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REVIEW ARTICLE

A systematic review of the surgical management of apical pelvic organ prolapse

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Abstract

Introduction and hypothesis This systematic review (PROSPERO:CRD42022275789) is aimed at comparing qualitatively the success, recurrence, and complication rates of sacrocolpopexy with concomitant hysterectomy, hysteropexy, sacrospinous fixation (SSF) with and without vaginal hysterectomy (VH) and uterosacral fixation (USF) with and without VH.

Methods A systematic search was performed using Embase, PubMed, Scopus, and Cochrane databases for studies published from 2011, on women with apical pelvic organ prolapse requiring surgical interventions. Risk of bias was assessed via the National Institutes of Health study quality assessment tool. The primary outcomes are the success and recurrence rate of each technique, for ≥12 months' follow-up. Findings were summarised qualitatively.

Results A total of 21 studies were included. Overall significant findings for a high success and low recurrence rate are summarised as: minimally invasive sacrocolpopexy (MISC) is superior to abdominal sacrocolpopexy (ASC); sacrospinous hysteropexy (SSHP) is superior to USF + VH, which is superior to uterosacral hysteropexy and mesh hysteropexy (MHP). Significant findings related to complications include: MISC recorded a lower overall complication rate than ASC except in mesh exposure; USF + VH tends to perform better than SSHP and SSF, with SSHP performing better than MHP in faecal incontinence and overactive bladder rates.

Conclusion There is no evidence to conclude that hysterectomy is superior to uterine-sparing approaches. MISC should be considered over ASC given similar efficacy and reduced complications. Superiority of MHP is unproven against native tissue hysteropexy. Further studies under standardised settings are required for direct comparisons between the surgical management methods.

Keywords Apical compartment prolapse · Hysteropexy · Pelvic organ prolapse · Sacrocolpopexy · Sacrospinous fixation · Uterosacral fixation

Abbreviations

AH	Abdominal hysterectomy
ASC	Abdominal sacrocolpopexy
CH	Concurrent hysterectomy
FI	Faecal incontinence
LH	Laparoscopic hysterectomy
LSC	Laparoscopic sacrocolpopexy
LSHP	Laparoscopic sacral hysteropexy
LUSHP	Laparoscopic uterosacral hysteropexy
MHP	Mesh hysteropexy
MISC	Minimally invasive sacrocolpopexy
OAB	Overactive bladder

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RSC	Robotic sacrocolpopexy
SSF	Sacrospinous fixation
SSHP	Sacrospinous hysteropexy
SUI	Stress urinary incontinence
USF	Uterosacral fixation
USHP	Uterosacral hysteropexy
UTI	Urinary tract infection
UUI	Urge urinary incontinence
VH	Vaginal hysterectomy

Introduction

Pelvic organ prolapse (POP) is common, occurring in up to 50.0% of women and can impair a patient's quality of life [1]. The median age of presentation is 60–69 [1]. Treatment options include both conservative and surgical management. Following an unsuccessful trial of conservative management such as pessaries and pelvic floor muscle training or depending on the patient's preference, various surgical procedures can be performed to correct POP [2]. Around 12.0% of women require surgical correction in their lifetime and options include the transvaginal or trans-abdominal route (which can be performed through an open, laparoscopic, or robotic approach [3, 4]). Different surgical treatment options are available depending on the type of prolapse. POP can be divided into three compartments. Anterior compartment prolapse is defined as the descent of the anterior vaginal wall (and underlying bladder ± urethra). Posterior compartment prolapse is defined as the descent of the posterior vaginal wall (and underlying rectum). Apical POP occurs because of the descent of the uterus, cervix, or the vaginal vault [5]. They can occur in isolation but more commonly occur in combination. The complications related to the use of transvaginal mesh and its subsequent ban has limited the number of options. Anterior compartment prolapse is treated with anterior colporrhaphy and posterior compartment prolapse is treated with posterior colporrhaphy [6]. In contrast, apical compartment prolapse has a variety of management options, especially in women with no prior history of hysterectomy. These patients can be offered surgical treatment involving total or subtotal hysterectomy or undergo uterine-sparing POP repair (Fig. 1). This paper is aimed at helping with the decision making in the management of apical prolapse in women with no previous hysterectomy.

Non-uterine-preserving surgical techniques can be performed via a transvaginal or trans-abdominal approach. Transvaginal techniques include vaginal hysterectomy (VH) with concomitant sacrospinous fixation (SSF) or uterosacral fixation (USF) [2]. Hysterectomy by itself is generally inadequate for the treatment of apical compartment POP [2]. The use of SSF and USF allows the cephalad-most part of the posterior fornix of the vagina after removal of the uterus, the vaginal apex, to be lifted towards the respective ligaments to reduce the risk of recurrence. [7]. The most common native structures used to re-support the prolapsed vaginal apex include the uterosacral and sacrospinous ligaments, particularly the latter [8–10].

As prevention for future prolapse, McCall's culdoplasty is a procedure that can be performed at the time of VH. However, this procedure is performed relatively less commonly nowadays and in addition to the extensive nature of our search, it has been omitted from the review.

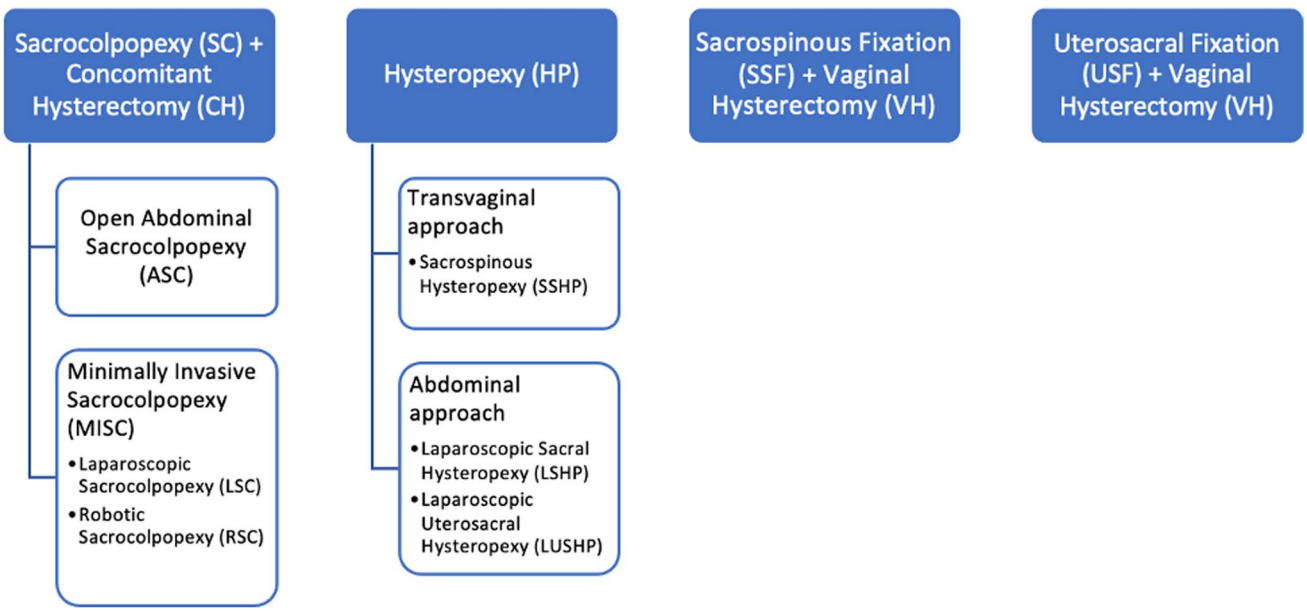

Fig. 1 Abbreviation of apical pelvic organ prolapse surgical techniques

Trans-abdominal techniques include total or subtotal hysterectomy with sacrocolpopexy, which can be performed using open, laparoscopic, or robot-assisted approaches [2]. As treatment for apical compartment prolapse, sacrocolpopexy involves the use of polypropylene mesh or less commonly autologous fascia to lift and secure fixation of the vaginal apex towards the sacral promontory [2]. Open abdominal sacrocolpopexy (ASC) was known to be the gold-standard surgical procedure for apical prolapse [5]. Requiring a large incision and some significant morbidity [11, 12], the approach has largely been superseded by the use of minimally invasive sacrocolpopexy (MISC) including laparoscopic sacrocolpopexy (LSC) and robotic sacrocolpopexy (RSC) owing to a shorter hospital stay, reduced wound-related morbidity and reduced blood loss. However, the cost of technology in RSC and the technical challenges in LSC deserve consideration.

A uterine-preserving technique for apical POP, hysteropexy, allows women to maintain their fertility while avoiding further damage to the pelvic floor supportive architecture, as well as the added surgical risk and psychological stress related to hysterectomy [13]. Previous studies have revealed that around 36.0–60.0% of women would prefer to preserve their uterus if all options presented with equal efficacy [14, 15]. Hysteropexy can be divided into transvaginal versus abdominal approaches [16]. The transvaginal approach includes sacrospinous hysteropexy (SSHP) and uterosacral hysteropexy. SSHP involves the transfixion of the cervix to the sacrospinous ligament using delayed absorbable or permanent suture [16]. The abdominal approach generally includes laparoscopic sacral hysteropexy (LSHP) and laparoscopic uterosacral hysteropexy (LUSHP) [16] but can also be done with an open incision or robot assisted. LSHP involves the use of polypropylene mesh or an autologous graft to secure the cervix/vagina posteriorly or the anterior cervix/vagina through the windows made in the broad ligament and attaching this graft to the sacrum [16]. LUSHP involved the securement of plicated uterosacral ligaments to the distal cervix [16].

Manchester repair, which involves excision of the cervix and reattachment to the cardinal ligaments, is typically used for elongation of the cervix [16]. Literature based on a consensus on the criteria for cervical elongation are lacking; hence, it was not included in this systematic review.

The aim of this systematic review is to compare qualitatively the different approaches to apical compartment POP repair, including success and complication rates. The results of this study will be useful in counselling patients to select an appropriate and individualised procedure for that patient.

Materials and methods

This systematic review followed PRISMA guidelines, and the protocol was registered with PROSPERO (CRD42022275789). Embase, PubMed, Scopus and Cochrane databases were used to perform a systematic search of the literature in October 2022, for studies comparing the success and recurrence rates of surgical management for apical POP (see Supplementary Information 1).

The patient population includes women who underwent the following procedures: SC+CH (routes: abdomen, laparoscopic or robotic), hysteropexy (routes: vaginal, laparoscopic or robotic), SSF ± VH and USF ± VH. Inclusion criteria consisted of English-language articles, human participants, studies with full texts available, a follow-up period of at least 12 months and studies published from 2011 onwards. Exclusion criteria consisted of studies on single-technique case series, use of transvaginal mesh and studies where hysterectomy status was unclear, or the percentage of prior hysterectomy was significant (>5.0%). Transvaginal mesh was excluded owing to the bans on surgical mesh use for POP repair by health regulations [17, 18]. Studies with fewer than 50 patients were excluded from this review.

Two authors completed the systematic search independently and identified a total of 9,273 articles from the initial search. All titles and abstracts were screened to exclude articles that did not meet the initial inclusion criteria. A total of 70 full-text articles were obtained and their eligibility for inclusion in the review were further assessed. Data extraction was performed by two independent authors and disagreements were discussed to reach a consensus. A third author was included for any unresolvable discrepancy. Areas that were evaluated from each paper include study design, follow-up duration, patient sample size, results of pre- and post-intervention patient-reported outcome measures (PROMs), long-term success and prolapse recurrence rate, as well as the complication rates of each technique. Findings of this literature were summarised through a qualitative analysis. Owing to the heterogeneity of the studies, including comparison groups, the definition of successful outcome and different PROMs, a quantitative analysis on the outcomes could not be carried out. Assessment of the risk of bias was completed via the National Institutes of Health (NIH) study quality assessment tool and was plotted via the Robvis tool (see Supplementary Information 2) [19].

Results

A total of 21 out of 9,273 articles identified in the initial search were included in the final data analysis [15, 20–37]. Fourteen were pre-post studies (12 retrospective and 2 prospective) and 7 of them were RCTs. All studies were published between the years 2012 to 2022. The search strategy results were visualised in Fig. 2.

Despite the authors' original intention to include studies with a follow-up period of at least 12 months, data from fewer than 12 months are present for the following reasons:

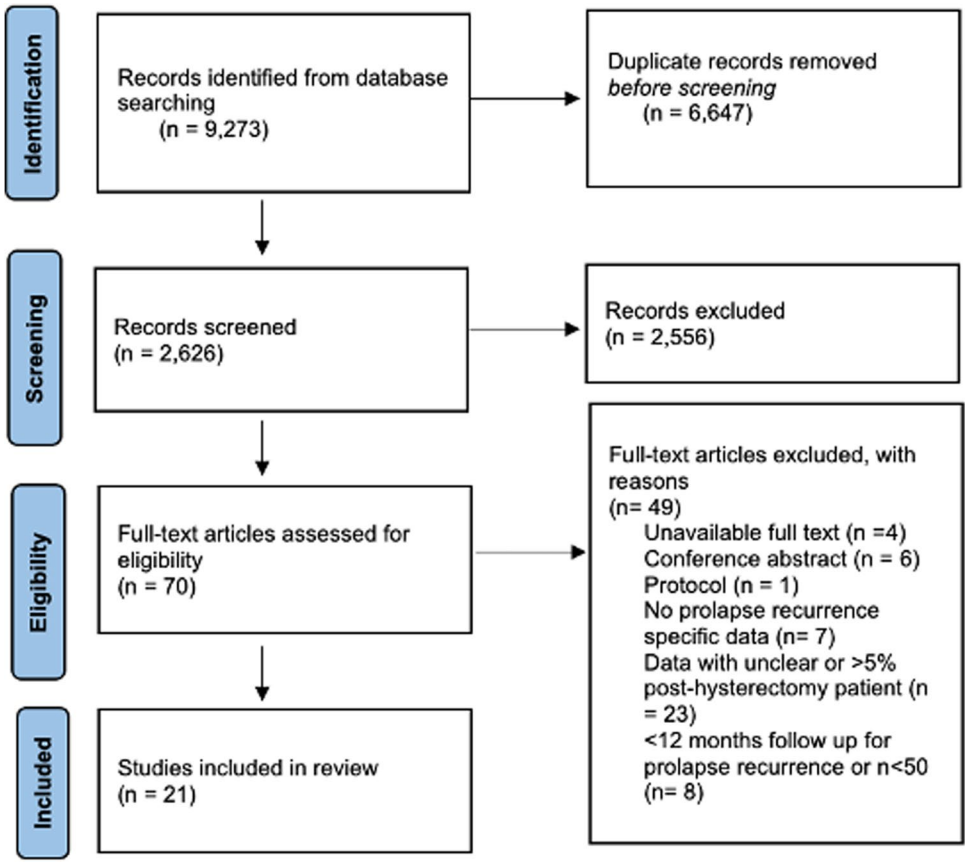

Fig. 2 PRISMA flow chart

Some retrospective studies have reported 6-month data in place for patients who were not assessed at 12 months. These 6-month data were then reported in combination with those assessed at 12 months [23, 30].
One retrospective study reported and acknowledged the different follow-up period for one of the two techniques in comparison [24].

Although the majority of the outcomes were collected from at least 12 months, this inclusion of 6-month data may contribute to bias in the results.

Success and prolapse recurrence rates

Across all studies, the definition of success and recurrence varied considerably. Definitions of success included:

1. No prolapse beyond the hymen, absence of bothersome bulge symptoms and no repeat surgery or pessary use.
2. No apical descent (POP-Q point C) greater than one half of the total vaginal length.
3. Achievement of POP stage 0 or 1.
4. Prolapse stage <II in all compartments, point C/D ≤5 and a total vaginal length of at least 7 cm.

Definitions of recurrence included:

1. Recurrent apical prolapse stage ≥2 with bothersome symptoms or repeat surgery for apical prolapse.
2. POP stage ≥2.
3. Patient report of postoperative vaginal bulge symptoms and/or any retreatment for POP with either a pessary or surgery.
4. Reoperation for the patient owing to POP-Q stage ≥2 or prolapse.

The detailed rates of each study are presented in Table 1.

Sacrocolpopexy (abdomen vs laparoscopic vs robotic)

Five studies compared the outcomes of ASC, LSC and RSC [20–24]. Nosti et al. reported a significant reduction in the apical recurrence rate from MISC (14.2%, 8 months' follow-up) compared with ASC (25.3%, 14 months' follow-up; p value < 0.001) [24].

Table 1 Comparison of reported success and apical recurrence rates between surgical procedures for pelvic organ prolapse in studies

Reference	Techniques	Success rate, *n* (%)	*p* value	Follow-up (months)	Apical recurrence rate, *n* (%)	*p* value
Sacrocolpopexy (abdominal vs laparoscopic vs robotic)						
Nosti et al. [24]	RSC	–	–	8[a]	45/262 (17.2)	0.069
	LSC	–			31/273 (11.3)	
	MISC	–	–		***76/535 (14.2)***	***< 0.001****
	ASC	–		14	***149/589 (25.3)***	
Geller et al. [20]	ASC	–	–	44	0/28 (0)	–
	RSC	–			0/23 (0)	
Siddiqui et al.[21]	RSC	–	–	12	7/86 (8.14)	0.16
	ASC	–			12/304 (3.95)	
Costantini et al. [22]	LSC	60/60 (100.00)	–	42	0/60 (0)	–
	ASC	60/60 (100.00)		44	0/60 (0)	
McDermott et al. [23]	LSC: BMI 18.5–24.9	57/64 (89.06)	0.7	26% at 6 months[b]; 74% at 12 months	–	–
	ASC: BMI 18.5–24.9	17/20 (85.00)		38% at 6 months[b]; 62% at 12 months	–	
	LSC: BMI 25–29.9	50/62 (80.65)	0.2		–	–
	ASC: BMI 25–29.9	33/38 (86.84)			–	
	LSC: BMI ≥30	21/24 (87.50)	1.0		–	–
	ASC: BMI ≥30	28/32 (87.50)			–	
Sacrocolpopexy vs hysteropexy						
Campagna et al. [25]	LSC + CH	56/58 (96.55)	0.30	12	4/58 (6.90)	0.261
	LSHP	71/78 (91.03)			10/78 (12.82)	
	LSC + CH	54/58 (93.10)	0.50	24	7/58 (12.07)	0.581
	LSHP	70/78 (89.74)			12/78 (15.38)	
Illiano et al. [26]	LSC + CH	82/82 (100)	–	60	0/82 (0)	–
	LSHP	54/54 (100)			0/54 (0)	
Sacrocolpopexy vs sacrospinous fixation						
Okcu et al. [27]	SC + AH	–	–	12	2/29 (6.90)	0.934
	SC + LH	–			1/20 (5.00)	
	SSF + VH	–			1/16 (6.25)	
Sacrocolpopexy vs uterosacral fixation						
Bastawros et al. [28]	LSC/RSC + CH	30/31 (96.77)	–	16.8	–	–
	USF + VH	30/31 (96.77)		13.6	–	
Smith et al. [29]	RSC + CH	80/92 (86.96)	0.589	Mean 63.7	0/92 (0)	–
	USF + VH	74/92 (80.43)		Mean 66	0/92 (0)	
Noor et al. [38]	MISC	332/337 (97)	0.99	12	–	–
	USF + VH	160/165 (97)			–	
Hysteropexy (laparoscopic vs vaginal, mesh vs native tissue)						
Davidson et al. [30]	MHP	–	–	Median 6 months[c] with >40% at 12 months (6–24)	***15/42 (35.71)***	***0.007**[d]***
	USHP	–			***7/55 (12.72)***	
van IJsselmuiden et al. [31]	LSHP	38/49 (77.55)	CI intervals contain 0	12	2/55 (3.64)	CI intervals contain 0
	SSHP	48/58 (82.76)			2/58 (3.45)	
Hysteropexy vs sacrospinous fixation						
Izett-Kay et al. [39]	LSHP with mesh	–	–	Mean 100	2/33 (6.0)	0.17
	SSF + VH	–			5/29 (17.2)	

Table 1 (continued)

Reference	Techniques	Success rate, *n* (%)	*p* value	Follow-up (months)	Apical recurrence rate, *n* (%)	*p* value
Hysteropexy vs uterosacral fixation						
Nager et al. [32, 33]	SSHP	–	–	12	13/86 (15.11)	> 0.05
	USF + VH	–			21/85 (24.71)	
	SSHP	–	–	24m	19/79 (24.05)	
	USF + VH	–			28/83 (33.73)	
	SSHP	–	–	36	24/78 (30.77)	
	USF + VH	–			33/80 (41.25)	
	SSHP	–	–	48	26/76 (34.21)	
	USF + VH	–			39/79 (49.37)	
	SSHP	–	–	60	***29/79 (36.71)***	***0.03****
	USF + VH	–			***42/78(53.85)***	
Milani et al. [34]	USHP	–	–	Mean 35	***11/52 (21.15)***	***0.002****
	USF + VH	–			***1/52 (1.92)***	
Schulten et al. [35]	SSHP	89/102 (87.25)	***95% CI = 0.8 to 22.2, difference is 11.5***	60	3/102 (2.94)	CI intervals contain 0
	USF + VH	77/102 (75.49)			7/102 (6.86)	
Detollenaere et al. [15]	SSHP	87/98 (88.78)	CI intervals contain 0	42	2/102 (1.96)	CI intervals contain 0
	USF + VH	75/90 (83.33)			7/100 (7.00)	
Sacrospinous fixation vs uterosacral fixation						
Topdagi Yilmaz et al. [36]	SSF + VH	71/80 (88.75)	0.588	Mean 59.28	3/80 (3.75)	0.692
	USF + VH	141/155 (90.97)		Mean 57.99	4/155 (2.58)	
Sacrocolpopexy, hysteropexy vs sacrospinous fixation						
Chen and Hua [37]	LSC + CH & LSHP	108/113 (95.58)	0.765	12	12/113 (10.62)	0.256
	SSF + VH	89/94 (94.68)			15/94 (15.96)	

Significant *P* value of <0.05 or significant confidence interval are shown in bold italic

BMI body mass index, *SC* sacrocolpopexy, *ASC* abdominal sacrocolpopexy, *RSC* robotic sacrocolpopexy, *LSC* laparoscopic sacrocolpopexy, *MISC* minimally invasive sacrocolpopexy, *CH* concurrent hysterectomy, *LSHP* laparoscopic sacral hysteropexy, *VH* vaginal hysterectomy, *LH* laparoscopic hysterectomy, *AH* abdominal hysterectomy, *SSF* sacrospinous fixation, *USF* uterosacral fixation, *MHP* mesh hysteropexy, *USHP* uterosacral hysteropexy, *SSHP* sacrospinous hysteropexy

[a]Difference in follow-up period between 8 months in MISC and 14 months in ASC from Nosti et al.'s study [24] was acknowledged by the authors to have a possible risk of biasbecause of its retrospective nature

[b]Six-month data were included for those patients who did not return for their 12-month follow-up in McDermott et al.'s study [23]

[c]Follow-up period in Davidson et al.'s study [30] was dependent on the patient's last follow-up visit. Median was 6 months, with over 40% of the patients with at least 12 months' follow-up and over 33% with at least 24 months

[d]When controlling for preoperative differences in age, menopausal status, and prolapse stage, this difference was no longer statistically significant

Sacrocolpopexy vs hysteropexy

Two studies compared the outcomes of LSC + CH and LSHP. LSC + CH demonstrated a trend of higher success and lower recurrence rate [25, 26].

Sacrocolpopexy vs sacrospinous fixation

The study by Okcu et al. compared the outcomes of SC with SSF, with no significant difference [27].

Sacrocolpopexy vs uterosacral fixation

Three studies compared the outcomes of SC and USF. MISC demonstrated a trend of a higher success rate in two studies [28, 29]. One study reported no difference [38].

Hysteropexy (laparoscopic vs vaginal, mesh vs native tissue)

Two studies compared the outcomes of hysteropexy [30, 31]. Davidson et al. reported a significant reduction in recurrence

rate for laparoscopic abdominal hysteropexy via the use of uterosacral ligament (12.7%, 6 months' follow-up) compared with mesh (35.7%, 6 months' follow-up; p value = 0.007) [30]. However, it was noted by the study's authors that the difference was not statistically significant once preoperative differences in age, menopausal status, and prolapse stage were controlled for. Van IJsselmuiden et al. reported no statistically significant difference between LSHP and SSHP [31].

Hysteropexy vs sacrospinous fixation

The study by Izett-Kay et al. compared the outcomes of LSHP using mesh with SSF, with no significant difference [39].

Hysteropexy vs uterosacral fixation

Five studies compared the outcomes of HP and USF [15, 32–35] with those of other techniques. Nager et al. reported that SSHP had a lower recurrence rate at 36.7%than the 53.9% from USF (p value = 0.03) at 5 years' follow-up [32]. Schulten et al. also reported a higher success rate following SSHP (87.3%, 60 months' follow-up) compared with USF + VH (75.5%, 60 months' follow-up) with a 95% confidence interval of 0.8–22.2 [35]. A similar trend can be observed in a study by Detollenaere's et al., which also reported a higher success rate with SSHP than USF and VH [15]. In contrast, Milani et al. reported a low recurrence rate from USF + VH (1.9%) at a mean follow-up of 35 months compared with USHP (21.2%; p value = 0.002) [34].

Sacrospinous fixation vs uterosacral fixation

Topdagi Yilmaz et al. compared the outcomes of SSF + VH with those of USF + VH. USF + VH demonstrated a trend toward a higher success and lower recurrence rate [36].

Sacrocolpopexy, hysteropexy vs sacrospinous fixation

Chen and Hua compared the outcomes of LSC or LSHP with those of SSF. LSC + CH and LSHP demonstrated a trend toward a higher success and lower recurrence rate [37].

Complication rates

The list of complications reported across studies was highly variable. For comparable analysis, complications that were included are buttock pain, pelvic pain, hip pain, dyspareunia, urinary retention, faecal and urinary incontinence, bleeding, infections, and mesh exposure. The detailed rates of each study are presented in Table 2.

Sacrocolpopexy (abdomen vs laparoscopic vs robotic)

Five studies compared the outcomes of ASC, LSC and RSC [20–24]. McDermott et al. reported a significant reduction in mesh exposure using ASC (2.6%, 6–12 months' follow-up) compared with LSC (17.7%, 6–12 months' follow-up; p value = 0.03) [23]. Nosti et al. also reported a lower overall complication rate in MISC (12.7%, 8 months' follow-up) compared with ASC (20.0%, 14 months' follow-up; p value < 0.01) [24].

Sacrocolpopexy vs hysteropexy

Two studies compared the outcomes of LSC + CH and LSHP, with both reporting a trend towards the reduction of rates of dyspareunia, stress urinary incontinence (SUI), urge urinary incontinence (UUI) and mesh exposure from LSHP compared with LSC + CH [25, 26].

Sacrocolpopexy vs sacrospinous fixation

The study by Okcu et al. compared the outcomes of ASC/LSC with SSF. A trend towards incontinence rates in ascending order was reported: SC + LH < SC + AH < SSF + VH [27].

Sacrocolpopexy vs uterosacral fixation

Three studies compared the outcomes of SC and USF. MISC demonstrated a trend towards lower incontinence rate in two studies [28, 29] as well as lower rates of pelvic pain, dyspareunia and urinary retention in one [38].

Hysteropexy (laparoscopic vs vaginal, mesh vs native tissue)

Two studies compared the outcomes of hysteropexy [30, 31]. Van IJsselmuiden et al. reported a significantly lower rate of faecal incontinence (FI, 3.5%) and overactive bladder (OAB, 13.5%) in SSHP than in LSHP using mesh (FI: 10.2%, $p = 0.017$ and OAB: 28.0%, $p = 0.012$) at 12 months' follow-up [31].

Hysteropexy vs sacrospinous fixation

Izett-Kay et al. compared the outcomes of LSHP with mesh against SSF, with no significant difference [39].

Hysteropexy vs uterosacral fixation

Five studies compared the outcomes of HP and USF [15, 32–35]. Detollenaere et al. reported a significantly lower rate of buttock pain from USF + VH (0.0%) than from SSHP (8.7%, 95% CI 2.6–14.5) at 42 months' follow-up [15].

Sacrospinous fixation vs uterosacral fixation

Topdagi Yilmaz et al. compared the outcomes of SSF + VH with USF + VH. A significantly lower rate of hip pain was noted by a VAS score of 6.08 for USF + VH (59 months'

Table 2 Comparison of reported complication rates between surgical procedures for pelvic organ prolapse in the studies

Reference	Techniques	*p* value	Follow-up (months)	Buttock pain, *n* (%)	Pelvic pain, *n* (%)	Hip pain, *n* (%)	Dyspareunia, *n* (%)	Urinary retention, *n* (%)	Incontinence, *n* (%)	Bleeding, *n* (%)	Infections, *n* (%)	Mesh exposure, *n* (%)
Sacrocolpopexy (abdomen vs laparoscopic vs robotic)												
McDermott et al. [23]	LSC: BMI 18.5–24.9	>0.05 for all	26% at 6 months[a]; 74% at 12 months	–	–	–	18/64 (28.13)	–	–	–	–	9/64 (14.06)
	ASC: BMI 18.5–24.9		38% at 6 months[a]; 62% at 12 months	–	–	–	7/20 (35)	–	–	–	–	0/20 (0)
	LSC: BMI 25–29.9	>0.05 for all ***except mesh exposure (0.03*)***		–	–	–	14/62 (22.58)	–	–	–	–	***11/62 (17.74)***
	ASC: BMI 25–29.9			–	–	–	8/38 (21.05)	–	–	–	–	***1/38 (2.63)***
	LSC: BMI ≥30	>0.05 for all		–	–	–	5/24 (20.83)	–	–	–	–	2/24 (8.33)
	ASC: BMI ≥30			–	–	–	7/32 (21.88)	–	–	–	–	3/32 (9.38)
Nosti et al. [24]	RSC	–	8[b]	–	–	–	–	–	–	>500 ml; 1/262 (0.3)	Wound 3/262 (1.1)	5/262 (1.90)
	LSC			–	–	–	–	–	–	>500 ml; 5/273 (1.8)	Wound 4/273 (1.5)	11/273 (4)
	MISC	***Overall Cx 12.7% MISC vs 20% ASC (<0.01*)***		–	–	–	–	–	–	>500 ml; 6/535 (1.1)	Wound 7/535 (1.3)	17/535 (3.21)
	ASC		14	–	–	–	–	–	–	>500 ml; 13/589 (2.2)	Wound 11/589(1.9)	15/589 (2.60)
Geller et al. [20]	ASC	>0.05 for all	44	–	–	–	–	–	–	–	–	2/28 (7.14)
	RSC			–	–	–	–	–	–	–	–	2/23 (8.70)
Siddiqui et al.[21]	RSC	>0.05 for all	12	–	–	–	–	–	–	–	Wound 6/125 (4.8)	3/125 (2.4)
	ASC			–	–	–	–	–	–	–	Wound 11/322 (3.42)	17/322 (5.28)
Costantini et al. [22]	LSC	>0.05 for all	42	–	–	–	–	–	–	–	–	3/60 (5)
	ASC		44	–	–	–	–	–	–	–	–	1/60 (1.67)

Table 2 (continued)

Reference	Techniques	*p* value	Follow-up (months)	Buttock pain, *n* (%)	Pelvic pain, *n* (%)	Hip pain, *n* (%)	Dyspareunia, *n* (%)	Urinary retention, *n* (%)	Incontinence, *n* (%)	Bleeding, *n* (%)	Infections, *n* (%)	Mesh exposure, *n* (%)
Sacrocolpopexy vs hysteropexy												
Campagna et al. [25]	LSC + CH	>0.05 for all	12	–	–	–	8/58 (13.79)	–	SUI 10/58 (17.24)	–	–	–
	LSHP			–	–	–	10/78 (12.82)	–	SUI 12/78 (15.38)	–	–	–
	LSC + CH	>0.05 for all	24	–	–	–	8/58 (13.79)	–	SUI 10/58 (17.24)	–	–	–
	LSHP			–	–	–	10/78 (12.82)	–	SUI 12/78 (15.38)	–	–	–
Illiano et al. [26]	LSC + CH	>0.05 for all	60	–	–	–	–	–	SUI 21/82 (25.61); UUI 3/82 (3.66)	–	–	6/82 (7.32)
	LSHP			–	–	–	–	–	SUI 11/54 (20.37); UUI 2/54 (2.70)	–	–	2/54 (3.70)
Sacrocolpopexy vs sacrospinous fixation												
Okcu et al. [27]	SC + AH	>0.05 for all	12	–	–	–	–	–	6/29 (20.69)	–	–	–
	SC + LH			–	–	–	–	–	3/20(15)	–	–	–
	SSF + VH			–	–	–	–	–	4/16 (25)	–	–	N/A
Sacrocolpopexy vs uterosacral fixation												
Bastawros et al. [28]	LSC/RSC + CH	N/A	16.8	–	–	–	–	–	–	–	–	0/31 (0)
	USF + VH		13.6	–	–	–	–	–	–	–	–	N/A
Smith et al. [29]	RSC + CH	>0.05 for all	Mean 63.7	–	–	–	–	–	For treatment 1/92 (1.09)	–	–	6/92 (6.6)
	USF + VH		Mean 66	–	–	–	–	–	For treatment 3/92 (3.26)	–	–	N/A
Noor et al. [38]	MISC	>0.05 for all	12	–	32/337 (10.7)	–	25/337 (8.45)	86/337 (25.8)	–	–	–	2/337 (0.6)
	USF + VH			–	11/165 (7.0)	–	12/165 (7.6)	32/165 (19.6)	–	–	–	N/A
Hysteropexy (laparoscopic vs vaginal, mesh vs native tissue)												

Table 2 (continued)

Reference	Techniques	*p* value	Follow-up (months)	Buttock pain, *n* (%)	Pelvic pain, *n* (%)	Hip pain, *n* (%)	Dyspareunia, *n* (%)	Urinary retention, *n* (%)	Incontinence, *n* (%)	Bleeding, *n* (%)	Infections, *n* (%)	Mesh exposure, *n* (%)
van IJsselmuiden et al. [31]	LSHP	>0.05 for all except ***faecal incontinence (0.017*) and OAB (0.012*)***	12	–	–	–	5/37 (13.51)	–	***FI 6/59 (10.17)***; ***OAB 14/50 (28)***	–	–	–
	SSHP			–	–	–	13/39 (33.33)	–	***FI 2/58 (3.45)***; ***OAB 7/52 (13.46)***	–	–	N/A
Davidson et al. [30]	MHP	>0.05 for all	104	–	3/27 (11.11)	–	–	–	–	–	Wound 1/42 (2.42)	3/42 (7.14)
	USHP		103.5	–	5/32 (15.63)	–	–	–	–	–	Wound 0/55 (0)	N/A
Hysteropexy vs sacrospinous fixation												
Izett-Kay et al. [39]	LSHP with mesh	N/A	Mean 100	–	–	–	–	–	–	–	–	0/33 (0)
	SSF + VH			–	–	–	–	–	–	–	–	N/A
Hysteropexy vs uterosacral fixation												
Detollenaere et al. [15]	SSHP	>0.05 for all except ***buttock pain (CI difference of 2.6 to 14.5, diff of 8.6*)***	42	***9/103 (8.73)***	–	–	–	15/103 (14.56)	–	–	3/103 (2.91)	–
	USF + VH			***0/105 (0)***	–	–	–	12/105 (11.43)	–	–	0/105 (0)	N/A
Nager et al. [32, 33]	SSHP	>0.05 for all	60	–	6/90 (6.67)	–	13/69 (18.84)	–	SUI 18/88 (20.45);UUI 22/88 (25)	Vaginal 5/90 (5.56)	UTI 38/91 (41.76); vaginal 4/90 (4.44)	7/91 (7.69)
	USF + VH			–	9/91 (9.89)	–	6/62 (9.68)	–	SUI 10/87 (11.49);UUI 17/87 (19.54)	Vaginal 2/91 (2.20)	UTI 43/92 (46.74); vaginal 9/91 (9.89)	N/A
Milani et al. [34]	USHP	>0.05 for all	Mean 35	–	–	–	2/52 (3.85)	–	SUI 15/52 (28.85);UUI 8/52 (15.38)	–	–	–
	USF + VH			–	–	–	3/52 (5.77)	–	SUI 16/52 (30.77);UUI 5/52 (9.62)	–	–	N/A

Table 2 (continued)

Reference	Techniques	*p* value	Follow-up (months)	Buttock pain, *n* (%)	Pelvic pain, *n* (%)	Hip pain, *n* (%)	Dyspareunia, *n* (%)	Urinary retention, *n* (%)	Incontinence, *n* (%)	Bleeding, *n* (%)	Infections, *n* (%)	Mesh exposure, *n* (%)
Schulten et al. [35]	SSHP	N/A	60	–	–	–	–	–	–	–	–	–
	USF + VH			–	–	–	–	–	–	–	–	N/A
Sacrospinous fixation vs uterosacral fixation												
Topdagi Yilmaz et al. [36]	SSF + VH	>0.05 for all except ***hip pain (0.00*)***	Mean 59.28	–	–	***VAS 6.85***	–	5/80 (6.25) at 12 weeks post	–	–	Bleeding at 12 weeks 3/80 (3.75)	N/A
	USF + VH		Mean 57.99	–	–	***VAS 6.08***	–	12/155 (7.74) at 12 weeks post	–	–	Bleeding at 12 weeks 3/155 (1.94)	N/A
Sacrocolpopexy vs sacrospinous fixation												
Chen and Hua [37]	LSC + CH & LSHP	>0.05 for all	12	–	–	13/113 (11.50)	–	–	New SUI 21/88 (23.86)	–	Vaginal 4/113 (3.54)	1/113 (0.88)
	SSF + VH			–	–	8/95 (8.42)	–	–	New SUI 8/70 (11.43)	–	Vaginal 5/94 (5.32)	N/A

Significant *P* value of <0.05 or significant confidence interval are shown in bold italic

BMI body mass index, *SC* sacrocolpopexy, *ASC* abdominal sacrocolpopexy, *RSC* robotic sacrocolpopexy, *LSC* laparoscopic sacrocolpopexy, *MISC* minimally invasive sacrocolpopexy, *CH* concurrent hysterectomy, *LSHP* laparoscopic sacral hysteropexy, *VH* vaginal hysterectomy, *LH* laparoscopic hysterectomy, *AH* abdominal hysterectomy, *SSF* sacrospinous fixation, *USF* uterosacral fixation, *MHP* mesh hysteropexy, *USHP* uterosacral hysteropexy, *SSHP* sacrospinous hysteropexy, *SUI* stress urinary incontinence, *UUI* urge urinary incontinence, *FI* faecal incontinence, *OAB* overactive bladder, *UTI* urinary tract infection

[a]Six-month data were included for those patients who did not return for their 12-month follow-up in McDermott et al.'s study [23]

[b]Difference in follow-up period between 8 months in MISC and 14 months in ASC from Nosti et al.'s study [24] was acknowledged by the authors as a possible risk of bias from its retrospective nature

follow-up) and a score of 6.85 for SSF +VH (58 months' follow-up, p value < 0.01) [36].

Sacrocolpopexy, hysteropexy vs sacrospinous fixation

Chen et al. compared the outcomes of SC with SSF, with no significant difference [37].

Rates of bowel, vascular and ureteral injury

Overall, the reported rates of bowel, vascular and ureteral injury across the papers varied with different techniques. For papers that reported these injuries as a complication with a follow-up of 6–104 months, the range of complication rates are as below.

The rates of bowel injury were reported to be 0.0% in LHP and SSHP [15, 25], 1.0–3.3% in USF + CH [15, 29], 1.1–1.5% in RSC [24, 29], 1.7–1.8% in LSC [24, 25], 2.0% in MISC and 5.0% in ASC [24].

The rates of vascular injury were reported to be 0.0% in LSC, MISC and SSF + CH, 0.3% in ASC and 0.5% in RSC [24, 37].

The rates of ureteral injury were reported to be 0.0% in several techniques, including RSC, LSC, MISC, SSHP, USHP and SSF + CH [24, 32, 34, 37]. The rate of ureteral injury was reported to be 0.3% for ASC [24] and ranged from 0.0 to 3.3% for USF + CH [32, 36].

The above data from this systematic review are also presented in a patient-friendly manner in Table 3 as a decision-making aid for counselling purposes.

Risk of bias

The risk of bias of each study is presented in Supplementary Material 2. Seven of the 21 papers were randomized controlled trial (RCT) studies. 50% of the RCT papers were considered unclear in their risk assessments, as other confounding factors such as the use of similar interventions were present. Blinding of participants and providers to treatment groups was not possible. The remaining 14 studies were pre-post studies, with around 70% of papers considered unclear to high risk. Selection bias was present in most studies, as the patients' population was not an appropriate representation of the whole. Reporting bias was present from missing data owing to loss to follow-up. Overall, most studies in this review had an unclear risk of bias.

Discussion

In this systematic review, the primary aim was to compare qualitatively the success, recurrence and complication rates of different apical POP surgeries. The techniques of interest included SC + CH, USHP/SSHP, SSF ± VH and USF ± VH. The overall success rate of all techniques was above 75.0% (range: 75.5–100%) over a follow-up period of 6 to 60 months, whereas the apical recurrence rate ranged from 0 to 53.9%. The complication rates ranged from 0.0% to 35.0% across a follow-up period of 6 to 104 months. Several significant findings from this review are discussed below.

Hysterectomy vs no hysterectomy

Out of the seven papers comparing techniques with and without hysterectomy [15, 25, 26, 32–35], only one paper recorded a significant reduction in recurrence rate with hysterectomy. In Milani et al.'s study, USF + VH demonstrated a lower recurrence rate of 1.9% compared with 21.2% from USHP at a mean follow-up of 25 months (p value = 0.002) [34]. Three of the 6 remaining papers showed no significant benefits in selecting hysterectomy over uterine-sparing techniques [15, 25, 26]. Furthermore, Nager et al.'s studies recorded a lower recurrence rate of 36.7% from SSHP, compared with USF+VH with a recurrence rate of 53.9% at a follow-up period of 60 months (p = 0.03) [32, 33]. Schulten et al.'s study also demonstrated a higher success rate with SSHP (87.3%) over USF + VH (75.5%) at a follow-up period of 60 months (95% CI 0.8–22.2) [35].

In terms of complication rates, the only study showing a significant difference between surgical options was Detollenaere et al. who demonstrated a 0% rate of buttock pain in patients undergoing USF + VH compared with 8.7% after SSHP (95% CI 2.6–14.5) [15]. Complication rates between hysterectomy and uterine-sparing procedures showed no significant difference.

Vaginal hysterectomy with SSF or USF has been a common recommendation for treatment of apical prolapse. More recently, women's preference for uterine sparing is increasing the uptake in such uterine-sparing apical surgery. [40]. This systematic review supports this trend and shows no significant benefit from concomitant hysterectomy with respect to risk of prolapse recurrence or complications.

Minimally invasive vs open abdominal sacrocolpopexy

Minimally invasive sacrocolpopexies such as LSC and RSC demonstrated lower recurrence and overall complication rates compared with ASC. Nosti et al. demonstrated a significant reduction in recurrence rate after MISC (14.2%) over a period of 8 months, compared with 25.3% after ASC over a period of 14 months (p value < 0.001) [24]. In addition, the same study recorded a significantly lower rate of overall complications from MISC (12.7%) compared with ASC (20.0%) with a p value < 0.01. The remaining 4 papers comparing MISC with ASC also demonstrated no significant differences in success, recurrence, or complication rates [20–23]. These

Table 3 Patient-friendly summary of reported success, recurrence, and complication findings between surgical procedures for pelvic organ prolapse in studies

		On success and recurrence rates (>12 months' follow-up)			On complications (>12 months' follow-up)			
	What happens during this operation?	Average success rates (%)	Average recurrence rates (%)	Considerations from significant findings	Reported bowel injury risk (%)	Reported vascular injury risk (%)	Reported ureteral injury risk (%)	Considerations from significant findings
Non-uterine-sparing techniques: uterus is removed via vaginal hysterectomy, so pregnancy and menstruation are not possible								
Sacrospinous fixation + VH	Cut is made inside the vagina where the top of the vagina is stitched to the sacrospinous ligament in the pelvis	91.72	10.79	–	–	0.00	0.00	Worse hip pain noted after SSF than after USF
Uterosacral fixation + VH	Cut is made inside the vagina where the top of the vagina is stitched to the uterosacral ligament in the pelvis	86.83	7.18		1.00–3.30	–	0.00–3.30	
Sacrocolpopexy	Cut is made in the abdomen in which mesh is used to attach the vagina to a bone near the bottom of the spine, can be performed as keyhole or open surgery	91.40	6.56	Lower recurrence rate in MISC than in ASC	–	–	–	Lower overall complications in MISC than in ASC, except for mesh exposure
→ MISC	Small cuts are made in the lower abdomen for keyhole surgery	93.01	5.80		2.00	0.00	0.00	
→ ASC	Large cut is made in the lower abdomen for open surgery	89.79	7.31		5.00	0.30	0.30	
Uterine-sparing techniques: uterus is maintained so pregnancy is possible								
Hysteropexy	Cut is made in the vagina or abdomen in which the cervix is attached to a ligament in the pelvis via mesh or native tissues	84.14	11.58	–	0.00	–	0.00	Lower rate of faecal incontinence and overactive bladder symptoms with native tissues than with mesh hysteropexy
→ Mesh	Mesh stays in the body permanently	–	15.12		–	–	–	
→ Native tissues	Sutures are used to attach the cervix to a ligament in the pelvis	–	8.05		–	–	–	

ASC abdominal sacrocolpopexy, *MISC* minimally invasive sacrocolpopexy, *VH* vaginal hysterectomy, *SSF* sacrospinous fixation, *USF* uterosacral fixation

findings aligned with the recent trend of preferencing RSC and LSC over the traditional open abdominal route as they can accomplish the procedure to similar standards in a minimally invasive fashion. Besides lower complication rates and similar efficacy, studies have also suggested shorter hospital stay and decreased blood loss via MISC, facilitating a quicker recovery rate compared with ASC [41, 42]. Lower wound-related morbidity translates into shorter length of stay, earlier return to work and other activities, with potential economic benefit to patients and health systems.

However, McDermott et al. noted that mesh exposure showed a discrepancy in complication rates between MISC and ASC [23]. For patients with BMI of 25–29.9, a significant rise in mesh exposure after LSC (17.7%) was recorded compared with ASC (2.6%) with a p value < 0.03 [23]. The risk of mesh erosions was more common with minimally invasive techniques in overweight patients and the author has noted that this may have been due to difficulty in controlling the thickness of vaginal dissection, as well as the reduced operational area for tactile feedback during laparoscopy [23]. Laparoscopic approaches using thumb tacks and other simplification of suturing, suggests greater difficulty in the placement of sutures, a feature overcome with robotic surgery. The latter offers a shorter learning curve and reduction in surgeon fatigue, as the robotic arms provide six degrees of freedom of instrument movement and three-dimensional visualisation. RSC also provides the added laparoscopic advantages of low morbidity and short recovery times, as well as maintaining high success rates. The benefits of robotic approaches to apical compartment prolapse repair may require well-designed multi-national studies to demonstrate a difference in outcome even where one may exist. The systematic review has not identified any such study.

SSF with VH vs USF with VH

No significant differences were noted between SSF and USF in terms of success and recurrence rates. Topdagi Yilmaz et al. reported a success rate of 88.8% for SSF over a mean follow-up period of 59 months and 91.0% for USF over a mean follow-up period of 58 months [36]. For complications, significant hip pain was noted after SSF (p value < 0.01) with no additional significant differences in other complications [36]. Postoperative pain scoring (VAS) was reported to be 6.85 for patients following SSF, indicating a higher level of pain, compared with 6.08 following USF [36]. This pain receded within a mean period of 5 weeks for most patients, with permanent pain in one [36]. As reported by previous studies, hip pain caused by SSF may be due to compression of the gluteal nerve [9].

Based on their success and recurrence rates, no clear superiority can be reported for SSF or USF. Both procedures demonstrated a lower rate of severe adverse effects owing to the known advantages of natural tissue-based repairment surgery. However, the sacrospinous ligament tends to be the preferred ligament among surgeons owing to the technical ease of application and shorter operation time [9]. Uterosacral ligament may also be avoided because of the potential risk of ureteral injury compared with SSF [43]. Vaginal USF has been linked with a 3.0–8.0% incidence risk of ureteral injury whereas laparoscopic USF has been linked with close to 0.0%, as the laparoscopic approach provides better visualisation, helping to prevent ureteral injury. Although the efficacy between USF and SSF for treating apical POP is comparable, the risk profile of the two procedures varies. Each patient should be counselled based on her personal context, especially for those with existing pain or ureteral issues.

Findings on success and complications

Despite the limitations of relatively small numbers, variable outcome measures and duration of follow-up, overall statistically significant findings for a high success and low recurrence rate can be summarised by the following: MISC is superior to ASC and SSHP is superior to USF + VH, which is superior to USHP and MHP.

The overall statistically significant findings for a low complication rate can be summarised by the following: MISC recorded a lower overall complication rate than ASC except in mesh exposure; and USF + VH tends to perform better than SSHP and SSF in terms of complications, with SSHP performing better than MHP regarding FI and OAB rates.

Comparing findings from this systematic review with those of the 2021 systematic review and meta-analysis by Larouche et al. [44] as well as the 2016 Cochrane Review by Maher et al. [45] similarities and differences between these reviews were noted. Larouche et al. [44] found a lower overall recurrence rate in MISC than in ASC, which aligned with our results, in which MISC demonstrated a lower recurrence and lower overall complication rate against ASC. The Cochrane Review, which included only RCTs, reported that the evidence was inconclusive when comparing uterine-preserving surgery with vaginal hysterectomy. However, 3 out of 7 papers comparing hysterectomy with no hysterectomy in this review demonstrated a lower recurrence and a higher success rate via uterine-preserving techniques compared with hysterectomy. Another 3 papers demonstrated no significant benefits in selecting hysterectomy over uterine-sparing techniques. Together with Larouche et al.'s [44] findings on the reduced operative time, blood loss and mesh exposure rate from hysteropexy, women should be offered the possibility of these less invasive uterine-sparing techniques, as no significant benefit from concomitant hysterectomy over uterine preservation can be reported.

Strengths and limitations

The strength of this review lies in the extensive literature search in which significant findings on success, recurrence, and complication rates were reported. These findings support the hierarchy of apical prolapse surgical management for the use of patient-counselling procedures that we have provided. A rigorous methodology has also been followed to ensure the robustness of its findings.

Several limitations are present in this systematic review. First, 14 out of 21 studies are pre-post studies with no control groups. Hence, the quality of such studies must be considered when interpreting the findings of this review. Second, the definition of success, recurrence and the selected complication types varied drastically between the studies. A wide discrepancy in the baseline patient population was also noted, especially for the inclusion of other gynaecological surgeries that may have occurred concomitantly or prior to intervention. Third, although the authors attempted to ensure uniformity in the sample size and follow-up period when selecting papers, both factors remained relatively inconsistent, leading to potential imprecision when interpretating outcomes. Owing to the heterogeneity of these studies in comparison groups, definitions and different PROMs, the authors did not perform a meta-analysis. Further studies to evaluate the efficacy and complications of each form of surgical management of POP under more controlled settings with standard definitions of success and recurrence, as well as a consistent baseline patient population, sample size and follow-up period, will be beneficial to provide more accurate comparisons.

Conclusion

This systematic review demonstrated an overall success rate of at least 75% for the surgical options mentioned. Based on significant findings of success and risk of recurrence, a general recommendation to the counselling procedure for patients considering surgical management for apical POP include:

1. There is a lack of evidence to conclude that hysterectomy is superior to uterine-sparing approaches.
2. MISC should be considered over ASC given the similar efficacy and significant reduction in overall complication rates.
3. The superiority of MHP is unproven relative to native tissue hysteropexy.

Given the lack of inferiority of native tissue repair and the potential risk of mesh complications, caution should be used in offering MHP. Women interested in surgical correction of apical POP should be well informed on all possible options and counselled with her pre-existing health conditions in mind. To provide personalised treatments and better-informed patient care, further studies are required to allow direct comparisons between the methods of surgical management in more controlled settings.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s00192-022-05408-x

Declarations

Conflicts of interest The authors declare that they have no conflicts of interest.

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