



Mid-term efficacy of surgical treatments for post-hysterectomy vaginal vault prolapse: a retrospective study

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Background: The surgical treatment of post-hysterectomy vaginal vault prolapse (PHVP) has been reported in several clinical studies, but mostly are short-term studies. This study aims to explore the mid-term efficacy of surgical treatments for PHVP.

Methods: A total of 138 PHVP patients underwent surgery from January 2005 to January 2020 at the Fourth Medical Center of PLA General Hospital, Beijing. The clinical data of 119 patients who completed follow-up were retrospectively analyzed. Both groups of patients are diagnosed Pelvic Organ Prolapse Quantification system (POP-Q) III–IV stage of prolapse, with obvious prolapse-related symptoms and requiring surgical treatment. Among them, pelvic floor reconstruction surgery (RPS) was performed in patients who wanted to retain vaginal function and colpocleisis were used for frail patients who cannot tolerate RPS. We used the POP-Q scores for the objective efficacy evaluation, and use the Pelvic Floor Distress Inventory-Short Form 20 (PFDI-20) and Pelvic Floor Impact Questionnaire-7 (PFIQ-7) to evaluate the subjective symptom during follow up. Among them, 61 patients underwent pelvic floor RPS (Group R), and 58 received colpocleisis (Group C).

Results: The surgeries in both groups were successfully completed, the median follow-up time after surgery was 4.3 years (0.25–13 years) and 5.3 years (0.33–15 years), respectively; the overall surgical success rate was 86.9% (53/61) and 100% (58/58), respectively; the subjective satisfaction rate was 90.2% (55/61) and 91.4% (53/58), respectively; and the PFDI-20 and PFIQ-7 scores in both groups were significantly improved compared with the preoperative levels ($P < 0.05$). In Group R, 6 cases (9.8%, 6/61) were dissatisfied after surgery; in Group C, 5 cases (8.6%, 5/58) were dissatisfied after surgery.

Conclusions: Reconstructive surgery and colpocleisis have a good mid-term effect on PHVP, with good outcome and few complications. The surgeon is expected to ascertain an appropriate surgical procedure based on the characteristics of the patient, the degree and the location of prolapse, in order to achieve the best surgical efficacy and minimize the damage.

Keywords: Gynecological surgery; post-hysterectomy vaginal vault prolapse (PHVP); treatment outcome

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Introduction

Hysterectomy is an important method for the treatment of benign and malignant gynecological diseases; it is among the most commonly performed gynecological surgical procedures in the world. Like any major surgical procedure, hysterectomy poses several short- and long-term risks to patients. As one of these risks, post-hysterectomy vaginal vault prolapse (PHVP) has become a new focus in the field of urogynecology. It is defined as “descent of the apex of the vagina (vaginal vault or cuff scar after hysterectomy)” in the International Urogynecological Association (IUGA) and the International Continence Society (ICS) joint report (1), and attributed to the lack of apical vaginal support. The incidence of PHVP ranges from 0.2% to 43%, and the latest data show that the incidence of PHVP after hysterectomy due to uterine prolapse is 11.6%, which is significantly higher than the incidence of 1.8% caused by other indications (2). Hysterectomy due to pelvic organ prolapse (POP) is an independent risk factor for recurrence of POP after surgery, and women are more likely to have pelvic floor dysfunction (PFD) symptoms after hysterectomy (3); about 6–8% of them eventually require corrective surgery (4). However, PHVP with indications of repeat surgery is almost always accompanied by varying degrees of prolapse of the anterior and posterior vaginal walls, and the degree of prolapse even exceeds the vaginal vault. In addition, repeat surgery may encounter problems such as scars, tissue adhesions, and unclear anatomical levels caused by the previous surgery. Those who have undergone previous surgery due to POP have higher expectations for repeat surgery. This poses a great challenge for repeat surgery for PHVP and increases the risk of surgical failure. Hence, it is of paramount importance to choose the right surgical procedure for those who require repeat surgery for PHVP. In this study, we retrospectively analyzed the PHVP patients who required repeat surgery in our hospital. We present the following article in accordance with the STROBE reporting checklist (available at <https://gs.amegroups.com/article/view/10.21037/gS-22-261/rc>).

Methods

Patients

Participants

A total of 138 PHVP patients underwent surgery at the Department of Obstetrics and Gynecology in the Fourth Medical Center of PLA General Hospital from January

2005 to January 2020, 119 (86%, 119/138) of whom completed follow-up, including 61 patients who underwent pelvic floor reconstruction surgery (RPS) (Group R), and 58 who received colpocleisis (Group C). Patients in both groups underwent hysterectomy due to benign diseases, specifically, 11 cases (18%, 11/61) and 4 cases (6.9%, 4/58) due to POP, respectively. The median follow-up time of the 2 groups was 4.3 years (0.25–13 years) and 5.3 years (0.33–15 years), respectively. The demographic characteristics of the 2 groups of patients are shown in *Table 1*. *Figure 1* is a flowchart of the study. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the ethics committee of the Fourth Medical Center of PLA General Hospital (No. 2022KY078-KS001). Individual consent for this retrospective analysis was waived.

POP grading

The Pelvic Organ Prolapse Quantification system (POP-Q) was adopted in this study. Most cases in the 2 groups had middle compartment prolapse. A concomitant bulge in the anterior wall of the vagina accompanying such prolapses was the most common and severe, while the posterior wall bulge was rare and mild. In Group R, 85.2% (52/61), 83.6% (51/61), and 18.0% (11/61) of patients suffered from POP-Q III–IV prolapses of the anterior, middle, and posterior compartment, respectively. In comparison, 86.2% (50/58), 86.2% (50/58), and 15.5% (9/58) patients in Group C had POP-Q III–IV prolapses of the anterior, middle, and posterior compartment, respectively (*Table 2*).

Concomitant urinary incontinence

According to medical history, questionnaire survey, 1-hour urinary pad test, urination diary, or urodynamic examination, there were 17 cases (27.9%, 17/61) accompanied by stress urinary incontinence (SUI), 1 case (1.6%, 1/61) of mixed urinary incontinence, 8 cases (13.1%, 8/61) with dysuria which required hand assistance, and 9 cases (14.8%, 9/61) with difficult defecation which required manual assistance in Group R. In Group C, there were 11 cases (18.9%, 11/58) accompanied by SUI, 9 cases (15.5%, 9/58) with dysuria which required manual assistance, and 7 cases (12.1%, 7/58) with difficult defecation which required manual assistance.

Surgical procedure

Surgical indications

The criteria proposed by Barber and Maher were applied: (I)

Table 1 The demographic characteristics of the PHVP patients

Demographic characteristics	Value
Group R (n=61)	
Age, median (range)	61 years (40–76 years)
BMI, median (range)	24.5 kg/m ² (19.1–32.6 kg/m ²)
Parity (time)	2 [1–7]
Sexually active	47 (77%, 47/61)
Group C (n=58)	
Age, median (range)	73 years (58–87 years)
BMI, median (range)	24.2 kg/m ² (18.2–30.3 kg/m ²)
Parity (time)	2 [1–8]
Sexually active	0

PHVP, post-hysterectomy vaginal vault prolapse; BMI, body mass index.

subjective symptoms significantly affected the quality of life; (II) patients refused pessary treatment; (III) POP-Q III or above (5).

Preoperative risk assessment

The American Society of Anesthesiologists (ASA) classification was used for preoperative risk assessment. In Group R, 30 cases (49.2%, 30/61) had 1 or more medical comorbidities, including 24 cases of hypertension or coronary heart disease, 11 cases of diabetes mellitus, and 2 cases of cerebrovascular disease. According to the ASA classification, the comorbidities in Group R were all below Grade III, including 31 cases (50.8%, 31/61) of Grade I and 30 cases (49.2%, 30/61) of Grade II. In Group C, 49 cases (84.5%, 49/58) had 1 or more medical comorbidities, including 40 cases of hypertension or coronary heart disease, 9 cases of diabetes mellitus, 8 cases of cerebrovascular disease, 2 cases of chronic obstructive pulmonary disease, and 1 case of hyperthyroidism. According to the ASA classification, 8 cases (13.8%, 8/58) were Grade I, and 50 cases (86.2%, 50/58) were Grade II–III.

Selection of surgical procedure

We used RPS was used for those who required preservation of vaginal function, and total colpocleisis was employed for frail, older patients who did not require preservation of vaginal function, had severe POPs, and could not tolerate RPS (6). Since all patients investigated in this study had experienced PHVP, and even if there had been patients

with bulging of the anterior or posterior vaginal wall, the apex of the vagina should have been suspended to reduce postoperative recurrence according to Delancy's model. For this reason, the selection of RPS in this study was mainly based on the suspension of the vaginal apex, combined with high uterosacral ligament suspension (HUS), sacrospinous ligament fixation (SSLF), and sacral colpopexy (SC). Those patients with \leq POP-Q II cystocele or rectocele after the vaginal vault was restored additionally underwent anterior and posterior vaginal wall repair with native tissue, and those with \geq POP-Q III cystocele or recurrent rectocele also received transvaginal mesh-based repair (TVM), using mesh kits or self-tailored polypropylene meshes. Patients with old perineal lacerations also underwent perineal body (PB) repair. Patients with moderate to severe SUI preoperatively received tension-free vaginal tape surgery for anti-urinary incontinence according to the Surgical Treatment of Female Stress Urinary Incontinence Guideline (7). The specific surgical procedures are shown in Table 3. All operations were performed by a senior surgeon in our hospital.

Follow-up and evaluation indicators

Follow-up

Outpatient follow-up including medical history and gynecological examination was performed at 2, 6, and 12 months after surgery, and once a year thereafter.

Perioperative indicators

Including operation time, blood loss, postoperative morbidity (referring to the body temperature exceeding 38 °C twice consecutively, 4 hours apart, within 24 hours after surgery), indwelling catheter time, postoperative hospital stay, and perioperative complication grades by the Clavien-Dindo Grading System (8).

Criteria for successful surgery

The 3 criteria proposed by Vallabh-Patel *et al.* (9) were adopted for RPS: (I) the distance between the most distal end of the prolapsed anterior or posterior vaginal wall and the hymen was ≤ 0 cm, and descent of vaginal vault was $\leq 1/2$ the full length of the vagina; (II) it was determined that the related symptoms of POP had disappeared according to the third question in Pelvic Floor Distress Inventory-Short Form 20 (PFDI-20) ("Do you often see or feel a vaginal mass protruding?"); (III) no surgery or pessary treatment was performed for the prolapse. Surgeries that met the above 3 criteria at the same time were considered successful.

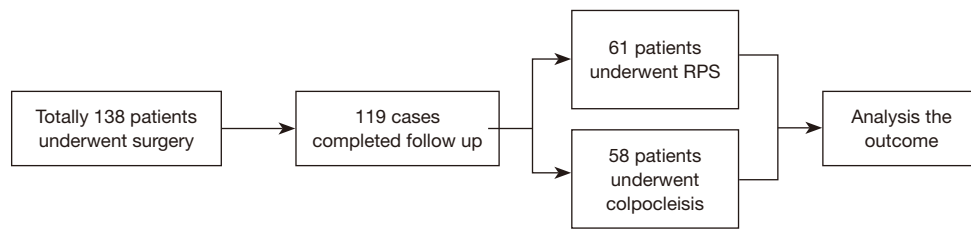


Figure 1 Progress of patients across the study period. RPS, pelvic floor reconstruction surgery.

Table 2 The POP-Q stages of the PHVP patients before surgery

Group	Location	Grade II, n (%)	Grade III, n (%)	Grade IV, n (%)	Total, n (%)
Group R (n=61)	Anterior compartment	2 (3.3)	50 (81.9)	2 (3.3)	54 (88.5)
	Middle compartment	10 (16.4)	45 (73.8)	6 (9.8)	61 (100.0)
	Posterior compartment	37 (60.7)	10 (16.4)	1 (1.6)	48 (78.7)
Group C (n=58)	Anterior compartment	3 (5.2)	47 (81.0)	3 (5.2)	53 (91.4)
	Middle compartment	8 (13.8)	44 (75.9)	6 (10.3)	58 (100.0)
	Posterior compartment	39 (67.2)	8 (13.8)	1 (1.7)	48 (82.7)

POP-Q, Pelvic Organ Prolapse Quantification system; PHVP, post-hysterectomy vaginal vault prolapse.

Table 3 Surgical procedures of the 119 PHVP patients

Classification	Number of cases	Percentage (%)
Group R	61	51.3 (61/119)
HUS + TVM	29	47.5 (29/61)
HUS + anterior TVM	21	34.4 (21/61)
HUS + posterior TVM	4	6.6 (4/61)
HUS + anterior/posterior TVM	4	6.6 (4/61)
SSLF + TVM	7	11.5 (7/61)
SSLF + anterior TVM	5	8.2 (5/61)
SSLF + posterior TVM	1	1.6 (1/61)
SSLF + anterior/posterior TVM	1	1.6 (1/61)
HUS + anterior/posterior wall repair	8	13.1 (8/61)
SC	17	27.9 (17/61)
Perineal body repair	39	63.9 (39/61)
Tension-free vaginal tape surgery	18	29.5 (18/61)
Group C	58	48.7 (58/119)
Total colpocleisis	58	100 (58/58)
Perineal body repair	51	87.9 (51/58)
Tension-free vaginal tape surgery	11	19 (11/58)

PHVP, post-hysterectomy vaginal vault prolapse; HUS, high uterosacral ligament suspension; TVM, transvaginal mesh-based repair; SSLF, sacrospinous ligament fixation; SC, sacral colpexy.

Objective and subjective efficacy evaluation

The objective efficacy evaluation mainly included the position of POP-Q indicator points (Aa, Ap, Ba, Bp, D), total vaginal length (TVL), and lengths of genital hiatus (GH) and PB, vaginal volume, and mesh exposure measured during postoperative follow-up. The Patient Global Impression of Improvement (PGI-I) specifically for POP patients was used to evaluate subjective satisfaction. The PGI-I was classified into 7 levels: (I) very much better; (II) much better; (III) a little better; (IV) no change; (V) a little worse; (VI) much worse; (VII) very much worse (10). Participant answers of “very good, very good, or relatively good” were regarded as subjectively satisfied, while the other answers indicated dissatisfaction. The PFDI-20 and Pelvic Floor Impact Questionnaire-7 (PFIQ-7) were used to assess the improvement of patients’ symptoms and quality of life. The higher the score, the greater the impact of POP on the patient (the poorer the quality of life); on the contrary, the less the impact on the patient’s quality of life.

Statistical analysis

The software SPSS 20.0 (IBM Corp., Armonk, NY, USA) was used for statistical analysis. Measurement data that conformed to the normal distribution were expressed as mean \pm SD, and those that did not conform to the normal distribution were expressed as the median (minimum to maximum). Counting data are expressed as absolute numbers and rates. The paired *t*-test was used for normally distributed data, and the Wilcoxon signed-rank test was employed for non-normally distributed data. The comparison of rates underwent χ^2 test or Fisher’s exact test. The difference was considered statistically significant when $P < 0.05$.

Results

Perioperative period

Totally 61 patients underwent RPS, including 21 cases (34.4%, 21/61) of HUS + anterior TVM, 4 cases (6.6%, 4/61) of posterior TVM, 4 cases (6.6%, 4/61) of anterior and posterior TVM, 5 cases (8.2%, 5/61) of SSLF + anterior TVM, 1 case (1.6%, 1/61) of posterior TVM, 1 case (1.6%, 1/61) of anterior and posterior TVM, 17 cases (27.9%, 17/61) of SC, 18 cases (29.5%, 18/61) of additional tension-free vaginal tape surgery for anti-urinary incontinence, and 39 cases (63.9%, 39/61) of PB repair. The median operation

time was 135 minutes (75–175 minutes), and the median intraoperative blood loss was 100 mL (80–800 mL). A patient who received SC had about 800 mL intraoperative bleeding from the presacral vein. No blood transfusion was required for any of the patients, and there was no case of organ or ureter injury. The postoperative morbidity rate was 3.3% (2/61); the median postoperative hospital stay was 7 days (5–22 days); and the median time of indwelling catheter was 6 days (2–13 days). The residual urine volume of 3 patients was more than 100 mL after the catheter was removed, which returned to normal after the indwelling catheter was intermittently opened and drugs to strengthen the contraction of the urinary muscle and relax the urethra were orally administered. A patient had a hematoma of about 5 cm in diameter beside the rectum after TVM, which was gradually absorbed and disappeared after conservative treatment. The perioperative complications were all Grade I by the Clavien–Dindo Grading System.

A total of 58 patients received total colpocleisis, including 11 cases (19%, 11/58) of additional tension-free vaginal tape surgery for anti-urinary incontinence, and 51 cases (87.9%, 51/58) of PB repair. The median operation time was 90 minutes (65–230 minutes), and the median intraoperative blood loss was 60 mL (20–300 mL). No blood transfusion was required for any of the patients, and there was no case of organ or ureter injury. The postoperative morbidity rate was 5.2% (3/58). The perioperative complications were all Grade I by the Clavien–Dindo Grading System. The median postoperative hospital stay was 6 days (4–9 days), and the median time of indwelling catheter was 5 days (2–7 days).

The age was significantly higher in Group C than in Group R, while the operation time and intraoperative blood loss were remarkably lower in Group R than in Group C (all $P < 0.05$). There was no statistical difference between the 2 groups in parity, body mass index (BMI), maximum birth weight, and postoperative hospital stay (all $P > 0.05$), as shown in *Table 4*.

Objective efficacy

The median follow-up time in Group R was 4.3 years (0.25–13 years). The vagina is wide enough to hold 2 fingers 1 year after surgery. The positions of the POP-Q indicator points Aa, Ba, Ap, Bp, and C were significantly higher than those before surgery; the GH was significantly reduced compared with that before surgery; and the PB was higher than that before surgery, with a statistically significant difference ($P < 0.05$). However, there was no statistically

Table 4 Characteristics of the PHVP patients who underwent RPS or total colpecteisis

Type	Group R		Group C		P value
	Median	Min to max	Median	Min to max	
Age (year)	61	40–76	73	58–87	<0.05
BMI (kg/m ²)	24.5	19.1–32.6	24.2	18.2–30.3	>0.05
Parity (time)	2	1–7	2	1–8	>0.05
Maximum birth weight (g)	3,450	3,000–5,500	3,575	3,000–4,000	>0.05
Operation time (min)	135	75–175	90	65–230	<0.05
Intraoperative blood loss (mL)	150	20–1,000	100	50–600	<0.05
Postoperative hospital stay (days)	7	6–22	6	4–8	>0.05

PHVP, post-hysterectomy vaginal vault prolapse; RPS, pelvic floor reconstruction surgery; BMI, body mass index.

Table 5 Measurements of the POP-Q indicator points in 61 PHVP patients before and after RPS (cm)

POP-Q, indicator points	Before surgery		1 year after surgery		Last follow-up	
	Median	Min to max	Median	Min to max	Median	Min to max
Aa	+3	–3 to +3	–3 ^a	–3 to –2	–2.5 ^c	–3 to –1
Ba	+4	–1 to +6	–3 ^a	–3 to –2	–2.5 ^c	–2 to 1
C	+3	–4 to +9.5	–8 ^a	–10.5 to –7	–8 ^c	–10 to –6
Ap	+1	–3 to +3	–3 ^a	–3 to –2	–2 ^c	–3 to –1
Bp	+3	–1 to +6	–3 ^a	–3 to –2	–2 ^c	–3 to 1
GH	5	2.5 to 7	3 ^a	2.3 to 5	3 ^c	2.5 to 5
PB	3	1.5 to 5.5	4.6 ^b	3 to 6	4.6 ^c	3 to 6
TVL	8	6 to 9.5	8 ^b	7 to 10.5	8 ^c	7 to 10.5

^aP<0.05 and ^bP>0.05, as compared with the level before surgery; ^cP>0.05, as compared with the level 1 year after surgery. POP-Q, Pelvic Organ Prolapse Quantification system; PHVP, post-hysterectomy vaginal vault prolapse; RPS, pelvic floor reconstruction surgery; GH, genital hiatus; PB, perineal body; TVL, total vaginal length.

significant difference between the last follow-up value and 1 year after surgery (all P>0.05), as shown in *Table 5*. At the last postoperative follow-up, there was no case where the descent of the vaginal vault was more than 1/2 the full length of the vagina. There were 6 cases (9.8%, 6/61) with the most distal end of the anterior vaginal wall beyond the hymen and 2 cases (3.2%, 2/61) with the most distal end of the posterior vaginal wall beyond the hymen, including 2 cases of anterior wall bulges undergoing anterior TVM. The farthest distance between the most distal end of the vaginal wall and the hymen in all patients was ≤1 cm. The overall surgical success rate that met the 3 criteria at the last follow-up after surgery was 86.9% (53/61).

The median follow-up time in Group C was 5.3 years (0.33–15 years). The TVL, GH, and PB 1 year after surgery

were significantly different from those before surgery (P<0.05), whereas there was no statistically significant difference between the last follow-up value and the value 1 year after surgery (P>0.05). There was no case of prolapse recurrence or postoperative regret, and the objective success rate was 100% (*Table 6*).

Subjective efficacy

At the last follow-up of Group R, 55 cases were deemed satisfied according to PGI-I, and the overall subjective satisfaction rate was 90.2% (55/61). A total of 6 cases were considered dissatisfied, including 3 cases of anterior vaginal mesh exposure, 2 cases of silk thread exposure on the vaginal vault, and 1 case of acute urinary leakage which

Table 6 TVL, GH, and PB in 58 PHVP patients before and after colpocleisis (cm)

Type	Before surgery		1 year after surgery		Last follow-up	
	Median	Min to max	Median	Min to max	Median	Min to max
TVL	8	5.5–10	3 ^a	2.5–3.5	3 ^b	2.5–3.5
GH	5	3.5–7	3.5 ^a	2–5	4 ^b	2–5.5
PB	3	2.5–4.5	4.5 ^a	2.5–5	4.5 ^b	2.5–5

^a, $P < 0.05$, as compared with the level before surgery; ^b, $P > 0.05$, as compared with the level 1 year after surgery. TVL, total vaginal length; GH, genital hiatus; PB, perineal body; PHVP, post-hysterectomy vaginal vault prolapse.

Table 7 PFDI-20 and PFIQ-7 scores before and after surgery in PHVP patients

Type	Scale	Before surgery		Last follow-up	
		Median	Min to max	Median	Min to max
Group R	PFDI-20	70.8	33.3–158.3	8.3 ^a	0–37.5
	PFIQ-7	90.5	23.8–180.9	14.3 ^a	0–38.1
Group C	PFDI-20	75	37.5–163.5	12.5 ^a	0–39.6
	PFIQ-7	76.2	28.6–176.2	9.5 ^a	0–52.4

^a, $P < 0.05$ compared with the level before surgery. PFDI-20, Pelvic Floor Distress Inventory-Short Form 20; PFIQ-7, Pelvic Floor Impact Questionnaire-7 Form; PHVP, post-hysterectomy vaginal vault prolapse.

was not obviously alleviated after anti-incontinence surgery for mixed urinary incontinence. The symptoms of this case were gradually relieved after behavioral intervention and oral anticholinergic drugs. The symptoms of the other 17 SUI cases disappeared after tension-free vaginal tape surgery for anti-urinary incontinence. The symptoms of 8 patients with dysuria preoperatively disappeared after surgery. The symptoms of 7 out of 9 patients with difficult defecation which required manual assistance preoperatively were obviously relieved after surgery, while there was no improvement in the other 2 cases. The PFDI-20 and PFIQ-7 scores at the last follow-up were significantly lower than those before surgery (all $P < 0.05$), as shown in *Table 7*. The 3 cases of anterior mesh exposed with a diameter of 1–1.5 cm healed after local excision of the exposed mesh. The 2 cases of apical silk thread exposure were all patients after HUS, and there was no descent of vaginal vault during the outpatient follow-up after the exposed silk thread was cut off half a year later.

At the last follow-up of Group C, 53 cases were deemed satisfied according to PGI-I, and the overall subjective satisfaction rate was 91.4% (53/58). None of them regretted losing vaginal function. A total of 5 cases were considered dissatisfied, including 2 patients with leakage of urine with a slight cough and after surgery, 2 cases with new mild SUI

after surgery, and 1 case without relief of postoperative difficult defecation. The symptoms of 11 cases with SUI preoperatively disappeared after anti-urinary incontinence surgery, and the symptoms of 2 cases were significantly reduced. The symptoms of 9 patients with dysuria which required manual assistance preoperatively were relieved after surgery. The symptoms of 6 out of 7 patients with difficult defecation which required manual assistance preoperatively were alleviated after surgery, while there was no improvement in the other 1 case. The PFDI-20 and PFIQ-7 scores at the last follow-up were significantly lower than those before surgery (all $P < 0.05$), as shown in *Table 7*.

Discussion

There are more than 20 surgical procedures for the treatment of PHVP reported in the literature (11). However, heterogeneous research makes it difficult to compare various surgical procedures or to draw a conclusion on which is the best surgical procedure (12). The Society of Obstetricians and Gynaecologists of Canada (SOGC) Guide 413 states that sexually active patients with symptomatic POP should be reconstructed with apical suspension and repair other defects, and vaginal closure should be used as an option (13). Therefore, the choice of

specific surgical procedures needs to be individualized based on the patient's location and degree of prolapses, sexual function requirements, age, physical condition, and previous POP procedures. The most commonly used procedures to correct PHVP are classified into 2 types, reconstruction and colpocleisis. Previous reports on VVP surgery mainly focus on short-term studies. This study provides medium time follow-up results, and also discusses the difficulties of VVP. In this study, 119 PHVP patients were treated with enhanced apical support combined with reconstruction surgery with native tissue or mesh reinforcement on the anterior and posterior vaginal walls, or colpocleisis. Satisfactory results were achieved, as discussed below.

Challenges of repeat RPS in PHVP patients

It is crucial in transvaginal RPS to recognize the peritoneum and enter the abdominal cavity successfully without damage. Since PHVP patients do not have a uterus, there is a lack of the normal anatomical space of the uterus during surgery. As a result, any mistake in the separation of the space may damage the surrounding bladder or rectum, and even the small intestine. This limits the choice of transvaginal HUS by those who are not familiar with transvaginal surgery, but it is not difficult or unattainable for those who are familiar with vaginal and pelvic organ anatomy and good at vaginal surgery. Based on the aptitude of an expert team at our hospital which has successfully performed more than 5,000 transvaginal surgeries and intra-abdominal HUS in the past 20 years, the peritoneum was successfully opened and intra-abdominal HUS was completed in 29 PHVP patients in this study. According to our experience, before entering the abdominal cavity, it is necessary to identify the location of the scar from the vaginal vault caused by the previous hysterectomy, namely, the mucosal depression on both sides of the vaginal vault, which is caused by the tissue retraction after the main and sacral ligaments are cut and ligated during the previous surgery. Then the depressions on both sides of the vaginal vault are clamped and pulled outwards appropriately to form a certain tension at the apex of the vagina. A small amount of vaginal mucosa at the top is cut off. The loose connective tissue between the bladder and rectum is bluntly and sharply separated, and if necessary, under the guidance of digital rectal examination. In the process of separating the loose connective tissue, the peritoneum should be carefully observed, identified, and opened after confirmation.

Dwyer and Fatton (14) first proposed extraperitoneal

HUS in 2008. Karmakar *et al.* (15) reported the results of a 5-year follow-up study of transvaginal extra-abdominal HUS in 2019, which showed that the success rate of apical suspension was 89%. Mounir *et al.* (16) retrospectively compared the effects of intra-abdominal and extra-abdominal HUS in the treatment of PHVP in 2020, and the results of a follow-up of average 7 months revealed that there was no statistically significant difference in the success rate (72.2% in the intra-abdominal group and 81.8% in the extra-abdominal group) and the perioperative complication rate between the 2 groups, but the operation time, hospital stay, and intraoperative bleeding in the extra-abdominal group were lower.

Use of colpocleisis in PHVP patients

Colpocleisis is an extremely effective procedure for both uterine prolapse and PHVP, regardless of the severity and complexity of the prolapse. Almost without exception, it can treat various pelvic prolapses successfully, though the premise of this procedure is the loss of vaginal function. A study by DeLancey and Morley (17) demonstrated that approximately 1/10 of the patients with vaginal vault prolapse underwent colpocleisis. In our study, nearly 50% of PHVP patients received colpocleisis, which was associated with the age and severity of prolapse in our patients. Compared with RPS, colpocleisis not only has obvious advantages in terms of the operation time, degree of trauma, blood loss, and postoperative rehabilitation, but can also effectively resolve the patients' symptoms related to prolapse and significantly improve their quality of life, with long-lasting efficacy and low recurrence rate. This is also the main reason why colpocleisis remains in use since its proposal by Geradin in 1823 and LeFort first published a paper on partial colpocleisis (18).

Generally, elderly and frail women who have no requirements for vaginal sex, experience severe prolapse, and cannot tolerate RPS-related trauma and general anesthesia, which are the main indications for colpocleisis. However, the definition of patient characteristics such as advanced age and frailty is under debate. In clinical practice, the age of those who are frail, diseased, widowed, and have surgical contraindications or relative contraindications to RPS, can be appropriately lowered (51–62 years old); conversely, the age for colpocleisis can also be appropriately prolonged (86–101 years old) (19). The median age of Group C in this study was 73 years (58–87 years), which was basically the same as the 75 years (59–87 years) reported in studies

from countries other than China and previous study of our research team (6). Suskind *et al.* (20) explored the frailty index (FI) as a predictive factor for RPS or colpocleisis and found that age was more relevant to the choice of the 2 surgical procedures, while FI was more related to surgical complications. Although FI was not used in this study, the ASA classification directly related to surgical risks was used for preoperative risk assessment and as 1 of the important reference factors for the choice of surgical procedures in PHVP patients. Since both are evaluated and graded based on the functional status of the patient's vital organs, they share something in common to a certain extent. The reason why the ASA classification was used in this study was that whether the adopted surgical procedure can be completed largely depends on whether the patient can tolerate the selected surgical procedure as determined by the anesthesiologist based on the ASA classification. According to the characteristics of the 2 groups of patients in this study, except that Group C was significantly older than Group R, and the proportion of ASA grades II–III was higher in Group C than in Group R, with statistically significant differences, there was no significant difference in the severity of perioperative complications between the 2 groups, as they were all Grade I by the Clavien-Dindo Grading System.

Colpocleisis has a lower risk of damaging adjacent organs, blood vessels, or nerves; and without the need to enter the abdominal cavity, the risk of surgery and trauma is further reduced. Urogynecologists and patients pay more attention to the occurrence of urinary incontinence after colpocleisis. The incidence rate of this complication reported in the literature was about 1–11% (18). The main causes for this complication are that the clinical symptoms of hidden or potential SUI appear after the correction of POP and the urethra is pulled down excessively during surgery. Considering that the patients undergoing colpocleisis are usually aged, with decreased contractility of the bladder detrusor, and the incidence of urinary retention may increase after anti-urinary incontinence, additional anti-SUI surgery for such patients should be cautious and attention should be paid to assess bladder and urethral function before surgery. In this study, additional tension-free vaginal tape surgery for anti-urinary incontinence was also performed on 11 PHVP patients (18.9%, 11/58) who had a clear SUI before surgery of colpocleisis. Although there were 2 patients with urinary leakage from a slight cough after surgery, none of them had dysuria. There were 2 cases (4.3%, 2/47) of new urinary incontinence after colpocleisis without anti-urinary incontinence surgery, who did not undergo another surgery

as the complication was mild.

Use of RPS in PHVP patients

The biggest difference between RPS and colpocleisis is that RPS retains the physiological functions of the vagina, which is the main reason why most POP patients are more willing to accept RPS. The PHVP mainly stems from defects in the apical support tissues; therefore, the surgical procedure aims to rebuild the apical support. At present, the most commonly used procedures to suspend the vaginal vault are mainly transvaginal HUS, SSLF, and SC, which are also recognized as standard A-level surgical procedures for the reconstruction of the apical support. In this study, the number of patients undergoing transvaginal HUS, transabdominal SC, and SSLF accounted for 60.7%, 27.9%, and 11.5%, respectively, of Group R, which all produced good outcomes in apical reconstruction. There was no recurrence of apical prolapse at an average 4.3-year-long (0.25–13 years) follow-up. However, most clinical apical support defects are associated with varying degrees of bulging of the anterior and/or posterior vaginal walls, weakening of the levator ani muscle, and in some patients, the degree of anterior and posterior wall prolapse exceeds the apex of the vaginal vault. Although a simple apical reduction can usually solve 55% of the anterior wall and 30% of the posterior wall bulge (21,22), it cannot solve all POPs, which usually requires repair with autologous tissue or mesh. Synthetic meshes were used for 36 patients with POP-Q III–IV severe prolapses and recurrent prolapses in this study, including 26 cases with anterior mesh repair, 5 cases with posterior mesh repair, and 5 cases with anterior and posterior mesh repair, which achieved good outcomes. In the postoperative follow-up, there were only 2 cases of prolapses of the anterior vaginal wall to the outside of the hymen, but the distance of the most distal end from the hymen was <1 cm, which did not require further surgery or pessary treatment.

An SC is a good choice for PHVP patients who can tolerate transabdominal or laparoscopic surgery. Since there is no need to remove the uterus, the operation of SC is simplified, and the pelvic organs can be better observed under direct vision, which facilitates separation of adhesions and removal of accessories. In this study, nearly 1/3 (27.9%, 17/61) of the patients in Group R chose SC which achieved good outcomes. There was no recurrence of prolapse during the postoperative follow-up. Nonetheless, transvaginal surgery is more difficult for PHVP than for uterine prolapse,

and the surgeon needs to have exemplary transvaginal surgery skills. In this study, transvaginal HUS was selected as the primary method for apical reconstruction, mainly based on the following considerations: Firstly, our team was the first to introduce and promote this operation in China, had accumulated rich experience in transvaginal surgery, and achieved good long-term outcomes (23,24). Secondly, in transvaginal apical suspension surgery, HUS can better maintain the physiological axis of the vagina, while SSLF excessively pulls the vaginal axis backward, potentially increasing the risk of recurrence of bulging of the anterior vaginal wall after surgery. It has been found that fixation of uterosacral ligaments (USLs) to the anterior vaginal wall at time of post-hysterectomy modified McCall culdoplasty appears to improve anatomic outcomes of the procedure reducing the risk of anterior prolapse, without implying a reduced safety, nor a greater surgical complexity (25).

A meta-analysis of 17 studies reported that the recurrence rate of the anterior compartment after SSLF was up to 21.3% (26). The SSLF can be a choice for those patients whose abdominal cavity is difficult to be entered via the vagina. Thirdly, compared with transabdominal surgery, another outstanding advantage of transvaginal surgery lies in that it utilizes the natural cavities of the human body, which causes less trauma to the patient, can repair defects in other parts of the vagina, and perform accompanying operations. Fourthly, compared with transabdominal reconstructive surgery, transvaginal RPS is the most cost-effective method for the treatment of PHVP (27).

In conclusion, PHVP itself is complex to a certain degree, and repeat surgery also represents a huge challenge. The limitation of the study was that the sample was small and the study was conducted in a single center. Each surgical procedure has its unique merits and demerits. The surgeon is expected to choose an appropriate surgical procedure based on the characteristics of the patient, the degree of prolapse, and the location, in order to achieve the best surgical efficacy and minimize the damage. For complex PHVP, those who lack sufficient experience should refer the patient promptly to an experienced surgeon specializing in pelvic floor surgery.

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Footnote

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Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the ethics committee of the Fourth Medical Center of PLA General Hospital (No. 2022KY078-KS001). Individual consent for this retrospective analysis was waived.

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