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REVIEW ARTICLE

# Uterine-preserving surgeries for the repair of pelvic organ prolapse: a systematic review with meta-analysis and clinical practice guidelines

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## Abstract

**Introduction and hypothesis** We aimed to systematically review the literature on pelvic organ prolapse (POP) surgery with uterine preservation (hysteropexy). We hypothesized that different hysteropexy surgeries would have similar POP outcomes but varying adverse event (AE) rates.

**Methods** MEDLINE, Cochrane, and clinicaltrials.gov databases were reviewed from inception to January 2018 for comparative (any size) and single-arm studies ($n \geq 50$) involving hysteropexy. Studies were extracted for participant characteristics, interventions, comparators, outcomes, and AEs and assessed for methodological quality.

**Results** We identified 99 eligible studies: 53 comparing hysteropexy to POP surgery with hysterectomy, 42 single-arm studies on hysteropexy, and four studies comparing stage ≥2 hysteropexy types. Data on POP outcomes were heterogeneous and usually from <3 years of follow-up. Repeat surgery prevalence for POP after hysteropexy varied widely (0–29%) but was similar among hysteropexy types. When comparing sacrohysteropexy routes, the laparoscopic approach had lower recurrent prolapse symptoms [odds ratio (OR) 0.18, 95% confidence interval (CI) 0.07–0.46), urinary retention (OR 0.05, 95% CI 0.003–0.83), and blood loss (difference −104 ml, 95% CI −145 to −63 ml) than open sacrohysteropexy. Laparoscopic sacrohysteropexy had longer operative times than vaginal mesh hysteropexy (difference 119 min, 95% CI 102–136 min). Most commonly reported AEs included mesh exposure (0–39%), urinary retention (0–80%), and sexual dysfunction (0–48%).

**Study Registration**
Registration with PROSPERO (CRD42017067899) and full protocol can be found at: http://www.crd.york.ac.uk/PROSPERO/display_record.php?ID=CRD42017067899

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**Conclusions** Hysteropexies have a wide range of POP recurrence and AEs; little data exist directly comparing different hysteropexy types. Therefore, for women choosing uterine preservation, surgeons should counsel them on outcomes and risks particular to the specific hysteropexy type planned.

**Keywords** Hysteropexy · Prolapse · Surgery · Uterine preservation · Systematic review · Risks

## Introduction

Pelvic organ prolapse (POP) is a common disorder, with an 11% lifetime risk of requiring surgery [1]. Given the large aging population, the number of surgeries for POP is expected to grow 43% in the coming three decades, increasing the surgical demand to >245,000 surgeries per year by 2050 [2], more than double the present annual rate of reconstructive mastectomy for breast cancer [3]. Women are increasingly choosing apical POP surgeries that preserve the uterus, a set of procedures also known as hysteropexies [4]. Past survey data indicate that more than a third of women will choose uterine-preserving POP surgery provided outcomes are similar [5], and systematic reviews demonstrate that patients may enjoy some safety benefits with hysteropexy as opposed to POP surgery with hysterectomy [6–8].

To meet this rising demand for uterine-preserving POP surgery, surgeons must improve their knowledge of hysteropexy in order to provide adequate surgical counseling for interested patients. Given the wide variety of hysteropexy approaches described in the literature and the heterogeneity of research methods used to investigate these surgeries, synthesis of this knowledge is challenging. No systematic reviews or guidelines exist to guide choice of hysteropexy type. Clinicians need coherent, evidence-based counseling points for patients regarding the risks and advantages of various hysteropexy approaches.

The Systematic Review Group of the Society for Gynecologic Surgeons (SGS) recently conducted a systematic review of randomized and nonrandomized studies comparing uterine-preserving surgeries for apical repair of POP with POP surgeries involving hysterectomy, with clinical practice guidelines (CPGs) on the choice between these procedures [8]. Here, we describe in greater detail data from comparative and large single-arm studies investigating hysteropexy, including studies comparing different types of hysteropexy.

## Methods

We searched MEDLINE, clinicaltrials.gov, and the Cochrane database from inception to January 2018. The searches included terms for various relevant procedures (Appendix 1). These are further analyses of our previously published systematic review utilizing the same search strategy to compare uterine preservation with hysterectomy in POP surgery [8]. Eligible studies had to include at least one group of adult women with a uterus in place and POP as their primary pathology who underwent uterine-preserving POP surgery with an apical support procedure. Studies had to report on one or more relevant outcomes in four categories: prolapse outcomes, other pelvic floor outcomes, perioperative outcomes, and adverse event (AEs). We included randomized controlled trials (RCTs) or nonrandomized comparative studies (nRCSs) of any size that compared one type of uterine-preserving apical POP surgery to another, as well as prospective or retrospective single-group studies (in which all women had uterine-preserving surgery) with at least 50 participants. RCTs and nRCSs that had a single arm of women receiving uterine-preserving surgery (e.g., compared with hysterectomy) were treated as single-group studies for the purposes of this manuscript. Publications could be in any language or any format (e.g., poster, abstract) that allowed for eligibility determination and outcome extraction.

### Study selection and data extraction

Abstracts and full texts were independently screened for eligibility in duplicate by 12 reviewers using the online software Abstrackr (http://abstrack.cebm.brown.edu/) [9]. Discrepancies were resolved by a third reviewer. Data extraction was completed by the same 12 independent reviewers, with each study extracted by two reviewers, at least one of whom had prior systematic review experience [10, 11]. We extracted data on study design, surgical interventions, population characteristics, and rates of outcomes of interest.

### Assessment of risk of bias

We assessed the methodologic quality of each study using predefined criteria from a three-tier system in which studies were graded as good (A), fair (B), or poor (C) based on scientific merit, the likelihood of biases, and the completeness of reporting. This grading was founded on the evaluators' impression of the study's risk of bias according to the Cochrane Risk of Bias tool and relevant questions from the Newcastle-Ottawa Scale [12, 13]. Qualities of individual outcomes were separately graded within each study based on adequate

outcome description, reproducibility and reliability, and outcome importance from the patient perspective.

## Data synthesis

We categorized surgeries as:

(1) open mesh sacrohysteropexy (SHP);
(2) laparoscopic or robotic-assisted mesh SHP;
(3) other open abdominal hysteropexy procedures (non-SHP);
(4) other laparoscopic or robotic-assisted hysteropexy procedures (non-SHP);
(5) transvaginal mesh hysteropexy (VMHP);
(6) transvaginal native-tissue hysteropexy (VNTHP) such as sacrospinous hysteropexy (SSHP) or uterosacral hysteropexy (USHP);
(7) the Manchester procedure;
(8) LeFort colpocleisis. Based on reporting by eligible studies and prioritization by the review group, we evaluated the following outcomes:

(1) repeat surgery for prolapse;
(2) prolapse recurrence, allowing any stated definition;
(3) prolapse recurrence symptoms;
(4) any postoperative urinary incontinence (UI), when necessary prioritizing stress UI (SUI), if reported;
(5) de novo postoperative UI, again prioritizing SUI, if reported;
(6) postoperative urinary retention or voiding dysfunction, allowing any definition;
(7) mesh exposure;
(8) sexual dysfunction, including dyspareunia;
(9) estimated blood loss (EBL);
(10) operating time (OT); and
(10) hospital stay duration.

We analyzed the percentages of women following each surgery type who experienced each categorical outcome and average values of continuous outcomes. When at least two studies reported the same outcome associated with the same type of surgery, we meta-analyzed results regardless of the degree of heterogeneity. Meta-analyses were conducted in OpenMeta (www.cebm.brown.edu/openmeta) [14] for either the arcsine transformed proportion [15] or mean value (for single surgery type analyses), or the odds ratio (OR) or difference in mean values (for comparative studies). We meta-analyzed with random-effects-model-restricted maximum likelihoods. The $I^2$ statistic was calculated for all meta-analyses to evaluate statistical heterogeneity.

In data synthesis and reporting, we considered methodologic quality, consistency of results across studies, directness of evidence, and other factors, such as imprecision or sparseness of evidence, to determine an overall quality of evidence in accordance with the Grades for Recommendation, Assessment, Development and Evaluation system, which uses four potential quality ratings: high, moderate, low, and very low [16]. If adequate data existed to make guideline statements or recommendations regarding the evidence for one type of hysteropexy over another, we were prepared to develop guideline statements incorporating the balance between benefits and harms of surgeries on which comparative data were available. All guideline statements would include a level of strength (strong or weak) based on the quality of relevant evidence and significance of medical benefit. Strong recommendations are worded as "we recommend" and indicate what most practitioners would do in a given clinical scenario. Weak recommendations are worded as "we suggest" and imply that the magnitude of the benefits are less certain. Support for recommendations could come from high-, moderate-, or low-quality studies (A, B, and C) independent of recommendation strength.

## Results

In the original search in 2016, we found 7324 citations, of which 337 abstracts were eligible and screened by full text. Of these screened full texts, 103 underwent data extraction, with 94 studies included in the final review. Five additional eligible studies were found in the updated search January 2018, resulting in 99 studies included in this publication: 53 studies comparing uterine-preserving POP surgery to a POP surgery involving hysterectomy (previously reported in prior review) [8], and 46 studies that included only arms describing a uterine-preserving POP surgery (Fig. 1). Within these 46 studies, there were 42 case series of ≥50 patients regarding a uterine-preserving POP surgery (35 reconstructive hysteropexy and 7 LeFort colpocleisis) and four nRCSs that compared one type of uterine-preserving surgery with another [17–20]. The 46 trials that included only uterine-preserving surgery arms are described in Tables 1, 2, 3, and 4; the nature and quality of the 53 trials comparing uterine-preserving POP surgery to POP surgery with hysterectomy have been previously described in or did not meet criteria for inclusion in the prior review [8]. The overall quality of evidence was moderate for all 99 trials which included at least one group of women having a uterine-preserving POP surgery. However, the overall quality of evidence from the 46 trials that only included hysteropexy arms was low, as the majority were single-group studies of low quality.

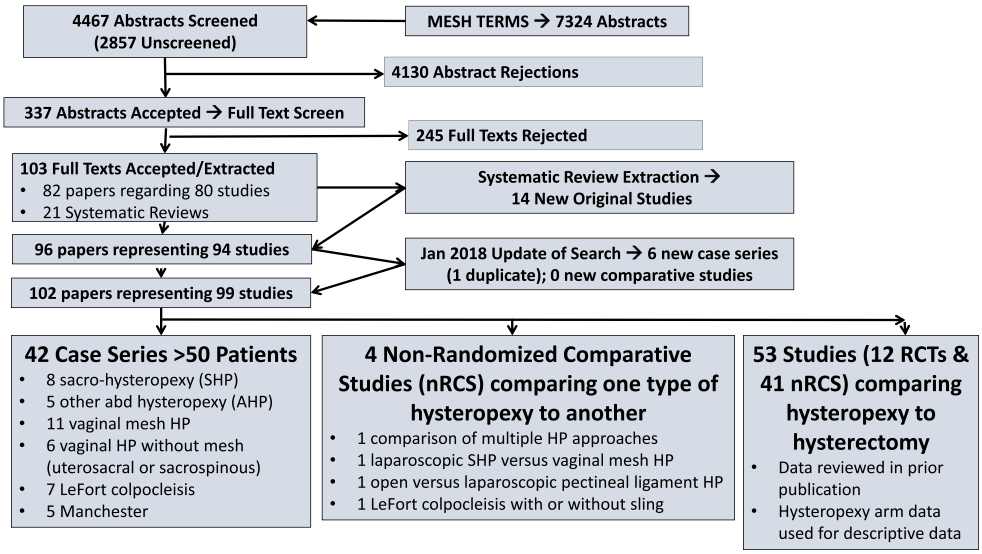


**Fig. 1** Screening, eligibility, and extraction of relevant studies for this systematic review on uterine-preserving pelvic organ prolapse (POP) surgery

## Abdominal or laparoscopic/robotic sacrohysteropexy or other abdominal hysteropexies

Two retrospective cohort studies, one of high [18] and one of moderate [17] quality, compared some approach of mesh SHP to vaginal hysteropexy. Gutman et al. compared laparoscopic SHP to VMHP [18], and Kow et al. compared multiple different arms including open- abdominal SHP, robotic SHP, laparoscopic SHP, robotic or laparoscopic uterosacral suspension, VMHP, and various types of VNTHP (Table 1) [17]. Two retrospective nRCSs [17, 19], both of moderate quality, compared the open approach to SHP with a laparoscopic/robotic approach. Paek et al. compared laparoscopic or robotic SHP to open abdominal SHP [19], and Kow et al. compared multiple approaches to abdominal hysteropexy (native tissue suspension or mesh SHP), as mentioned earlier [17].

Eight single-arm studies, all of low quality, described some approach to SHP [21–28]. Five of these investigated a laparoscopic approach [22–24, 26, 28], two a robotic approach [21, 25], and one an open approach [27]. We also utilized the SHP arms from 12 publications representing 11 studies, described in our prior publication, which compared SHP to POP surgeries with hysterectomy [8].

One study of low quality compared open and laparoscopic approaches to an abdominal native-tissue hysteropexy (pectineal ligament suspension) [20]. Four case series, all of low quality, investigated an abdominal approach to hysteropexy that was not SHP (Table 1) [29–32]. Four additional studies detailed in our prior review compared some type of non-SHP abdominal hysteropexy to POP surgery with hysterectomy, and the hysteropexy arms from these studies were utilized in these analyses [8].

Prolapse recurrence outcomes following SHP and other abdominal hysteropexies, either with open or laparoscopic approaches, were quite heterogeneous ($I^2$ ranges from 31 to 86%, Table 5). Prolapse outcomes were mostly investigated in the short- to medium-term (6–64 months, Table 1), with a total range of follow-up from 6 months [33] to 12 years [31]. The prevalence of recurrent POP in these time frames varied from 0 to 28% for repeat surgery for prolapse, 0–32% for prolapse recurrence by set definitions, and 5–30% for subjective return of prolapse or recurrent prolapse symptoms (Table 5). Prolapse recurrence by objective definitions was common following laparoscopic/robotic SHP (2 studies, moderate quality, mean 20.9%, 95% CI 4.4–45.4%), but recurrent prolapse symptoms (5 studies, low quality, mean 10.1%, 95% CI 6.6–14.2%) or repeat prolapse surgery (10 studies, moderate quality, mean 3.9%, 95% CI 1.9–6.6%) were less common following this procedure.

UI outcomes, whether any postoperative or de novo UI, were also highly heterogeneous regarding abdominal hysteropexy by laparoscopic or open approaches ($I^2$ 0–93%), although many procedures and trials lacked data on this outcome (Table 5). Most data on UI was regarding SHP (laparoscopic or open), where the prevalence of postoperative UI ranged from 0 to 42% overall (6 studies, low quality, mean 16.9%, 95% CI 5.8–27.9%), and de novo UI ranged from 1 to 10% (4 studies, low quality, mean 4.4%, 95% CI 0.2–8.5%).

AE rates for abdominal hysteropexies varied widely and were scantily reported, but the most commonly reported AEs other than UI included urinary retention (described in some trials as objective or subjective voiding dysfunction), mesh exposure, and sexual dysfunction (usually reported in the form of dyspareunia). Urinary retention had a wide variety of definitions and time frames, as indicated by a prevalence range of 0–79%, but the mean rate was lower for laparoscopic (3 studies, moderate quality, mean 2.9%, 95% CI 1.0–5.6%) than for open (4 studies, moderate quality, mean 25.5%, 95% CI 2.4–61.6) approaches to SHP, with direct comparison in only one trial (moderate quality, OR 0.05, 95% CI 0.003–

**Table 1** Studies evaluating sacrohysteropexy (SHP) or other abdominal hysteropexy procedures (non-SHP) with only arms involving uterus preservation (hysteropexy) in prolapse surgery

| Study | Study design | Study quality | Mean age ± SD or (range) | Mean BMI ± SD or (range) | Surgeries described or compared | No. women | Length of follow-up (actual or mean/median) | Definition of POP recurrence |
|---|---|---|---|---|---|---|---|---|
| Kow et al. [17] | Retr nRCS | B | 46.6 ± 13.5 | 26.1 ± 4.7 | Abd SHP vs. LS SHP vs. RA SHP vs. vag HP | 240 (15 abd SHP; 95 LS SHP; 28 RA SHP; 102 vag HP) | Median 16.4 months abd SHP; 22.6 months LS SHP; 6.1 months RA SHP; 14 months vag HP | Positive response PFDI questions[a] and POP-Q stage ≥ II |
| Gutman et al. [18] | Pros nRCS | A | 58.3 ± 9.4 LS SHP; 65.7 ± 9.4 VMHP | 26.2 ± 5.3 LS SHP; 27 ± 4.2 VMHP | LS SHP vs. VMHP | 150 (74 LS SHP; 76 VMHP) | 1 year | Positive response PFDI question[b] or C > -TVL/2; POP-Q points beyond hymen or reoperation or pessary |
| Paek et al. [19] | Retr nRCS | B | 62.2 ± 11.6 | 25.1 ± 3.2 | Abd SHP vs. LS or RA SHP | 111 (57 abd SHP; 54 LS or RA SHP) | Mean 30 months | Nonvalidated questionnaire (subjective) or POP-Q stage ≥ II (objective) at 12 months |
| Joshi et al. [20] | Retr nRCS | C | 26.5 ± 4.5 | 23 ± 2.2 | Abd vs. LS pectineal ligament HP | 194 (abd 176; LS 18) | Mean 6.5 year | Descent of cervix to lower half of vagina (Baden-Walker stage ≥ I) |
| Mourik et al. [21] | Retr CS | C | 57.7 (36–77) | 25.8 (20.3–35.2) | RA SHP | 50 | Median 16 months | Baden-Walker grade ≥ II |
| Costantini et al. 2011 [22] | Pros CS | C | 58.8 ± 12.4 (26–77) | 24.6 (18.6–41.9) | Abd and RA SHP | 55 (47 abd SHP; 8 RA SHP) | 63.8 ± 33 months | Prolapse symptoms or voiding disorder (subjective) or POP-Q stage ≥ II (objective) |
| Rahmanou et al. 2014 [23] | Pros CS | C | 55.1 (31–76) | 26.5 (18–39) | LS SHP | 140 | 1–4 years | Prolapse at/beyond hymen |
| Fayyad and Siozos [24] | Pros CS | C | 61 (24–78) | 29 (22–40) | | 70 | 1 year | Vag bulge >none on P-QOL |

**Table 1** (continued)

| Study | Study design | Study quality | Mean age ± SD or (range) | Mean BMI ± SD or (range) | Surgeries described or compared | No. women | Length of follow-up (actual or mean/median) | Definition of POP recurrence |
|---|---|---|---|---|---|---|---|---|
| | | | | | LS SHP (vag placement of mesh) | | | (subjective) or POP-Q stage ≥ II (objective) |
| Grimminck et al. [25] | Pros CS | C | 56.8 (36–77) | 25.2 (19.6–35.2) | RA SHP | 100 | 5 years | POP-Q stage ≥ II |
| Kupelian et al. [26] | Retr CS | C | Mean 58 (95% CI 38–75) | Median 26 (IQR 6) | LS SHP (wrap-around on vagina) | 113 | Mean 2.6 years | Not defined, but reported PGI-I worse and POP-Q stages at 3 months |
| Khan et al. [27] | Retr CS | C | 32.6 | ND | Abd SHP | 60 | 6 weeks to 5 years (unclear when most prolapse follow up donw) | Lower-most part of cervix below ischial spines |
| Krause et al. [28] | Pros CS | B | 44 (30–70) | ND | LS SHP | 81 | Mean 20.3 months | Baden-Walker grade ≥ II |
| Hsieh [29] | Pros CS | C | 42.33 (39.93–44.-73) | ND | LS round ligament HP | 55 | Mean 24.2 months | Uterine prolapse to POP-Q stage >0 |
| Rimailho et al. [30] | Retr CS | C | 52 (31–70) | ND | Abd mesh suspension of cervix to ischial spines | 92 | Mean 4.5 years | Baden-Walker grade I or II |
| Khanam et al. [31] | Retr CS | C | (20–40) | ND | Abd rectus sheath hysteropexy | 280 | 3% patient up at 12 years (most 6–12 months) | Patient-reported symptoms on follow-up (no validated questionnaire) |
| Veit-Rubin et al. [32] | Retr CS | C | Median 57 (33–81) | Median 26 (18–39) | LS lateral mesh suspension | 254 | Median 7.5 months | POP-Q < −1 at all points |

*nRCS* nonrandomized comparative study, *CS* case series, *BMI* body mass index, *SD* standard deviation, *Retr* retrospective, *Pros* prospective, *SHP* sacrohysteropexy, *Abd* open abdominal, *LS* laparoscopic (nonrobotic), *RA* robotic-assisted, *Vag* vaginal/transvaginal, *HP* hysteropexy, *POP-Q* Pelvic Organ Prolapse Quantification, *PFDI* Pelvic Floor Distress Inventory, *P-QOL* Prolapse Quality of Life Questionnaire, *PGI-I* Patient Global Impression of Improvement, *VMHP* vaginal mesh hysteropexy, *TVL* total vaginal length, *ND* no data

[a] Do you usually have a sensation of bulging or protrusion from the vaginal area? and Do you usually have a bulge or something falling out that you can see or feel in the vaginal area?

[b] Do you usually have a bulge or something falling out that you can see or feel in the vaginal area?

**Table 2** Studies evaluating vaginal mesh hysteropexy (VMHP) with only arms involving uterus preservation (hysteropexy) in prolapse surgery

| Study | Study design | Study quality | Mean age ± SD or (range) | Mean BMI ± SD or (range) | Surgeries described or compared | No. women | Length of follow-up (actual or mean/median) | Definition of POP recurrence |
|---|---|---|---|---|---|---|---|---|
| Khandwala et al. 2014 [34] | Retr CS | C | 67.0 ± 11.26 (34–89) | 28.2 ± 4.9 (20.3–45.7) | Prolift-M SS VMHP | 74 | Mean 13.7 months | Positive response PFDI question[a] or POP-Q stage ≥ II or pessary or surgery for prolapse |
| Sheng et al. [35] | Pros CS | C | ND | ND | VMHP (various types) | 65 | 2 years | Not defined |
| Jirschele et al. [36] | Pros CS | C | 67.0 ± 11.3 | 26.0 ± 4.4 | SS VMHP | 99 | 12 months | Positive response PFDI question[a]or POP-Q points at or beyond hymen (>0) |
| Khandwala et al. 2013 [37] | Pros CS | C | 66.9 ± 10.5 | 28.1 ± 4.6 | Prolift-M SS VMHP | 157 | Mean 13 months | Positive response PFDI question[a] or POP-Q stage ≥ II or same or worse on SGI |
| De Vita et al. [78] | Pros CS | C | 55.5 (38–74) | ND | VMHP (anterior/central, posterior/central, or total mesh) | 80 | Median 21 months | POP-Q stage ≥ II |
| Huang et al. [79] | Pros CS | C | 64.8 ± 10.3 (40–85) | 23.6 ± 2.8 | VMHP (IVS, Perigee, Prolift) | 67 | Mean 19.6 months | POP-Q points Ba, Aa, C > −1 |
| Milani et al. [80] | Pros CS | C | 64 (16–93) | 25.6 (18.9–41.8) | VMHP | 64 | 12 months | POP-Q stage ≥ II of treated compartment or pessary or surgery for prolapse |
| Meschia et al. [81] | Retr CS | C | ND | ND | Prolift-M SS VMHP | 236 | Mean 8 months | Not defined (only abstract available) |
| Feiner et al. [82] | Pros CS | C | 61 ± 11 | 25 ± 4 | Anterior Prolift with SSHP | 100 | 12 months | POP-Q stage ≥ II |
| Fink et al. [83] | Retr CS | C | 61 (43–82) | 27.9 (19.1–37.8) | Endofast VMHP | 66 | Mean 22 months | POP-Q stage ≥ II |
| Li et al. [84] | Pros CS | C | ND | ND | Prolift A or prolift T VMHP | 74 | 19 months (up to 33 months) | POP-Q stage > II |

*CS* case series, *Retr* retrospective, *Pros* prospective, *BMD* body mass index, *SD* standard deviation, *vag* vaginal/transvaginal, *HP* hysteropexy, *POP-Q* Pelvic Organ Prolapse Quantification, *PFDI* Pelvic Floor Distress Inventory, *SGI* Subject Global Impression questionnaire, *SS* sacrospinous, *SSHP* sacrospinous hysteropexy, *VMHP* vaginal mesh hysteropexy, *ND* no data

[a] Yes, and more than not at all bothersome in response to: Do you usually have a bulge or something falling out that you can see or feel in the vaginal area?

**Table 3** Studies evaluating vaginal native tissue hysteropexy (VNTHP), including sacrospinous hysteropexy (SSHP), uterosacral hysteropexy (USHP), and the Manchester procedure, with only arms involving uterus preservation (hysteropexy) in prolapse surgery

| Study | Study design | Study quality | Mean age ± SD or median (range) | Mean BMI ± SD or (range) | Surgeries described or compared | No. women | Length of follow-up (actual or mean/median) | Definition of POP recurrence |
|---|---|---|---|---|---|---|---|---|
| Lin [42] | Pros CS (2 series; 1 to identify risk factors for recurrence and 1 with risk factors eliminated | C | 45.1 ± 12.5 | ND | SSHP | 60 (33 risk-factor study, 27 clinical study) | 5 years | Not defined |
| Dietz et al. 2008 [43] | Pros CS | C | 57.2 ± 11.9 | ND | SSHP | 72 | Mean 12.7 months | POP-Q stage ≥ II |
| Dietz et al. 2007 [44] | Pros CS | C | 64 ± 13.5 | ND | SSHP | 133 | Mean 22.5 months | POP-Q stage ≥ II |
| Dubernard et al. [45] | Retr CS | C | Median 37 (27–64) | ND | Shirodkar procedure (trachelectomy and USHP) | 51 | Median 81 months | Recurrence of prolapse requiring additional surgery |
| Bohoussou et al. [46] | Retr CS | C | 64.7 ± 10.7 (39–92) | ND | Various HP (does not specify) | 268 | ND | Not measured (not one of outcomes) |
| Abdulsid et al. [47] | Retr CS | C | NDn | ND | Various HP (does not specify) | 72 | >3 months (no further data) | Not defined |
| Nava et al. [50] | Retr CS | C | (20–50) | ND | Manchester[a] | 55 | 45 days | Not measured |
| Oversand et al. [51] | Retr CS | C | Median 67 (IQR 56–75) | ND | Manchester | 431 | Up to 5 years | POP-Q stage ≥2 and nonvalidated patient subjective success[b] at 1 year |
| Ayhan et al. [52] | Retro CS | C | 34.68 ± 4.24 | ND | Manchester | 202 | Mean 3.6 years | Baden- Walker grade 2–3 |
| Conger and Keettel [53] | Retr CS | C | ND | ND | Manchester | 960 | ND | Patient-reported symptoms of prolapse |
| Tipton and Atkin [54] | Retr CS | C | 43 (29–52) | ND | Manchester | 82 | Median9 years | Patient-reported symptoms of prolapse with subsequent pregnancy |

*CS* case series, *IQR* interquartile range, *Retr* retrospective, *Pros* prospective, *vag* vaginal/transvaginal,*BMI* body mass index, *SD* standard deviation, *HP* hysteropexy, *POP-Q* Pelvic Organ Prolapse Quantification, *SSHP* sacrospinous hysteropexy, *USHP* uterosacral ligament plication hysteropexy, *VMHP* vaginal mesh hysteropexy, *ND* no data

[a] Vaginal procedure involving trachelectomy and cardinal/uterosacral ligament plication across the midline distal to the cervical stump

[b] Defined as being completely cured or improved from the prolapse problem, with options in the checklist being cured, improved, unchanged, and deteriorated

**Table 4** Studies evaluating LeFort colpocleisis with only arms involving obliterative surgery for prolapse with uterus preservation

| Study | Study design | Study quality | Mean age ± SD or median (range) | Mean BMI ± SD or (range) | Surgeries described or compared | No. women | Length of follow-up (actual or mean/median) | Definition of POP recurrence |
|---|---|---|---|---|---|---|---|---|
| Catanzarite et al. [61] | Retr nRCS | B | ND | ND | LeFort with vs. without sling for SUI | 283 (92 with sling; 191 without sling) | 30 days | Not measured |
| Ubachs et al. [62] | Retr CS | C | ND | ND | LeFort | 141 | Mean 63.2 months | Not defined |
| Mueller et al. [63] | Retr CS | C | Separated categorically | ND | LeFort | 4776 | ND | Not measured |
| Szczesniewska et al. [64] | Retr CS | C | 76.5 (68–85) | 35% BMI >30 | LeFort | 65 | ND | Symptomatic improvement (nonvalidated) |
| Marin Ardila [65] | Retr CS | C | 72.3 (55–88) | ND | LeFort | 51 | 6 months | Not defined |
| Goldman et al. [66] | Retr CS | C | Elderly (no other data) | ND | LeFort | 118 | 1–15 years | Not defined |
| Falk and Kaufman [67] | Retr CS | C | 63.9 (Range 50–76) | ND | LeFort | 100 | 2–22 years | Not defined other than good anatomic result |
| Wang et al. [68] | Retr CS | C | 72.4 ± 7.0 | 22.5 ± 2.6 | LeFort | 278 | Median 3 years | Not defined |

*nRCS* nonrandomized comparative studies, *POP* pelvic organ prolapse, *CS* case series, *SUI* stress urinary incontinence, *Retr* retrospective, *BMI* body mass index, *SD* standard deviation, *ND* no data

0.83) [19]. Mesh exposure in relevant surgeries ranged from 0 to 6.8%, with similar rates described with open (6 studies, moderate quality, mean 3.8%, 95% CI 1.5–7.0%) and laparoscopic (9 studies, moderate quality, mean 1.8%, 95% CI 0.7–3.4%) approaches, with the direct comparison made in three trials (moderate quality, OR 0.33, 95% CI 0.05–2.41) [17, 19, 20]. Sexual dysfunction was fairly common following these procedures, ranging from 0 to 16%, and relatively high for SHP at a mean prevalence of 8.5% (5 studies, low quality, 95% CI 3.2–13.9%) for open and laparoscopic approaches combined.

## Comparison of different sacrohysteropexy approaches

In comparison with laparoscopic versus open abdominal SHP, similar outcomes were seen in repeat surgery for POP (3 studies, moderate quality, OR 0.97, 95% CI 0.22–4.23) [17, 19, 20] and recurrence of prolapse by objective criteria (1 trial, moderate quality, OR 0.97, 95% CI 0.41–4.71) [17]. However, for symptoms of recurrent POP, a lower chance of prolapse recurrence with the laparoscopic SHP was demonstrated in one trial (moderate quality, OR 0.18, 95% CI 0.07–0.46) [19]. The laparoscopic approach had lower odds of urinary retention (1 trial, moderate quality, OR 0.05, 95% CI 0.003–0.83) [19] and lower EBL (2 trials with 3 comparisons, moderate quality, mean difference −104 ml, 95% CI −145 to −63 ml) [17, 19] compared with the open approach. Data comparing laparoscopic and open SHP regarding mesh exposure had low heterogeneity and narrow CIs, and no significant difference was seen between approaches. Also, no significant differences were seen in sexual dysfunction, EBL, or hospital stay between approaches, although CIs and heterogeneity measures around these data were large. There was sufficient evidence from these three comparative trials to generate a guideline about the approach to SHP (Table 7).

## Vaginal mesh hysteropexy

As mentioned above, two studies of moderate quality compared VMHP with an abdominal SHP [17, 18], with the Kow et al. study also including data allowing for comparison of VMHP with other vaginal surgery. Eleven case series (Table 2), all of low quality, studied some type of VMHP [34–37]. Two studies compared VMHP with some other type of POP surgery (vaginal hysterectomy or sacrocolpopexy of the vaginal vault), and the VMHP arms of these were utilized in these analyses [38, 39]. An additional 15 publications on 14 studies described in our prior review compared VMHP with POP surgery plus hysterectomy; VMHP arms were integrated in these analyses as well [8].

Data regarding prolapse outcomes for VMHP were also heterogeneous ($I^2$, 77–87%) around prolapse recurrence, with

**Table 5** Abdominal hysteropexy approaches, either sacrohysteropexy (SHP) or non-SHP types, including description of open or laparoscopic/robotic approaches and open versus laparoscopic/robotic SHP

| Outcome | Any SHP, l aparoscopic/robotic or open | Open abdominal SHP | Laparoscopic/robotic SHP | Any non-SHP abdominal hysteropexy, laparoscopic/robotic or open | Open abdominal non-SHP hysteropexy | Laparoscopic/robotic non-SHP hysteropexy | Laparoscopic/robotic vs. open abdominal SHP |
|---|---|---|---|---|---|---|---|
| | Mean (95% CI) ; $I^2$<br>Studies *n* (range) | Mean (95% CI); $I^2$<br>Studies *n* (range) | Mean (95% CI); $I^2$<br>Studies *n* (range) | Mean (95% CI); $I^2$<br>Studies *n* (range) | Mean (95% CI); $I^2$<br>Studies *n* (range) | Mean (95% CI); $I^2$<br>Studies *n* (range) | OR or difference (95% CI): $I^2$<br>Studies *n* (range) |
| Repeat surgery for prolapse, % | 21.8 (16.0–27.7); 65%<br>15 (869); 0–22.0%) | 4.9 (0.2–15.6) ; 82%<br>4 (168); 0–22.0% | 3.9 (1.9–6.6); 52%<br>10 (607); 0–14% | 9.9 (4.2–17.7); 88%<br>6 (700); 0–28% | 10.4 (3.7–19.8); 76%<br>2 (274); 6.3–14.4% | 8.9 (2.4–18.8); 86%<br>5 (225); 0–27.9% | **0.97 (0.22–4.23); 11%**<br>3 (195 vs. 248); 0.31–2.57 |
| Prolapse recurrence (any definition), % | 13.6 (3.3–23.9); 85%<br>5 (229); 1.7–32.3% | 7.6 (1.1–19.3); 71%<br>3 (127); 1.7–13.5% | 20.9 (4.4–45.4); 85%<br>2 (102); 11–32% | 9.5 (4.4–16.5); 71%<br>5 (401); 0–18% | 5.2 (2.8–9.3)<br>1 (194) | 9.7 (4.0–17.6); 62%<br>5 (225); 0–17.9% | 0.97 (0.20–4.71)<br>1 (123 vs. 15) |
| Prolapse recurrence symptoms, % | 13.6 (5.3–22.0); 86%<br>5 (405); 5.0–29.7 | 45.6 (33.2–58.5)<br>1 (57) | **10.1 (6.6–14.2); 31%**<br>5 (348); 5.0–15% | 12.7 (4.2–24.8); 63%<br>2 (182); 6.7–17% | 6.7 (1.7–23.1)<br>1 (30) | 17.1 (11.9–23.9)<br>1 (152) | 0.18 (0.07–0.46)<br>1 (54 vs. 57) |
| Urinary incontinence postop (any type), % | 16.9 (5.8–27.9); 85%<br>6 (259); 0–42.1% | 14.8 (6.5–25.8); 70%<br>5 (186); 0–31% | 18.3 (0.4–65.5); 93%<br>2 (73); 3.7–42% | **11.1 (6.0–17.3); 0%**<br>2 (117)[c]; 8.0–12% | 12.0 (6.7–20.3)<br>1 (92) | 8.0 (2.0–26.9)<br>1 (25) | 0.32 (0.07–1.41)<br>1 (54 vs. 57) |
| Urinary incontinence postop (any type, de novo), % | 4.4 (0.2–8.5); 63%<br>4 (260); 1.0–9.6% | ND<br>0 | 1.0 (0.1–6.8)<br>1 (100) | 2.0 (0.9–4.8)<br>1 (245)[c] | ND<br>0 | 2.0 (0.9–4.8)<br>1 (245) | ND<br>0 |
| Urinary retention postop (any definition[a]), % | 13.8 (3.0–30.5); 95%<br>8 (537); 3.6–79.4% | 25.5 (2.4–61.6); 96%<br>4 (181); 7.3–79.4% | **2.9 (1.0–5.6); 3%**<br>3 (209); 0–6.7% | **1.0 (0.2–2.4); 40%**<br>5 (515); 0–4.0% | 0.0 (0.0–4.4)<br>1 (176) | **3.1 (0.6–7.4); 0%**<br>4 (94); 0–4.0% | 0.05 (0.003–0.83)<br>1 (54 vs. 57) |
| Mesh exposure, % | **1.2 (0.4–2.0); 15%**<br>14 (844); 0–6.8% | **3.8 (1.5–7.0); 0%**<br>6 (186); 0–6.7% | **1.8 (0.7–3.4); 43%**<br>9 (658); 0–6.8% | **0.9 (0.3–2.0); 0%**<br>3 (462); 0–1.2% | 0.6 (0.1–3.9)<br>1 (176) | **1.4 (0.4–3.0); 0%**<br>3 (286); 0–1.2% | **0.33 (0.05–2.41); 23%**<br>3 (195 vs. 248); 0.11–3.16 |
| Sexual dysfunction[b], % | 8.5 (3.2–13.9); 68%<br>5 (340); 2.7–16.0 | 5.6 (0.3–16.8); 74%<br>3 (124); 0–13.5% | 9.5 (4.3–16.4); 58%<br>3 (216); 5.5–16% | **3.4 (1.6–5.7); 0%**<br>4 (301); 0–4.6% | **2.4 (0.5–5.9); 0%**<br>2 (122); 2.2–3.3% | **4.1 (1.7–7.4); 0%**<br>2 (179); 0–4.6% | 0.92 (0.01–57.6); 75%<br>2 (177 vs. 72); 0.11–7.82 |
| Estimated blood loss, ml | 109 (64–154); 99%<br>13 (659); 2–244 | 212 (173–251); 74%<br>4 (131); 159–244 | 72 (40–104); 90%<br>8 (493); 19.6–136 | 72 (3.2–141); 96%<br>4 (243); 10–123 | ND<br>0 | 75 (10–139); 97%<br>4 (243); 10–123 | **−104 (−145–−63); 0%**<br>2 (177 vs. 87); −89–−109 |
| OT, min | 160 (122–199); 100%<br>17 (809); 40–345 | 159 (112–207); 100%<br>6 (192); 89–239 | 161 (105–217); 100%<br>11 (617); 40–345 | 128 (55–201); 99%<br>4 (243); 52–122 | ND<br>0 | 128 (52–204); 99%<br>4 (243); 52–222 | 16 (−82–114); 98%<br>3 (177 vs. 87); −67, 106 |
| Hospital stay, days | 4.0 (2.3–5.7); 99%<br>12 (617); 1–11 | 6.6 (3.8–9.3); 99%<br>5 (164); 2.4–11 | 2.2 (1.3–3.1); 81%<br>7 (453); 1–3.7 | **2.1 (1.7–2.3); 0%**<br>2 (87); 2.0–2.1 | ND<br>0 | **2.0 (1.7–2.3); 0%**<br>2 (87); 2.0–2.1 | ND<br>0 |

Estimates based on meta-analysis (from at least two studies) with low statistical heterogeneity ($I^2$ < 50%) are in bold font

*OT* operating time, *CI* confidence interval, *de novo* new in women not experiencing symptom prior to surgery (occurring for first time postoperatively), *n* total sample size across studies, *ND* no data, *OR* odds ratio, *Postop* postoperatively

[a] Voiding dysfunction (subjective or objective)

[b] Dyspareunia or pain with sexual intercourse

[c] Stress urinary incontinence only

a range of recurrent POP by set definitions from 2 to 33% (13 studies, moderate quality, mean 9.5%, 95% CI 5.3–14.7%) and a range of recurrent prolapse symptoms from 3 to 16% (3 trials, low quality, mean 8.3%, 95% CI 2.4–17.2%). However, for repeat POP surgery following VMHP, data was less heterogeneous ($I^2$ 5%) for the 12 trials reporting this outcome, with a range of repeat POP surgery from 3 to 29% (12 studies, moderate quality, mean 4.5%, 95% CI 3.1–6.1%). Most of these trials studied POP outcomes in the short to medium term (12–24 months, Table 2), with a wide total range of follow-up from 2 months [40] to 5 years [41].

AEs most commonly reported for VMHP were also UI, mesh exposure, sexual dysfunction, and urinary retention (Table 6). Postoperative UI after VMHP ranged from 3 to 12% (2 studies, low quality, mean 7.5%, 95% CI 1.4–17.8%) and de novo UI from 1.5 to 29% (6 studies, low quality, mean 5.9%, 95% CI 1.9–11.7%), but heterogeneity around these data was high ($I^2$ 68–81%). The prevalence of urinary retention after VMHP also ranged widely, from 0 to 40% (6 studies, moderate quality, mean 15.9%, 95% CI 7.9–26%), as did the prevalence of sexual dysfunction, from 0 to 48% (5 studies, low quality, mean 8.7%, 95% CI 0.5–25.7%), with high data heterogeneity for these outcomes as well ($I^2$ 82 and 92%, respectively). The rate of mesh exposure was more consistent ($I^2$ 31%), with 17 trials (moderate quality) reporting a range of 0–19% (mean 5.4%, 95% CI 4–7%). Operating time (OT), hospital stay, and EBL were all heterogeneous ($I^2$ 92–100%) for VMHP, with wide ranges from 58 to 171 min for OT (14 trials, moderate quality, mean 112 min, 95% CI 91–133 min), 1–6 days hospital stay (10 trials, moderate quality, mean 3.4 days, 95% CI 2.1–4.6 days), and 49–161 ml of EBL (14 trials, moderate quality, mean 117 ml, 95% CI 98–135 ml).

## Vaginal mesh hysteropexy compared with sacrohysteropexy

The two studies that compared VMHP with laparoscopic/robotic SHP [17, 18] demonstrated that VMHP decreased OT compared with laparoscopic SHP (2 studies, moderate quality, mean difference 119 min, 95% CI 102–136 min). However, other outcomes investigated, including repeat POP surgery, mesh exposure, sexual dysfunction, EBL, and hospital stay, were similar (Table 6). There was sufficient evidence to make a clinical guideline regarding VMHP versus laparoscopic/robotic SHP hysteropexy (Table 7).

## Vaginal native-tissue hysteropexy, including Manchester procedure

Six case series of low quality described outcomes with VNTHP (Table 3) [42–47]. Of the case series, four investigated SSHP [42–44, 47]; one USHP [45], and one mixed uterine-preserving POP surgeries of a transvaginal approach without further specification of surgical methods [46]. Thirteen studies described in our prior review, four RCTs and nine nRCSs, compared transvaginal native-tissue hysteropexy with POP surgeries plus hysterectomy, and the hysteropexy arms of these studies were utilized in this analysis of VNTHP [8]. Of these 13 comparative studies, all except two (one describing USHP [48] and one describing various transvaginal methods [49]), had SSHP as the hysteropexy arm.

Five single-arm studies of low quality described outcomes after the Manchester procedure (Table 3), in which the cervix is removed and the uterosacral ligaments plicated across the midline to suspend the new vaginal apex [50–54]. Six nRCSs reviewed in our prior publication compared the Manchester procedure with POP surgery plus hysterectomy, and the Manchester arms of these trials were utilized in these analyses [8].

Heterogeneous data ($I^2$, 49–87%) were seen regarding prolapse recurrence after VNTHP, such as SSHP and USHP (Table 6). The range of repeat surgery for prolapse after VNTHP was 0–12% (6 studies, moderate quality, mean 4.1%; 95% CI 1.7–7.5%), and recurrent prolapse by set definitions ranged from 0 to 50% (11 studies, low quality, mean 19%, 95% CI 10.2–29.8%). Only one trial (low quality) investigated recurrent prolapse symptoms (3.3%) after VNTHP specifically [44]. Trials that investigated prolapse outcomes after VNTHP had follow-up times from 4 [55] to 86 months after VNTHP [56], although two trials had unclear data on the timing of follow-up [46, 47] and five [46, 49, 57–59] did not measure prolapse outcomes following surgery.

For the Manchester procedure, POP outcomes were just as heterogeneous ($I^2$, 79–98%, Table 6) despite the small number of trials investigating this procedure. Repeat surgery for POP after Manchester ranged from 1.1 to 5.4% (5 studies, low quality, mean 2.8%; 95% CI 1.3–4.8%) and recurrent POP by set definitions from 5.4 to 19.4% (4 studies, low quality, mean 12.7%, 95% CI 6.7–20.3%). Three trials with a large number of patients investigated the prevalence of repeat POP symptoms after Manchester, which ranged from 2.2 to 21.4% (low quality, mean 7.6%, 95% CI 0.7–20.6%). These studies followed up patients from 45 days to 9 years postoperatively [50, 54], with two trials having no prolapse outcomes [50, 60] and one lacking data on follow-up duration [53].

AEs after VNTHPs were poorly investigated in the literature, with only five trials reporting heterogeneous data ($I^2$ 85%) on postoperative UI (4 on SSHP or USHP; 1 on Manchester), with a wide range of 0–48%. De novo UI was only reported in two studies on the Manchester procedure (low quality, mean 8.5%, 95% CI 6–11%), and urinary retention reported on seven (low quality, mean 17.8%, 95% CI 12.4–24%). Sexual dysfunction ranged from 4.1 to 16.3%, with data from two studies on SSHP or USHP surgery and two on the Manchester (low quality).

**Table 6** Vaginal hysteropexies, including vaginal mesh hysteropexy (VMHP), vaginal native tissue hysteropexy (VNTHP) such as sacrospinous or uterosacral, Manchester procedure, and LeFort colpocleisis, including comparison of VMHP to laparoscopic/robotic sacrohysteropexy (SHP)

| Outcome | VMHP<br>Mean (95% CI); $I^2$<br>Studies *n* (range) | VNTHP (USHP SSHP, or Various)<br>Mean (95% CI); $I^2$<br>Studies *n* (range) | Manchester<br>Mean (95% CI); $I^2$<br>Studies *n* (range) | LeFort<br>Mean (95% CI); $I^2$<br>Studies *n* (range) | Laparoscopic/robotic SHP vs. VMHP<br>OR or difference (95% CI); $I^2$<br>Studies *n* (range) |
|---|---|---|---|---|---|
| Repeat surgery for prolapse, % | **4.5 (3.1–6.1); 5%** | **4.1 (1.7–7.5); 49%** | 2.8 (1.3–4.8); 70% | **0.6 (0.1–1.5); 0%** | **0.96 (0.12–7.62); 47%** |
| | 12 (767); 2.6–29% | 6 (380); 1.0–12% | 5 (1758); 1.1–5.4 | 3 (489); 0–0.4% | 2 (196 vs. 175); 0.19–1.82 |
| Prolapse recurrence (any definition), % | 9.5 (5.3–14.7); 87% | 19.0 (10.2–29.8); 87% | 12.7 (6.7–20.3); 84% | **6.2 (3.4–9.7); 29%** | 1.1 (0.2–5.9) |
| | 13 (1223); 1.9–33% | 11 (515); 0–50% | 4 (750); 5.4–19.4% | 3 (311); 4.0–9.3% | 1 (65 vs. 61) |
| Prolapse recurrence symptoms, % | 8.3 (2.4–17.2); 77% | 3.3 (0.8–12.4) | 7.6 (0.7–20.6); 98% | **3.3 (1.6–5.5); 0%** | ND |
| | 3 (233); 3.0–16% | 1 (23) | 3 (1489); 2.2–21.4% | 4 (329); 2.5–5.7% | 0 |
| Urinary incontinence postop (any type), % | 7.5 (1.4–17.8); 68% | 19.7 (4.0–43.3); 87% | 16.3 (10.2–25.0) | **12.6 (9.7–16.0); 0%** | ND |
| | 2 (120)c; 3.7–12% | 4 (119); 0–48% | 1 (98) | 4 (424); 10.2–15.6% | 0 |
| Urinary incontinence postop (any type, de novo), % | 5.9 (1.9–11.7); 81% | ND | **8.4 (6.0–11.0); 0%** | 7.4 (1.3–17.7); 71% | ND |
| | 6 (563); 1.5–29.2% | 0 | 2 (478); 6.1–8.6 | 2 (147); 4.0–12.8% | 0 |
| Urinary retention postop (any definition[a]), % | 15.9 (7.9–26.0); 82% | ND | 17.8 (12.4–24.0); 87% | 8.2 (0.0–30.2); 93% | 0.61 (0.14–2.64) |
| | 6 (404); 0–40% | 0 | 7 (1854); 10–33% | 2 (194); 1.9–18% | 1 (74 vs. 77) |
| Mesh exposure, % | **5.4 (4.0–7.0); 31%** | ND | ND | ND | **1.18 (0.36–3.88); 0%** |
| | 17 (1344); 0–19% | 0 | 0 | 0 | 2 (197 vs. 179); 1.04–2.51 |
| Sexual dysfunction[b], % | 8.7 (0.5–25.7); 92% | **12.3 (4.9–22.4); 23%** | 6.5 (3.0–11.3); 60% | ND | 2.51 (0.10–62.3) |
| | 5 (227); 0–48% | 2 (70); 7.4–16.3% | 2 (521); 4.1–8.3% | 0 | 1 (123 vs. 102) |
| Estimated blood loss, ml | 117 (98–135); 92% | 127 (66–189); 98% | 236 (183–289); 92% | 105 (41–169); 98% | **13 (−13–39); 0%** |
| | 14 (1356); 49–161 | 5 (231); 46–202 | 8 (809); 185–350 | 3 (477); 74–180 | 2 (197 vs. 178); −25–13 |
| OT, min | 112 (91–133); 99% | 90 (55–125); 100% | 71.7 (65.5–78.0); 87% | **89 (80–98); 0%** | **119 (102–136); 41%** |
| | 12 (1206); 58–171 | 7 (303); 51–160 | 8 (743); 63–110 | 2 (111); 76–90 | 2 (197 vs. 178); 109–127 |
| Hospital stay, days | 3.4 (2.1–4.6); 100% | 5.2 (2.9–7.4); 85% | 5.5 (4.3–6.7); 97% | 7.7 (1.0–14.3); 62% | 0 (−1.2–1.2) |
| | 10 (926); 1–5.9 | 4 (202); 3–7 | 8 (743); 2.6–8 | 3 (252); 4–12 | 1 (74 vs. 76) |

Estimates based on meta-analysis (from at least two studies) with low statistical heterogeneity ($I^2 < 50\%$) are in bold font

*CI* confidence interval, *de novo* new in women not experiencing symptom prior to surgery (occurring for first time postoperatively), *n* total sample size across studies, *ND* no data, *OR* odds ratio, *Postop* postoperatively, *SSHP* sacrospinous hysteropexy, *USHP* uterosacral hysteropexy, *OT* operating time

[a] Voiding dysfunction (subjective or objective)

[b] Dyspareunia or pain with sexual intercourse

[c] Stress urinary incontinence only

OT, hospital stay, and EBL were all heterogeneous ($I^2$ 85–100%) for VNTHP, with means ranging from 51 to 160 min for OT time, 3–8 days hospital stay, and 46–350 ml EBL.

### LeFort colpocleisis

One retrospective study of moderate quality compared LeFort colpocleisis outcomes with and without a midurethral sling procedure, in which both arms were combined for this analysis [61]. Seven case series of low quality described populations of women following LeFort colpocleisis (Table 4) [62–68]. One nRCS detailed in our prior review compared LeFort colpocleisis with POP surgery plus hysterectomy, and the LeFort arm from was included in our analyses [8].

Prolapse recurrence, as expected, was very low after LeFort colpocleisis, with less heterogeneity ($I^2$ 0–29%) around data than in reconstructive procedures. Repeat POP by set definitions ranged from 4 to 9.3% (3 studies, low quality, mean 6.2%, 95% CI 3.4–9.4%), repeat symptoms of POP from 2.5 to 5.7% (4 studies, low quality, mean 3.3%, 95% CI 1.6–5.5%), and repeat surgery was rare (3 studies, low quality, mean 0.6%, 95% CI 0.1–1.5%). Few studies on LeFort colpocleisis defined prolapse recurrence well (Table 4); one study lacked data on the length of follow-up [64], while two others did not measure prolapse outcomes [61, 63]. Studies measuring prolapse outcomes and had information on follow-up length hd follow-up times rangig from 6 months to 22 years [65, 67].

Urinary symptoms after LeFort colpocleisis were frequently reported but poorly defined. Postoperative UI was common, ranging from 10.2 to 15.6% (4 studies, low quality, mean 9.6%, 95% CI 9.7–16%), and de novo UI was common, at 4–12.8% (2 studies, low quality, mean 7.4%, 95% CI 1.3–17.7%). Urinary retention was prevalent, ranging from 2 to 18% (2 studies, low quality, mean 8.2%, 95% CI 0–32%). LeFort procedures were brief (mean OT 76–90 min), with low EBL (mean 74–180 ml). However, hospital stay was long, ranging from 4 to 12 days in the 3 studies that adequately reported this outcome [62, 64, 69].

**Table 7** Clinical practice guidelines (CPGs) regarding the use of certain apical-support uterine-preservation surgeries for pelvic organ prolapse (POP) (hysteropexy). All CPGs are intended to begin with the statement: "For women who desire and have no contraindications to uterine preservation…"

| Relevant surgical comparison | Quality of contributing studies (*n*); study quality | GRADE recommendation | Choice recommended |
|---|---|---|---|
| LS or RA mesh SHP versus open mesh SHP | 3 nRCs (1 pros); 1 high quality, 2 moderate quality | 2B | LS or RA SHP rather than open SHP to minimize EBL and urinary retention without altering mesh exposure or repeat prolapse surgery risk |
| LS or RA mesh SHP versus VMHP | 2 nRCs (1 pros); 1 high quality, 1 moderate quality | 2B | VMHP rather than LS or RA SHP to minimize operating time without altering mesh exposure or repeat prolapse surgery risk |

*LS* laparoscopic, *RA* robotic-assisted, *SHP* sacrohysteropexy, *pros* prospective, *EBL* estimated blood loss, *VMHP* vaginal mesh hysteropexy

## Discussion

This planned secondary analysis of a systematic review describes the outcomes and AEs associated with uterine-preserving procedures for POP (hysteropexies) and found very limited comparative data to inform the choice of one type of hysteropexy over another. Furthermore, most data on hysteropexy is of low quality, as many trials are case series or have poorly reported or defined outcomes.

Those few trials that do compare different approaches to hysteropexy emphasize that minimally invasive (laparoscopic or robotic) SHP approaches have advantages over open abdominal approaches but have a longer OT, with a similar AE rates to VMHP. This difference is likely more attributable to the route of surgery than to the specific uterine fixation technique used. Data on prolapse recurrence comparing one type of hysteropexy with another was limited and indicates few differences between approaches. However, some low-quality descriptive data exist on outcomes and AEs of individual uterine-preserving surgeries, which can help surgeons when counseling patients on those surgeries.

This review is aimed at informing the patient who has made the decision to have a uterine-preserving POP surgery and is exploring various surgical options with her physician. Our previous review described that most high- or moderate-quality literature on the topic of hysteropexy explores the risks and benefits of whether or not to preserve the uterus (vs. hysterectomy) in POP surgery [8]. This updated review notes that studies with hysteropexy only as the focus are usually lower quality (case series) and often do not utilize the most modern surgical options. Comparative studies in this analysis were more recent and reported on current options that patients often consider and surgeons often offer, such as laparoscopic/robotic SHP, vaginal mesh hysteropexy, and LeFort colpocleisis [17, 18, 61]. Despite the fact that surgical options for POP are often changing and continue to expand due to overwhelming demand [2, 70], it is encouraging that data collected by this review is relevant to the contemporary

surgical climate. Moreover, the choices informed by these data (such as choice between laparoscopic/robotic SHP and VMHP for patients who want a reconstructive procedure), fits with current surgical training for POP surgeons [71, 72].

Differences found between hysteropexy approaches in this trial are consistent with past knowledge about advantages and limitations of minimally invasive procedures in benign gynecological surgery. Past systematic review has demonstrated that benign hysterectomy through a minimally invasive route (laparoscopic) has longer OT than open abdominal or vaginal routes but less morbidity and recovery time than open abdominal approaches [73]. This has prompted the American College of Obstetrics and Gynecology (ACOG) to recommend the vaginal route as the preferred approach to hysterectomy, with laparoscopic routes as the second choice [74]. However, in POP surgery, there are no such recommendations on surgical approach, and routes that avoid morbidity or reduce costs may have different rates of POP recurrence, making consistent decisions difficult [75]. In the context of uterine-preserving POP surgery, where hysterectomy is not part of the procedure but surgical approach choices are similar to hysterectomy options, this review demonstrates that insufficient data exist to consistently choose one approach to hysteropexy or for use by large societies to recommend a preferred approach. Even CPGs used in this report, which suggest the sensible approach of avoiding longer or more invasive surgery, are based on moderate evidence and cannot be applied to all patients.

In most investigations of one hysteropexy approach versus another, mostly comparing laparoscopic/robotic SHP to the open abdominal route or VMHP, prolapse outcomes demonstrate no significant differences between approaches. These results, however, need to be taken in the context of the limited number of studies (2–3 studies making similar comparisons), the moderate quality of these studies (nRCSs), and varying definitions of prolapse recurrence. The prolapse outcome that was most reliable across studies (lowest heterogeneity and most consistently reported and defined) was repeat surgery for recurrent prolapse, and this was similar in all direct hysteropexy comparisons. However, all POP retreatment rates must be interpreted considering follow-up time from the index surgery, which varied in relevant trials. The one disparate prolapse outcome between hysteropexy approaches found in this review was the increased prevalence of recurrent prolapse symptoms in the Paek et al. trial, which used a nonvalidated questionnaire to assess this outcome [19]. Clearly, limitations in these data highlight the fact that insufficient evidence exists to recommend one type of mesh hysteropexy over another to improve POP outcomes, and no comparative data exists on nonmesh hysteropexy procedures. Therefore, clinical suggestions made in this review are based on differences in surgery risk and morbidity with the assumption that differences in POP outcomes after mesh hysteropexy either do not exist or have yet to be demonstrated. Prospective, randomized trials comparing one type of uterine-preserving surgery would be invaluable to the field.

This review incorporated data on both obliterative and reconstructive approaches to uterine-preserving POP repair; this may aid surgeons counseling women who are unsure about future sexual activity. Descriptive data from this review demonstrates that LeFort colpocleisis is a surgery with a short operative time, low EBL, and consistently low rates of POP recurrence. No studies compare LeFort colpocleisis with reconstructive hysteropexy, and such investigations are usually not possible or meaningful, as women who choose LeFort are not typically of a similar population as those who choose reconstructive hysteropexy [68, 76]. Specifically, women who are younger, have more optimal health, and desire future sexual activity often elect for reconstructive procedures, so data on the LeFort often involves women who are older, less healthy, and are not prioritizing sexual function following surgery [77]. This selection bias is best exemplified in the long hospital admission times observed after LeFort surgery despite the low EBL and OT, even in recent publications [63, 64]. The poor health of the population getting this low-morbidity surgery limits ethical feasibility of comparing LeFort procedures to anything other than different obliterative procedures.

Strengths of this study include incorporation of all published data on the topic up to the date of this review, including non-English publications, posters, and abstracts. This review also utilized a large team of experts in pelvic surgery, including experienced systematic review researchers, which allowed for optimal adherence to a rigorous systematic review protocol and enhanced data accuracy. Furthermore, inclusion of studies in all languages allowed a more worldwide perspective on surgical choices; most systematic reviews only consider English studies and may disregard surgeries commonly performed in non-English-speaking locales. We ensured data was collected on AEs that highly affect patient quality of life, including urinary symptoms, mesh erosion, and sexual function. The integration of all comparative and noncomparative studies with uterine-preserving POP arms is particularly important in describing frequencies of AEs, which are vital to informed consent conversations.

Limitations of this review are mostly linked to the paucity of comparative literature on the topic and the poor quality of most studies that describe uterine-preserving POP surgery. As noted above, most comparative literature on uterine-preserving POP surgery aims to compare hysteropexy with POP surgery plus hysterectomy, as opposed to comparing different surgical choices for hysteropexy. Case series inherently contain a large amount of selection, follow-up, and measurement bias, so results from such studies must be interpreted with this in mind. Furthermore, most studies are short-term in their follow-up, making accurate conclusions about long

term POP outcomes in these patients difficult. Finally, as noted in our prior review on this topic [8], most studies investigating hysteropexy do not measure outcomes that patients who choose these surgeries may prioritize, such as body image, future fertility, and future uterine/cervical malignancy risk. The two moderate- to high-quality comparative studies in this review [17, 18], one of which provided years of follow-up, report some vital information for future directions of investigation, and it is our hope that future randomized trials will compare one type of uterine-preserving POP surgery with another. For appropriate patients who are considering uterine-preserving POP surgery, such data are vital to inform them of the most safe and effective approach. Furthermore, such data would allow our field to expand or alter surgeon training to include superior uterine-preserving techniques in POP surgery.

In summary, this secondary review discovered that literature focusing on hysteropexy, which assumes a patient has already made the choice to preserve their uterus during POP surgery, is mostly of lower quality, finds few differences in outcomes between hysteropexy approaches, and often does not compare or describe the most modern hysteropexy choices. Therefore, surgeons with a patient who desires uterine preservation during POP surgery should be cautious about offering one type of hysteropexy over another. However, women should be counseled that minimally invasive approaches, such as laparoscopic or vaginal approaches, limit morbidity or, in the case of vaginal surgery, operating time. If surgical choices are restricted due to surgeon training or patient medical conditions, women should be counseled on data particular to the surgery being selected, including the risk of prolapse return, urinary symptoms, and AEs.

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## Compliance with ethical standards

**Conflicts of interest** KVM is a textbook editor for Elsevier publications and has not yet received any royalties for that publication. The other authors have no conflicts to disclose.

## Appendix 1: literature search strategy

Among the Medical Subject Headings (MeSH) searched were uterine prolapse, pelvic organ prolapse, prolapse, descensus, vaginal prolapse, pelvic floor, rectocele, cystocele, sacrocolpopexy, sacropexy, colpopexy, hysteropexy, uterine preservation, Manchester, colpocleisis, Fothergill, LeFort, randomized trial, longitudinal studies, clinical trial, controlled clinical trial, comparative study, prospective study, retrospective study, meta-analysis, and systematic review. Included studies could be in any published format (e.g., journal article, abstract, poster) as long as data could be extracted from the form in which it was published. We did not attempt to identify unpublished articles or abstracts, and we did not contact study authors. The search was limited to humans and included any language. Studies in languages that were not fluently read by one of our group members were interpreted with the assistance of a fluent speaker in the medical field or with professional translational software to extract relevant findings. Reference lists of selected articles and review papers were screened for additional eligible references.



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