Posterior Compartment Prolapse Occurrence After Anterior Vaginal Wall Suspension

Rena D. Malik, Alana L. Christie, and Philippe E. Zimmern

OBJECTIVE To determine the long-term rate of posterior compartment prolapse (PCP) occurrence after native tissue repair of the anterior compartment with anterior vaginal wall suspension (AVWS) procedure.

METHODS An institutional review board approved surgical prolapse database was reviewed for women who underwent AVWS for any degree of anterior compartment prolapse with minimum of 6-month follow-up and no history of apical or posterior compartment repair. Demographic data, smoking status, parity, and uterine status were collected. The primary outcome was need for secondary PCP repair.

RESULTS A total of 300 women met inclusion criteria with a mean age of 63.8 ± 10.8 years, mean BMI of 26.1 ± 6.2 kg/m^2, and a mean parity of 2.5 ± 1.4. At the time of AVWS 46 women (15%) had uterine-sparing AVWS, 74 (25%) had concomitant hysterectomy, and 180 (60%) had prior hysterectomy. Forty-eight women (16%) had secondary posterior compartment repair for PCP (60% abdominal route, 40% done vaginally) over a mean follow-up of 7.1 ± 4.4 years.

CONCLUSION At long-term follow-up, less than 20% of women undergoing AVWS underwent PCP repair. UROLOGY 133: 84–90, 2019. © 2019 Elsevier Inc.

Pelvic organ prolapse (POP) is a common occurrence in women, with a lifetime risk of 11.1% requiring surgical intervention for treatment, of which up to 30% may require reoperation for recurrent prolapse.[1] The International Urogynecological Association and the International Continence Society recommend regular evaluation for POP recurrence at the primary site as well as secondary sites.[2] Prolapse in alternate compartments after repair of the primary defect has been theorized to be due to alteration in vaginal pressure distortion. The newly supported compartment can tolerate higher transmission of pressure forces whereas an unsupported weaker compartment may start to gradually decompensate.[3,4] Additionally, intrinsic patient factors such as connective tissue quality, genital hiatus size, or pelvic floor muscular dysfunction are often involved in patients with history of previous prolapse, and could predispose to secondary prolapse in alternate compartments.[5]

There is limited data on the occurrence of posterior compartment prolapse (PCP) after native tissue repair of the anterior compartment, particularly with long-term follow-up. This is of particular interest following the United States Food and Drug Administration public health notification regarding complications associated with transvaginal mesh for POP and recent removal of these products from the market. Subsequently, there is heightened interest in native tissue surgical repair for POP and urinary incontinence (UI). The use of native tissue has proven to be successful for both UI & POP.[6] The Anterior Vaginal Wall Suspension (AVWS) procedure is 1 native tissue repair of the anterior compartment, which incorporates a transvaginal bladder neck suspension and broad-based anterior compartment support, with excellent functional outcomes noted at intermediate follow-up.[7,8] However, epidemiologic data indicates the time interval between primary POP repair and a second procedure can be up to 12 years, reinforcing the need for continued follow-up and data on patients undergoing prolapse repair.[1]

Uterine-preservation in conjunction with POP repair has been extensively reported with acceptable outcomes in comparison to concomitant hysterectomy in appropriately selected patient populations with short-term follow-up.[9-11] However, it remains largely unknown if uterine sparing impacts the rate of secondary PCP. We hypothesize that uterine sparing may provide a protective effect against high enterocele development of the posterior compartment due to its space occupying effect.

Conflicts of interest: *None.*
Financial Disclosure: *None.*

From the University of Maryland School of Medicine, Baltimore, MD; and the Department of Urology, UT Southwestern Medical Center, Dallas, TX

Address correspondence to: Rena Malik, M.D., University of Maryland School of Medicine, 29 S Greene St Suite 500, Baltimore, MD 21021. E-mails: Rmalik@SOM.Umaryland.edu; rmalik@som.umaryland.edu

Submitted: June 17, 2019, accepted (with revisions): August 6, 2019

https://doi.org/10.1016/j.urology.2019.08.010
0090-4295

The primary objective of this study was to report the natural history of secondary PCP requiring surgical repair in women undergoing native tissue repair for any stage symptomatic anterior vaginal wall prolapse with intermediate to long-term follow-up. Our secondary objective was to identify factors associated with delayed PCP requiring secondary surgical repair.

METHODS

An institutional review board-approved surgical prolapse database was reviewed to identify women with symptomatic anterior compartment prolapse (ACP) who underwent native tissue vaginal repair using an AVWS procedure with or without PCP from 1996 to 2016. Data from 2004 onwards was prospectively maintained whereas data prior to that was collected retrospectively. Patients were excluded if they underwent prior or concomitant posterior or apical compartment prolapse repair, had less than 6 months follow-up after undergoing AVWS, lacked a postoperative physical examination, or had neurologic conditions impacting the lower urinary tract. Data collected included patient demographics, smoking status, parity, uterine status, cystocele grade at the time of AVWS, office visit interval time, occurrence, and type of PCP (high enterocele vs rectocele) based on physical examination, time to secondary surgical repair of PCP, and type of posterior compartment repair.

All included patients underwent standardized history and physical examination with POP defined based on consensus-based terminology issued by International Continence Society/International Urogynecological Association.[2] Physical examination and a standing voiding cystourethrogram (VCUG) were utilized to assess cystocele stage. On examination, prolapse was evaluated using the Baden-walker (BW) grading until 1999 when the POP Quantification classification was adopted. Patients previously graded utilizing the BW system was subsequently converted to POP Quantification for standardization: grade 0 = Aa/Ba −3, grade 1 = Aa/Ba −2, grade 2 = Aa/Ba −1 or 0, grade 3 = Aa/Ba +1 or greater. Based on physical examination ACP was defined as small, stage 0-1 prolapse, or large, stage 2-4 prolapse. Standing VCUG was conducted using a standardized protocol with resting and straining lateral views to objectively evaluate urethral position and bladder support.[12] Patients with concomitant PCP with bothersome symptoms (ie vaginal bulge, splinting to defecate) at the time of initial examination were offered the option of surgical repair or conservative management depending on patient preference.

Indication for AVWS was the presence of bothersome symptoms related to anterior compartment laxity, resulting from lateral defects of the anterior vaginal wall, such as bothersome bulge, urethral hypermobility resulting in stress UI, or storage lower urinary tract symptoms related to prolapse in addition to a supine examination with Valsalva with a clinically significant anterior prolapse (defined as point Ba ≥ -1) and/or evidence of grade 2 or 3 cystocele on VCUG. Patients who desired uterine preservation were confirmed to have a negative pap smear and normal uterine size, with no pathology on pelvic ultrasound preoperatively, as well as the absence of apical prolapse on physical examination. At the time of AVWS, uterine descent under general anesthesia assessed with traction on the cervix was confirmed not to extend beyond the distal third of the vagina.

The AVWS procedure is a modification of the 4-corner suspension technique originally described by Raz et al.[13] Briefly, 2 parallel anterior vaginal wall incisions are made from the bladder neck down to the vaginal apex about 1 cm medial to each vaginal sulcus, and lateral vaginal flaps are developed. Next, 2 sets of nonabsorbable sutures are placed in a running helical fashion beneath the anterior vaginal wall from the vaginal apex to the bladder neck to provide a broad base of support and prevent suture pull-through. In patients undergoing uterine preservation, the proximal suspension sutures are secured in the cardinal ligament complex lateral to the cervix.[9] A small suprapubic incision is made to expose the tendinous portion of the rectus fascia behind the pubic bone. Transvaginally, the endopelvic fascia is perforated using blunt and sharp dissection, and the retropubic space is freed. Using a double-pronged ligature carrier advanced under fingertip guidance, the vaginally placed suspension sutures are transferred through the retropubic space from the vagina to the suprapubic region on both sides. Cystoscopy with a 70 degree lens is performed to confirm absence of bladder injury during suture transfer. The vaginal incisions are closed. The suspension sutures elevating the anterior vaginal plate are then tied loosely suprapubically to support the anterior vaginal plate with limited tension.[14]

Postoperatively patients were evaluated at 1, 6, and 12 months postoperatively and then annually to assess for bothersome POP and/or lower urinary tract symptoms as well as physical examination including pelvic examination. Examinations were performed by faculty, Female Pelvic Medicine and Reconstructive Surgery fellows, and/or Female Pelvic Medicine and Reconstructive Surgery trained physician assistants. Patients were considered for secondary PCP repair if they had new or persistent bothersome symptoms and a supine examination with a clinically significant or grade 2 enterocele or rectocele (defined as C$\geq$-1 or Bp ≥ -1). All patients were offered conservative management including pessary, physical therapy, and/or constipation management with a variety of regimens including dietary changes and medical management. Patients underwent enterocele repair either vaginally with a high midline levator myorrhaphy[15] and enterocele closure utilizing nonabsorbable suture with a Moschowitz purse string technique or abdominally with abdominal sacrocolpopexy (ASC). Rectocele repair was done via a midline vaginal incision with standard vaginal posterior colporrhaphy technique.[16]

The primary outcome was prolapse occurrence in the posterior compartment requiring surgical repair. We additionally assessed prolapse occurrence in the posterior compartment on examination, regardless of the decision to repair it or not. Factors associated with PCP occurrence were also analyzed.

Statistical analysis was performed to compare patients who underwent surgical intervention for PCP to those who did not. Similarly, patients with clinically significant PCP were compared to women without PCP. Descriptive statistics were reported for continuous and categorical variables using the mean ± SD and frequency and percentage, respectively. Fisher's exact test and Student's *t* test were utilized for comparison of categorical and continuous variables between groups, and the binomial test was used to determine if categorical measures were split differently than 50%. Kaplan-Meier analyses were used to estimate the time to PCP occurrence and surgical intervention. All analyses were performed at the 0.05 significance level using SAS 9.4 (SAS Institute Inc. Cary NC).

RESULTS

Between 1996 and 2016, 548 underwent AVWS for symptomatic ACP. Of those, 300 women met inclusion criteria. Nearly half underwent AVWS for large ACP, (stage 2-4) (41%), whereas the remainder (59%) had stress UI resulting from urethral hypermobility with concomitant small ACP. Patient characteristics are presented on Table 1. Mean age was 63.8 ± 10.8 years, with a mean follow-up of 5.2 ± 4.0 years. Patients had an average of 1.2 ± 0.8 visits per year during the follow-up period.

Of all included women, 16% ($n = 48$) had bothersome PCP for which they chose to proceed with surgical intervention. In comparing them to women who did not undergo surgery for PCP, their characteristics were similar except that those having surgery had significantly longer mean follow-up (7.1 ± 4.4 vs 4.9 ± 3.9 years, $P < .001$). ACP and PCP stage prior to AVWS was not significantly associated with proceeding with posterior compartment repair. Of patients who had uterine preservation at the time of AVWS, only 3 (6.3%) required surgical repair for PCP.

The majority of women undergoing secondary surgery ($n = 29$, 60%) underwent abdominal repair with robotic or open ASC and the remainder ($n = 18$) underwent vaginal repair with high midline levator myorrhaphy. Patients with isolated enterocele defects were more likely to have abdominal repair in comparison to vaginal repair (78% vs 22%; $P = .018$). Of patients who underwent PCP repair, 89.9% of patients were free from

Table 1. Patient characteristics by Post-AVWS surgery experience

	Total ($n = 300$)	No Post-AVWS Posterior Repair ($n = 252$)	Post-AVWS Posterior Repair ($n = 48$)	*P*
Age				
Mean ± SD	63.8 ± 10.8	63.7 ± 10.8	64.5 ± 11.1	.6333
Range	35-90	38-87	35-90	
≥65 y	151 (50.3)	127 (50.4)	24 (50.0)	.9598
Follow-up, y				
Mean ± SD	5.2 ± 4.0	4.9 ± 3.9	7.1 ± 4.4	.0006
Median (range)	4.2 (0.5-18.7)	3.9 (0.5-18.7)	5.8 (0.9-17.9)	.0036
Visits per y				
Mean ± SD	1.2 ± 0.8	1.2 ± 0.8	1.2 ± 0.7	.8989
Median (range)	1.0 (0.2-3.9)	1.0 (0.2-3.9)	0.9 (0.3-3.5)	.9710
Race				
Asian	6 (2.0)	3 (1.2)	3 (6.3)	.0935
Black	10 (3.3)	7 (2.8)	3 (6.3)	
Hispanic	12 (4.0)	10 (4.0)	2 (4.2)	
Other	6 (2.0)	6 (2.4)	0 (0.0)	
White	266 (88.7)	226 (89.7)	40 (83.3)	
BMI				
Mean ± SD	26.1 ± 6.2	26.2 ± 6.5	25.7 ± 4.0	.5168
Normal weight (<25)	135 (45.6)	110 (44.4)	25 (52.1)	.1692
Overweight (25-30)	93 (31.4)	76 (30.6)	17 (35.4)	
Obese (≥30)	68 (23.0)	62 (25.0)	6 (12.5)	
Smoking status				
Never smoker	249 (84.4)	209 (84.3)	40 (85.1)	.5712
Former smoker	39 (13.2)	34 (13.7)	5 (10.6)	
Current smoker	7 (2.4)	5 (2.0)	2 (4.3)	
Parity				
Mean ± SD	2.5 ± 1.4	2.4 ± 1.4	2.5 ± 1.2	.8446
0-2	171 (57.8)	144 (57.8)	27 (57.4)	.9610
≥3	125 (42.2)	105 (42.2)	20 (42.6)	
Systemic HRT				
No	185 (61.7)	159 (63.1)	26 (54.2)	.2436
Yes	115 (38.3)	93 (36.9)	22 (45.8)	
Anterior compartment prolapse*				
Stage 0-1 (Small)	177 (59.0)	154 (61.1)	23 (47.9)	.0885
Stage 2-4 (Large)	123 (41.0)	98 (38.9)	25 (52.1)	
Posterior compartment prolapse*				
Stage 0-1	252 (84.0)	216 (85.7)	36 (75.0)	.0635
Stage 2-4	48 (16.0)	36 (14.3)	12 (25.0)	
Uterine status				
Uterine sparing	46 (15.3)	43 (17.1)	3 (6.3)	.1626
Concomitant hysterectomy	74 (24.7)	61 (24.2)	13 (27.1)	
Prior hysterectomy	180 (60.0)	148 (58.7)	32 (66.7)	
Hysterectomy type				
Abdominal	143 (56.7)	114 (55.1)	29 (64.4)	.2501
Vaginal	109 (43.3)	93 (44.9)	16 (35.6)	

HRT, Hormone Replacement Therapy, SD, Standard deviation.
* At time of Anterior Vaginal Wall Suspension.

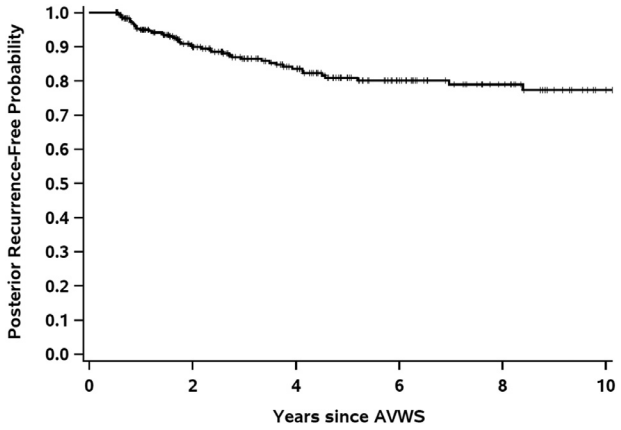

Figure 1. Time to posterior compartment repair after AVWS.

posterior compartment repair at 2 years (95% CI: 85.5, 93.1), and 80.9% were free from posterior compartment repair at 5 years (95% CI: 74.8, 85.7) (Fig. 1).

On physical examination prior to AVWS 144 out of 300 (48%) and 30 out of 300 (10%) were noted to have evidence of rectocele and enterocele, respectively. Of those patients, 30 out of 144 (21%) of rectocele patients and 10 out of 30 (33%) of enterocele patients proceeded to have surgical repair for PCP. Overall, only 40 out of 174 (23%) of patients with any PCP prior to AVWS proceeded with delayed surgical repair following AVWS.

Based on physical examination prior to posterior compartment repair, 5 out of 30 (17%), 12 out of 30 (40%), and 13 out of 30 (43%) had improved, unchanged, or worsening rectocele and 2 out of 10 (20%), 4 out of 10 (40%), and 4 out of 10 (40%), had improved, unchanged, or worsening enterocele. Change in physical examination (improved, stable, or worse examination) in patients with pre-existing PCP was not significantly associated with secondary surgical repair.

De-novo prolapse in the posterior compartment was seen in a total of 71 women after AVWS (24%), of which 41% proceeded with surgical repair. Specifically, de-novo enterocele, rectocele, or enterocele and rectocele were found in 9 (3%), 21 (7%), and 15 (5%) patients. In addition, 25 women (8%) with prior rectocele were found to have new enterocele and 1 woman (0.3%) with prior enterocele was found to have a new rectocele.

Patients who had a grade 2 rectocele or enterocele at physical examination on last follow-up or last follow-up prior to posterior compartment repair were compared to patients without a clinically significant PCP in Table 2. Patients with grade 2 rectocele or enterocele were noted to have significantly longer mean follow-up (6.0 ± 4.3 vs 4.9 ± 3.9 years, $P = .05$), more often had stage 2-4 ACP prior to AVWS (52% vs 37%, $P = .02$), more often had stage 2-4 PCP prior to AVWS (37% vs 8%, $P < .001$) and were less likely to have uterine sparing at the time of AVWS (5% vs 19%, $P = .006$). In comparison, those with uterine sparing were less likely to have posterior compartment surgical repair however this was not statistically significant. ($P = .27$) Figure 2 shows the time to PCP repair (Fig. 2A) and PCP occurrence (Fig. 2B) following AVWS and based on uterine status at time of AVWS.

DISCUSSION

In our review of AVWS native tissue repair for all grade symptomatic anterior prolapse, the primary outcome was to determine the rate of PCP requiring surgical intervention with intermediate to long-term follow-up. With a mean follow-up of 5.4 years, ranging from 6 months to nearly 19 years, the occurrence of PCP requiring surgical correction in our cohort was 16%.

There exists limited data on the rate of PCP following native tissue repair of the anterior compartment. A previous study found evidence of stage 2 or greater prolapse in the posterior compartment in 2 of 15 women (13%) however this is limited by a small sample size. [3] In a recent pragmatic randomized controlled trial of women undergoing transvaginal anterior or PCP repair, 2-year recurrence rates of prolapse range from 31%-82%, depending on outcome measure with only 5% pursuing operative repair.[17] In our cohort, the rate of postoperative clinically significant rectocele and/or enterocele was 27%, of which 59% proceed to have surgical intervention with intermediate to long-term follow-up. The large majority of patients in our cohort who underwent surgical repair of posterior compartment defects did so by 3.5 years while PCP continued to be seen on examination as far as 10 years out. This underscores the importance of long-term follow-up in these patients to assess for recurrence or de-novo prolapse in a different compartment.

In our practice, we have found good results with conservative management of PCP with subjective improvement in symptoms most often with dietary changes and bowel regimens consisting of laxatives and stool softeners. Additionally, we find that patients are hesitant to pursue surgical management of the posterior compartment due to concerns related postoperative pain and dyspareunia which have been reported to range from 2% to 46%.[18]

Uterine preservation may have an impact on the occurrence of PCP. The risk of prolapse after hysterectomy has been theorized to be due to connective-tissue damage and atrophy of the remnant uterosacral ligaments.[19] We additionally hypothesize that the space occupied by the newly supported uterus may also provide a protective effect against later enterocele development. Our study revealed that the presence of PCP after AVWS was associated with undergoing concomitant hysterectomy at the time of AVWS. We did not find this same association with secondary posterior compartment surgery however; this may be due to the low rates of posterior compartment surgery in our cohort as a whole. A recently published meta-analysis found PCP outcomes to be similar in 4 studies comparing a transvaginal approach to POP repair with and without uterine-sparing, however these were limited by short-term follow-up of 3 years or less.[10]

Of patients that underwent posterior compartment repair more than half had abdominal or robotic sacrocolpopexy. The rates of ASC have increased in recent years with ASC nearly doubling yearly from 2008 to 2011 in the medicare population.[20] This increase is likely due to numerous factors as patients may have a preference for abdominal versus vaginal approach based on sexual activity, comorbidities, previous surgical history or age. Furthermore, patients with a history of anterior repair are

Table 2. Patient characteristics by presence of Grade ≥2 rectocele or enterocele post-AVWS

	Total ($n = 300$)	No grade ≥2 rectocele or enterocele ($n = 219$)	Grade ≥2 rectocele or enterocele ($n = 81$)	P
Age				
Mean ± SD	63.8 ± 10.8	63.8 ± 10.9	63.6 ± 10.5	.8891
Range	35-90	38-90	35-85	
≥65 y	151 (50.3)	114 (52.1)	37 (45.7)	.3268
Follow-up, y				
Mean ± SD	5.2 ± 4.0	4.9 ± 3.9	6.0 ± 4.3	.0457
Median (range)	4.2 (0.5-18.7)	3.9 (0.5-18.7)	5.0 (0.5-17.9)	.0646
Visits per y				
Mean ± SD	1.2 ± 0.8	1.1 ± 0.8	1.2 ± 0.8	.5634
Median (range)	1.0 (0.2-3.9)	1.0 (0.2-3.9)	1.0 (0.3-3.5)	.7106
Race				
Asian	6 (2.0)	3 (1.4)	3 (3.7)	.7324
Black	10 (3.3)	7 (3.2)	3 (3.7)	
Hispanic	12 (4.0)	9 (4.1)	3 (3.7)	
Other	6 (2.0)	5 (2.3)	1 (1.2)	
White	266 (88.7)	195 (89.0)	71 (87.7)	
BMI				
Mean ± SD	26.1 ± 6.2	25.9 ± 6.4	26.4 ± 5.5	.5659
Normal weight (<25)	135 (45.6)	98 (45.4)	37 (46.3)	.9893
Overweight (25-30)	93 (31.4)	68 (31.5)	25 (31.3)	
Obese (≥30)	68 (23.0)	50 (23.1)	18 (22.5)	
Smoking status				
Never smoker	249 (84.4)	182 (84.7)	67 (83.8)	.9820
Former smoker	39 (13.2)	28 (13.0)	11 (13.8)	
Current smoker	7 (2.4)	5 (2.3)	2 (2.5)	
Parity				
Mean ± SD	2.5 ± 1.4	2.5 ± 1.5	2.5 ± 1.2	.9822
0-2	171 (57.8)	128 (59.3)	43 (53.8)	.3941
≥3	125 (42.2)	88 (40.7)	37 (46.3)	
Systemic HRT				
No	185 (61.7)	140 (63.9)	45 (55.6)	.1855
Yes	115 (38.3)	79 (36.1)	36 (44.4)	
Anterior compartment Prolapse*				
Stage 0-1	177 (59.0)	138 (63.0)	39 (48.1)	.0201
Stage 2-4	123 (41.0)	81 (37.0)	42 (51.9)	
Posterior compartment Prolapse*				
Stage 0-1	252 (84.0)	201 (91.8)	51 (63.0)	<.0001
Stage 2-4	48 (16.0)	18 (8.2)	30 (37.0)	
Uterine status				
Uterine sparing	46 (15.3)	42 (19.2)	4 (4.9)	.0006
Concomitant hysterectomy	74 (24.7)	44 (20.1)	30 (37.0)	
Prior hysterectomy	180 (60.0)	133 (60.7)	47 (58.0)	
Hysterectomy type				
Abdominal	143 (56.7)	101 (57.7)	42 (54.5)	.6400
Vaginal	109 (43.3)	74 (42.3)	35 (45.5)	

HRT, Hormone Replacement Therapy, SD, Standard deviation.
* At time of Anterior Vaginal Wall Suspension.

likely to have weakened fascial supports due to baseline abnormalities in connective tissue, and may be more likely to have a coexisting high enterocele and rectocele defect in the posterior compartment for which ASC may provide a more durable operation. Additionally, in our practice, we have found the use of MR defecography, which allows for a dynamic and functional evaluation of the pelvic floor in the context of valsalva,[21] to offer a superior staging modality to clinical physical examination particularly in patients undergoing secondary prolapse repair. It allows us examine for the presence of occult enterocele which subsequently may alter our surgical management of these patients favoring ASC.[22]

The results of our data should be interpreted in the context of its limitations. Our data represents a single institution experience which limits its generalizability. Due to the absence of validated prolapse and sexual dysfunction specific questionnaires at the start of data acquisition we did not include these in our study population. Similar to many tertiary referral centers, our patients often have

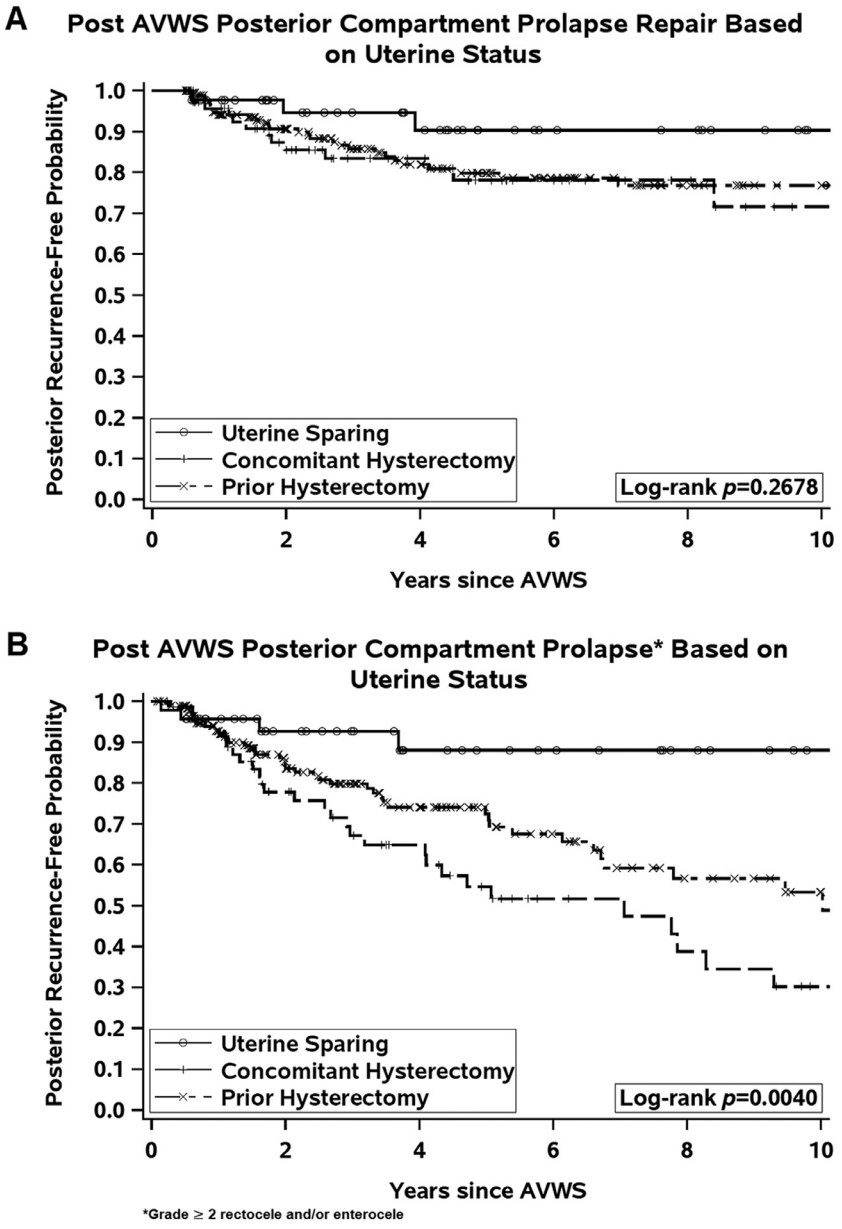

Figure 2. Post-AVWS time to (A) Posterior compartment prolapse (B) Posterior compartment repair based on uterine status.

variable interval times between visits due to travel constraints, age limitations, and/or insurance cover. However, our patients averaged 1.2 visits per year which is consistent with most other clinical practices. Uterine-sparing was determined by patient preference and surgeon determination of suitability, hence those who underwent uterine-sparing may have more favorable anatomy at baseline which may bias towards less likelihood of development of PCP.

CONCLUSION

Patients undergoing native tissue repair of the anterior compartment alone by AVWS have a less than 20% chance of needing a repeat intervention for PCP with long-term follow-up after an AVWS. The rate of PCP on physical examination may be greater; however, many patients do not choose to undergo surgical repair. This is useful for patient counseling prior to native tissue repair in the anterior compartment.

REFERENCES

1. Olsen AL, Smith VJ, Bergstrom JO, Colling JC, Clark AL. Epidemiology of surgically managed pelvic organ prolapse and urinary incontinence. *Obstet Gynecol.* 1997;89:501–506. https://doi.org/10.1016/S0029-7844(97)00058-6.
2. Haylen BT, Maher CF, Barber MD, et al. An International Urogynecological Association (IUGA)/International Continence Society (ICS) joint report on the terminology for female pelvic organ prolapse (POP). *Int Urogynecology J.* 2009;27:165–194. https://doi.org/10.1007/s00192-015-2932-1.

3. Withagen M, Milani A, de Leeuw J, Vierhout M. Development of de novo prolapse in untreated vaginal compartments after prolapse repair with and without mesh: a secondary analysis of a randomised controlled trial. *BJOG Int J Obstet Gynaecol*. 2012;119:354–360. https://doi.org/10.1111/j.1471-0528.2011.03231.x.
4. Clark AL, Gregory T, Smith VJ, Edwards R. Epidemiologic evaluation of reoperation for surgically treated pelvic organ prolapse and urinary incontinence. *Am J Obstet Gynecol*. 2003;189:1261–1267. https://doi.org/10.1067/S0002-9378(03)00829-9.
5. Denman MA, Gregory WT, Boyles SH, Smith V, Edwards SR, Clark AL. Reoperation 10 years after surgically managed pelvic organ prolapse and urinary incontinence. *Am J Obstet Gynecol*. 2008;198:555.e1–555.e5. https://doi.org/10.1016/j.ajog.2008.01.051.
6. Raz Shlomo, Siegel Andrew L, Short Julie L, Synder Jeffrey A. Vaginal wall sling. *J Urol*. 1989;141:43–46. https://doi.org/10.1016/S0022-5347(17)40581-7.
7. Lavelle RS, Christie AL, Alhalabi F, Zimmern PE. Risk of prolapse recurrence after native tissue anterior vaginal suspension procedure with intermediate to long-term followup. *J Urol*. 2016;195:1014–1020. https://doi.org/10.1016/j.juro.2015.10.138.
8. Lee D, Dillon BE, Bradshaw K, Zimmern PE. Total hysterectomy and anterior vaginal wall suspension for concurrent uterine and bladder prolapses: long-term anatomical results of additional vault and/or posterior compartment prolapse repair. *Urol Sci*. 2015;26:51–56. https://doi.org/10.1016/j.urols.2014.09.001.
9. Coskun B, Lavelle RS, Alhalabi F, Christie AL, Zimmern PE. Anterior vaginal wall suspension procedure for moderate bladder and uterine prolapse as a method of uterine preservation. *J Urol*. 2014;192:1461–1467. https://doi.org/10.1016/j.juro.2014.06.027.
10. Meriwether KV, Antosh DD, Olivera CK, et al. Uterine preservation vs hysterectomy in pelvic organ prolapse surgery: a systematic review with meta-analysis and clinical practice guidelines. *Am J Obstet Gynecol*. 2018;219:129–146. https://doi.org/10.1016/j.ajog.2018.01.018. .e2.
11. Detollenaere RJ, den Boon J, Stekelenburg J, et al. Sacrospinous hysteropexy versus vaginal hysterectomy with suspension of the uterosacral ligaments in women with uterine prolapse stage 2 or higher: multicentre randomised non-inferiority trial. *BMJ*. 2015;351:h3717.
12. Showalter PR, Zimmern PE, Roehrborn CG, Lemack GE. Standing cystourethrogram: an outcome measure after anti-incontinence procedures and cystocele repair in women. *Urology*. 2001;58:33–37. https://doi.org/10.1016/S0090-4295(01)01015-9.
13. Raz S, Klutke CG, Golomb J. Four-corner bladder and urethral suspension for moderate cystocele. *J Urol*. 1989;142:712–715.
14. Wilson T, Zimmern P. Anterior vaginal wall suspension. In: Vasavada, Appell, Sand, Raz, eds. *Female Urology, Urogynecology, and Voiding Dysfunction*. CRC Press; 2004:283–290. http://www.crcnetbase.com/doi/10.1201/b14154-18. Accessed 5 January 2017.
15. Zimmern PE, Haab F. [Fixation of the vaginal vault by high midline levator myorrhaphy]. *Progres En Urol J Assoc Francaise Urol Soc Francaise Urol*. 1999;9:552–554.
16. Gilleran JP, Gaines N. Posterior colporrhaphy (with or without perineorrhaphy).. *Native Tissue Repair for Incontinence and Prolapse*. Cham: Springer; 2017:167–177. https://doi.org/10.1007/978-3-319-45268-5_13.
17. Glazener CM, Breeman S, Elders A, et al. Mesh, graft, or standard repair for women having primary transvaginal anterior or posterior compartment prolapse surgery: two parallel-group, multicentre, randomised, controlled trials (PROSPECT). Lancet. https://doi.org/10.1016/S0140-6736(16)31596-3.
18. Maher C, Baessler K. Surgical management of posterior vaginal wall prolapse: an evidence-based literature review. *Int Urogynecology J*. 2006;17:84–88. https://doi.org/10.1007/s00192-005-1295-4.
19. Petros P. Influence of hysterectomy on pelvic-floor dysfunction. *Lancet*. 2000;356:1275. https://doi.org/10.1016/S0140-6736(05)73879-4.
20. Wang LC, Al Hussein Al Awamlh B, Hu JC, et al. Trends in mesh use for pelvic organ prolapse repair from the medicare database. *Urology*. 2015;86:885–891. https://doi.org/10.1016/j.urology.2015.08.022.
21. Khatri G, Leon AD de, Lockhart ME. MR imaging of the pelvic floor. *Magn Reson Imaging Clin*. 2017;25:457–480. https://doi.org/10.1016/j.mric.2017.03.003.
22. Carmel M, Khatri G, Bailey A, Zimmern P. PD50-02 impact Of MRI defecography on clinical evaluation and surgical management of pelvic organ prolapse. *J Urol*. 2015;193:e1046. https://doi.org/10.1016/j.juro.2015.02.2010.