brubaker L. Sacrocolpopexy without concomitant posterior repair improves posterior compartment defects. https://doi.org/10.1007/s00192-008-0628-5.
23. Antosh DD, Gutman RE, Park AJ, et al. Vaginal dilators for prevention of dyspareunia after prolapse surgery: A Randomized Controlled Trial. Obstet Gynecol. 2013;121:1273–80. https://doi.org/10.1097/AOG.0b013e3182932ce2.
24. Antosh DD, Kim-Fine S, Meriwether KV, et al. Changes in sexual activity and function after pelvic organ prolapse surgery: a systematic review. Obstet Gynecol. 2020;136(5):922–31. https://doi.org/10.1097/AOG.0000000000004125.