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Systematic Review

Permanent Compared With Absorbable Suture in Apical Prolapse Surgery

A Systematic Review and Meta-analysis

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OBJECTIVE: To explore how permanent compared with absorbable suture affects anatomic success in native tissue vaginal suspension (uterosacral ligament suspension and sacrospinous ligament suspension) and sacrocolpopexy with mesh.

DATA SOURCES: MEDLINE, EMBASE, and ClinicalTrials.gov were searched through March 29, 2022.

METHODS OF STUDY SELECTION: Our population included women undergoing apical prolapse surgery (uterosacral ligament suspension and sacrospinous ligament suspension and abdominal sacrocolpopexy). Our intervention was permanent suture for apical prolapse surgery, and our comparator was absorbable suture. We determined a single anatomic success proportion per study. Adverse events collected included suture and mesh exposure, surgery for suture and mesh complication, dyspareunia, and granulation tissue. Abstracts were doubly screened, full-text articles were doubly screened, and accepted articles were doubly extracted. Quality of studies was assessed using GRADE (Grading of Recommendations Assessment, Development and Evaluation) criteria. In single-arm studies using either permanent or absorbable suture, random effects meta-analyses of pooled proportions were used to assess anatomic success. In comparative studies investigating both suture types, random effects meta-analyses of pooled risk ratios were used.

TABULATION, INTEGRATION, AND RESULTS: Of 4,658 abstracts screened, 398 full-text articles were assessed and 63 studies were included (24 vaginal suspension [13 uterosacral ligament suspension and 11 sacrospinous ligament suspension] and 39 sacrocolpopexy). At 2-year follow-up, there was no difference in permanent compared with absorbable suture in uterosacral ligament suspension and sacrospinous ligament suspension (proportional anatomic success rate 88% [95% CI 0.81–0.93] vs 88% [95% CI 0.82–0.92]). Similarly, at 18-month follow-up, there was no difference in permanent compared with absorbable suture in sacrocolpopexy (proportional anatomic success rate 92% [95% CI 0.88–0.95] vs 96% [95% CI 0.92–0.99]). On meta-analysis, there was no difference in relative risk (RR) of success for permanent compared with absorbable suture for uterosacral ligament suspension and sacrospinous ligament suspension (RR 1.11, 95% CI 0.93–1.33) or sacrocolpopexy (RR 1.00, 95% CI0.98–1.03).

CONCLUSION: Success rates were similarly high for absorbable and permanent suture after uterosacral ligament suspension, sacrospinous ligament suspension, and sacrocolpopexy, with medium-term follow-up.

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Pelvic organ prolapse (POP) is common. One in eight women will undergo POP surgery in their lifetimes.[1] Abdominal sacrocolpopexy with mesh and native tissue vaginal suspensions, including uterosacral ligament suspension and sacrospinous ligament fixation, are commonly performed surgeries to treat apical POP.[2–5]

There is conflicting evidence to support the choice of suture material during POP surgery and whether suture type affects anatomic or subjective outcomes after surgery. The choice of suture type often is determined by surgeon preference. Some studies have demonstrated that permanent suture has lower failure rates[6] than absorbable suture, whereas others have shown similar anatomic outcomes.[7] Permanent suture classically has been used at the vaginal apex and sacrum; however, use of permanent suture increases the risk of suture or mesh erosion into the vagina.[5,8] Because of this, the use of delayed absorbable suture has gained popularity. Subsequently, a number of studies have shown similar rates of postoperative parameters such as POP recurrence and reoperation with the use of absorbable suture.[8–10] A recent survey showed that surgeons preferred absorbable suture for uterosacral ligament suspension and sacrospinous ligament suspension[11] and that, although most surgeons used permanent sutures for the sacral attachment, most surgeons preferred absorbable suture for the vaginal attachment of sacrocolpopexy.[8,11]

We aimed to systematically review the literature to explore the anatomic outcomes of using either permanent or absorbable suture for apical POP surgery. We hypothesized that permanent suture results in better anatomic outcomes but with more suture complications.

METHODS

No IRB approval was required for this work. PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines were followed. Registration with PROSPERO and full protocol can be found at: https://www.crd.york.ac.uk/PROSPERO/display_record.php?RecordID=265848.

SOURCES

We searched MEDLINE, EMBASE, and ClinicalTrials.gov from their inception through June 11, 2021, and then ran an updated search on March 29, 2022, and April 18, 2022 (for ClinicalTrials.gov). The search included numerous MeSH terms, such as "apical pelvic organ prolapse," "sacrocolpopexy," "uterosacral ligament suspension," "sacrospinous ligament suspension," "suture material," and other associated text words (Appendix 1, available online at http://links.lww.com/AOG/C974). No filters or limits were used. Non–human studies and conference abstracts were excluded. Authors were not contacted for additional information.

STUDY SELECTION

Our population included studies of women who underwent apical prolapse surgery, including native tissue vaginal apical suspensions (uterosacral ligament suspension and sacrospinous ligament suspension) and sacrocolpopexy with type 1 polypropylene mesh. Studies of hysteropexy and McCall culdoplasty and those not including apical prolapse surgery were excluded. Additionally, we excluded studies that involved cadavers, tissue samples, and animal studies. Our intervention was defined as permanent suture (including polytetrafluoroethylene, polypropylene, poliglecaprone 25, silk, and polyamide). We chose to exclude braided polyester based on studies that have demonstrated high rates of adverse events and expert consensus that these sutures are not commonly used anymore.[12] Our comparator group was absorbable or delayed absorbable suture (polyglactin, polydioxanone, polyglyconate, glycolide, dioxanone, and trimethylene carbonate). No absorbable sutures were excluded from inclusion.

Our content experts (P.P., C.L.G., D.M.P.) collectively determined a single composite anatomic success proportion for each study. This determination took into account pelvic organ prolapse quantification (POP-Q) measurements, stage or grade, subjective symptoms of bulge, re-operations, and re-treatments. We were careful to make sure cases were not double counted and to arrive at a proportion that considered all of the above factors. Adverse events including suture exposure, surgery for suture or mesh complication, mesh erosion, dyspareunia, and granulation tissue were collected. Randomized controlled trials (RCTs), prospective or retrospective nonrandomized comparative and cohort studies, and single-arm case series were included. Video presentations, conference abstracts, and articles in languages other than English were excluded.

Seventeen reviewers independently screened abstracts and potentially relevant full-text articles in duplicate. Discrepancies were resolved by a third reviewer (P.P., C.L.G., D.M.P.). Abstracts were doubly screened using Abstrackr (http://abstrackr.cebm.brown.edu),[13] then full-text articles were doubly screened. Data extraction was completed in duplicate

into customized forms by the same independent reviewers. Study and participant characteristics, intervention details, outcome definitions, results, and adverse events were extracted. The quality of studies was assessed using GRADE (Grading of Recommendations Assessment, Development and Evaluation) criteria.[14] The risk of bias and methodologic quality of each study were assessed based on Cochrane risk of bias and other questions from the Newcastle-Ottawa Scale.[15,16] Based on these potential biases, each study was graded by two to three reviewers as good (A), fair (B), or poor (C) quality.

In studies using either absorbable or permanent suture (single-arm studies), random effects meta-analyses of pooled proportions were used to assess anatomic success using Stata's Metaprop Statistical Program,[17] which uses the Freeman-Tukey double arcsine transformation to stabilize the variances. In studies investigating both suture types (comparative studies), random effects model–restricted maximum likelihoods were used to meta-analyze risk ratios. The I^2 statistic was used to reflect heterogeneity; all subgroups were planned a priori, and studies reporting the same outcome were meta-analyzed regardless of the degree of heterogeneity. Adverse events were compared with the two-sample test of proportions. Analyses were performed using Stata 17, and $P<.05$ was considered statistically significant.

RESULTS

The literature search identified 4,658 abstracts; 398 full-text articles were retrieved and assessed in detail. In total, we included 63 studies that met eligibility criteria. We categorized the studies into 24 vaginal native tissue repair studies and 39 sacrocolpopexy studies (Fig. 1).

Twenty-four vaginal suspension studies with 2,309 patients met inclusion criteria. Two studies[7,18] (both uterosacral ligament suspension) compared both suture types, and 22 used one suture type (12 permanent[12,19–29] and 10 absorbable[6,30–38]). Of these single-arm studies, 11 used uterosacral ligament suspension[6,12,27–29,33–38] and 11 used sacrospinous ligament suspension.[19–26,30–32] Of the patients undergoing uterosacral ligament suspension, 473 had absorbable suture and 1,044 had permanent suture. Of the patients undergoing sacrospinous ligament suspension, 609 had absorbable suture and 183 had permanent suture. The average age of the study populations ranged from 53 to 59 years, and average body mass index (BMI, calculated as weight in kilograms divided by height in meters squared) was between 22 and 30. Most studies reported POP-Q stage. When reported, the majority of patients had at least stage 3 prolapse (Table 1).

We assigned two studies a quality grade of A, six were assigned a grade of B, and 16 were assigned a grade of C. Overall, four studies were RCTs, eight were comparative (one prospective, seven retrospective), and 12 were single-arm (six prospective, six retrospective). The mean follow-up time was 23 months (Table 1).

Of the 13 uterosacral ligament suspension studies, the majority placed sutures on both sides (11/13, 84.6%, two not reported) and the majority specifically referenced the Shull method or a modified Shull method (11/13, 84.6%). Most of the time, two sutures were placed in both uterosacral ligaments (7/13, 53.8%). Two studies (15%) did not report the number of sutures, and three studies (23.1%) placed three on each side. Suture caliber was reported most of the time (9/13, 69.2%), and most sutures were 2-0, 1-0, or 0 in caliber. Two studies (15%) of permanent suture actually included both absorbable and permanent sutures.

Of 11 sacrospinous ligament suspension studies, we found that sutures were placed solely at the right sacrospinous ligament 63.6% (7/11) of the time. One study placed sutures at the left ligament, one in both ligaments, and one at the right or in both ligaments; one study did not record suture attachment site(s). The majority of studies (8/11, 72.7%) described placing two sutures at each attachment site; three studies did not report suture number. Suture caliber was reported most of the time (8/11, 72.7%), with 0 or 1-0 used most often. Permanent suture (8/11, 72.7%) was used more often than absorbable suture (3/11, 27.3%) in the sacrospinous studies.

Overall, at 23-month follow-up, there was no difference in permanent compared with absorbable suture in uterosacral ligament suspension or sacrospinous ligament suspension (proportional anatomic success rate 88%, 95% CI 0.84–0.91). The proportional anatomic success rate of permanent suture in vaginal suspension (n=14) was 88% (95% CI 0.81–0.93); for absorbable suture in vaginal suspension (n=12), it was also 88% (95% CI 0.82–0.92) (Fig. 2, Appendix 2 [Appendix 2 is available online at http://links.lww.com/AOG/C974]). There was high heterogeneity between groups ($I^2=84.4\%$), with no difference in success rates across groups. Further subgroup analysis by type of vaginal suspension (uterosacral ligament suspension or sacrospinous ligament suspension) also showed no differences between suture types (Appendix 3, available online at http://links.lww.com/AOG/C974). The proportional anatomic success rate of permanent suture

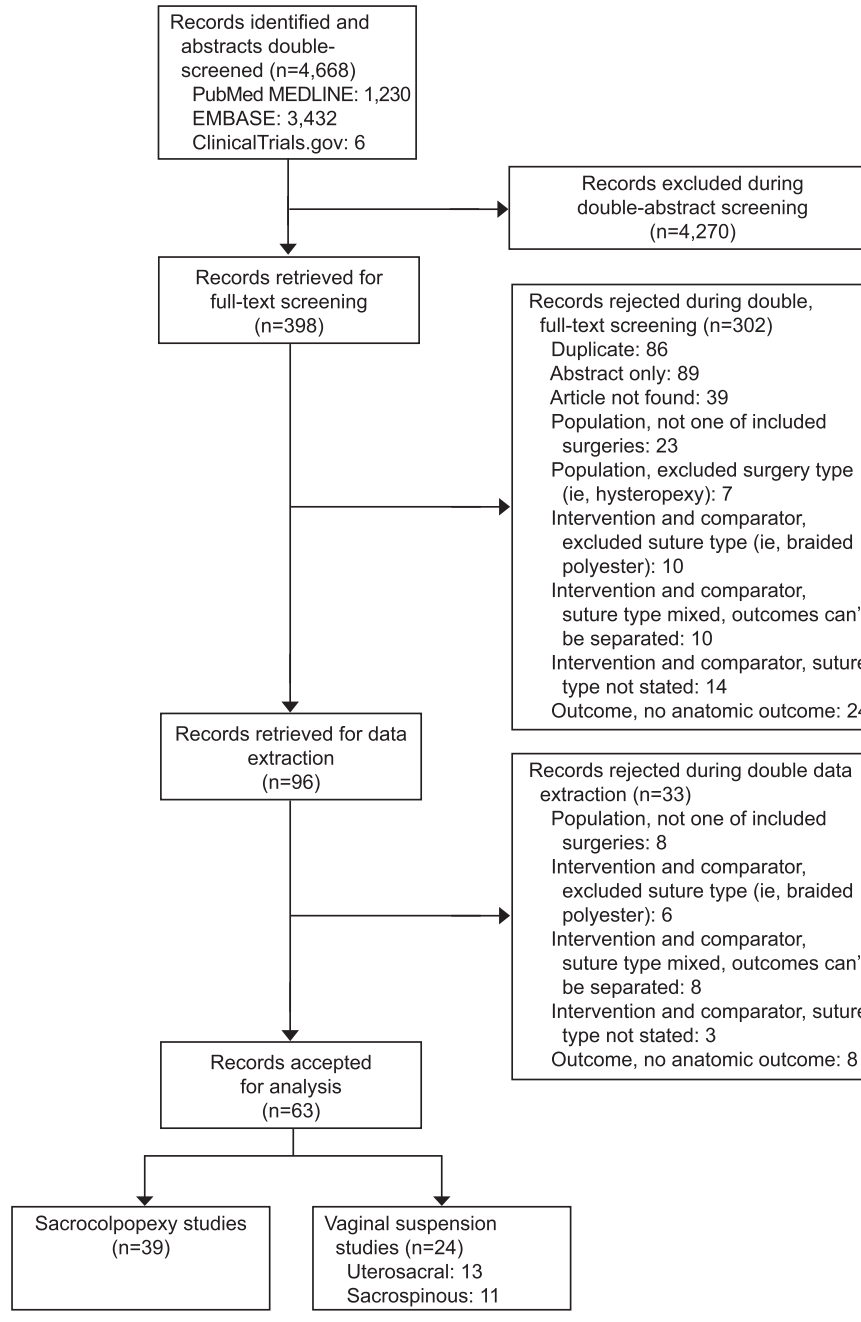

Fig. 1. Selection process in accordance with PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analyses) guidelines.

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for uterosacral ligament suspension (n=6) was 83% (95% CI 0.68–0.94); for absorbable suture (n=9), it was 88% (95% 0.82–0.93). The proportional anatomic success rate of permanent suture for sacrospinous ligament suspension (n=8) was 91% (95% 0.85–0.95); for absorbable suture (n=3), it was 87% (95% 0.72–0.97).

Most studies (14/24, 58.3%) reported on adverse events, with eight reporting on presence or absence of suture exposure, six reporting on surgery for suture complications, seven reporting on dyspareunia, and five reporting on granulation tissue. There was more suture exposure in the permanent suture group compared with the absorbable suture group, with a 5.6% difference (95% CI 0.03–0.09). There were more surgeries for suture and mesh in the permanent suture group compared with the absorbable suture group, with a 4.6% difference (95% CI 0.01–0.08). There was more granulation tissue in the permanent suture group compared with the absorbable suture group, with a 10.1% difference (95% CI 0.06–0.14). There

Table 1. Summary of Native Tissue Vaginal Suspension Studies

Study	Study Design (Quality)	No. of Participants	Age (y)	BMI (kg/m²)	Preoperative Prolapse Severity	Mean Follow-up Time (mo)	Surgery Type (Suture Type)
Kowalski, 2021[18]	RCT (A)	44	P: 63.6±10.2 A: 62.1±13.7	P: 29.7±4.6 A: 28.4±6.2	POP-Q stage 3–4: P: 68% A: 64%	12	Uterosacral, Shull method (P: polytetrafluoroethylene; A: polydioxanone)
Bradley, 2018[7]	Comparative, retrospective (B)	242	P: 64.8±8.1 A: 62.2±10.5	P: 28.5±5.4 A: 27.1±4.9	POP-Q stage 3–4: P: 79% A: 59%	12	Uterosacral, Shull method (P: surgeon preference; A: polyglyconate)
Da Silveira, 2020[19]	RCT (B)	59	65.4±8	27.9±3.8	POP-Q mean: Ba: +3.76 C: +1.46 Bp: + 1.81	60	Sacrospinous (polypropylene)
Goldberg, 2001[20]	Comparative, retrospective (C)	168	67 (30–89)†	NR	POP-Q stage 3–4: greater than 82%	39	Sacrospinous (polytetrafluoroethylene)
Mothes, 2015[21]	Single group, prospective (C)	110	63 (39–89)‡	NR	POP-Q stage 3–4: 100%	14	Sacrospinous (polyamide)
Maggiore, 2013[22]	Comparative, prospective (C)	86	61.1	24.6	POP-Q stage 3–4: 79%	36	Sacrospinous (polypropylene)
Peng, 2010[23]	Single group, retrospective (C)	35	60.2	NR	POP-Q mean: Ba: +0.82 Bp: −1.97	13	Sacrospinous (silk)
Astepe, 2019[24]	Comparative, retrospective (C)	43	59±8.3	30±3.5	POP-Q stage 2–4: 100%	17	Sacrospinous (permanent, not specified)
Salvat, 1996[25]	Single group, retrospective (C)	20	64.7 (46–86)†	NR	NR	72	Sacrospinous (polyamide)
Shastri, 2020[26]	Single group, retrospective (C)	106	53 (40–70)†	NR	POP-Q stage 3–4: 100%	6	Sacrospinous (polypropylene)
Wheeler, 2007[27]	Single group, retrospective (C)	35	64.2±10.2	27±4.5	POP-Q mean: C: −1.5 Ba: +2.2 Bp: +0.21	24	Uterosacral, not Shull (polypropylene)
Lee, 2021[12]	Comparative, retrospective (C)	149	67 (56–78)‡	24.8±2.6	POP-Q stage 3–4: 76%	12	Uterosacral, Shull method (polypropylene and polydioxanone)
Nager, 2021[28]	RCT (A)	87	66.2±7.4	28.1±4.4	POP-Q stage 3–4: 78%	60	Uterosacral, Shull method (1 polypropylene and 1 absorbable on each side)
Barber, 2000[29]	Single group, retrospective (C)	41	65±11	NR	POP-Q stage 3–4: 87%	15.5	Uterosacral, Shull method (1 permanent and 1 delayed absorbable on each side)
Mowat, 2018[30]	Single group, prospective (C)	51	66.1±8.9	27.6±3.9	POP-Q median: C: −2 Ba: +1 Bp: 0	17	Sacrospinous (polydioxanone)
Dangal, 2018[31]	Single group, prospective (C)	95	NR	NR	POP-Q stage 3–4: 87%	6	Sacrospinous (polydioxanone)
Greisen, 2021[32]	Single group, prospective (C)	103	65‡	26‡	POP-Q stage 3–4: 16.5%	6	Sacrospinous (polydioxanone)
Chung, 2012[6]	Comparative, retrospective (B)	141	60.1 (1)	28±0.5	POP-Q stage 3–4: 63%	5	Uterosacral, Shull method (polydioxanone)
Jeffery, 2009[33]	Single group, retrospective (C)	53	63±11.6	28±6.3	BW grade 2–4: 66%	15	Uterosacral, modified high uterosacral ligament suspension (polydioxanone)
Wong, 2011[34]	Single group, retrospective (C)	57	56±6.9	30±5.4	POP-Q median: C: −2 Ba: +1 Bp: −1	12	Uterosacral, Shull method (polyglyconate)
Spelzini, 2017[35]	RCT (B)	124	56.7±9	24.5±3.5	POP-Q median: C: 0 Ba: +1 Bp: −1	12	Uterosacral, Shull method (polydioxanone)
Schiavi, 2017[36]	Single group, retrospective (C)	146	61.6±8.3	27.3±3.8	POP-Q mean: C: +2.3 Ba: +3.2 Bp: +1.5	48	Uterosacral, Shull method (polydioxanone)

(*continued*)

Table 1. Summary of Native Tissue Vaginal Suspension Studies (*continued*)

Study	Study Design (Quality)	No. of Participants	Age (y)	BMI (kg/m²)	Preoperative Prolapse Severity	Mean Follow-up Time (mo)	Surgery Type (Suture Type)
Rappa, 2016[37]	Comparative, retrospective (B)	360	Normal weight: 69.1 (5.7) Overweight or obesity: 69.5 (11.4)	Normal weight: 22.1±1.2 Overweight or obesity: 30.7 mean (4.4)	POP-Q stage 3–4: Normal weight: 65% Overweight or obesity: 65.9%	12.5	Uterosacral, Shull method (polydioxanone)
Chill, 2021[38]	Comparative, retrospective (B)	112	63.2±8.5	27.2±4.1	POP-Q stage 3–4: 95.5%	19.4	Uterosacral (polydioxanone)

Study	No. of Sutures	Side of Attachment	Suture Caliber	Definition of Treatment Success*	Anatomic Success [n/N (%)]		Adverse Events	
					Permanent Suture	Absorbable Suture	Permanent Suture	Absorbable Suture
Kowalski, 2021[18]	4 (2/side)	Both	CV-2, 0	1–4	15/20 (75)	19/20 (90)	2/20 suture exposure 2/20 dyspareunia 0/22 granulation tissue	1/20 suture exposure 1/20 dyspareunia 0/22 granulation tissue
Bradley, 2018[7]	NR	Both	NR	1, 3, 4	43/54 (80)	156/188 (83)	1/53 suture exposure 5/53 surgery for suture complication (pain) 3/53 granulation tissue	0/184 suture exposure 6/184 surgery for suture complication (pain) 5/184 granulation tissue
Da Silveira, 2020[19]	NR	Right	0	1, 3, 4	45/59 (76)	NA	1/59 suture exposure	NA
Goldberg, 2001[20]	2	Right	0	1, 4	151/168 (90)	NA	4/168 dyspareunia	NA
Mothes, 2015[21]	2	Both	0	1–4	104/110 (95)	NA	NR	NA
Maggiore, 2013[22]	2	Right	NR	1, 2	75/86 (87)	NA	10/86 dyspareunia	NA
Peng, 2010[23]	2	Right	No. 7	1, 2	33/35 (94)	NA	2/35 suture exposure 2/35 surgery for suture complication	NA
Astepe, 2019[24]	2	Right	NR	1–3	37/43 (86)	NA	NR	NA
Salvat, 1996[25]	NR	Right or both	"Decimal 4"	1	18/20 (90)	NA	NR	NA
Shastri, 2020[26]	2	Left	1	1	87/88 (99)	NA	NR	NA
Wheeler, 2007[27]	4 (2/side)	Both	0 or 1	1–4	26/26 (100)	NA	NR	NA
Lee, 2021[12]	6 (3/side) 1 absorbable and 2 permanent on each side	Both	0 polypropylene and 1-0 polydioxanone	1–4	127/149 (85)	NA	7/149 suture exposure 9/149 surgery for suture complication 25/149 granulation tissue (surgery)	NA
Nager, 2021[28]	4 (2/side)	Both	0 or 2-0	1, 2, 4	42/78 (54)	NA	19/91 suture exposure 2/86 dyspareunia 11/91 granulation tissue	NA
Barber, 2000[29]	4 (2/side)	Both	1-0 for both	1, 2	37/41 (90)	NA	NR	NA
Mowat, 2018[30]	2	Right	NR	1, 2	NA	41/43 (96)	NA	1/51 surgery for suture complication 12/48 dyspareunia

(*continued*)

Table 1. Summary of Native Tissue Vaginal Suspension Studies (*continued*)

Study	No. of Sutures	Side of Attachment	Suture Caliber	Definition of Treatment Success*	Anatomic Success [n/N (%)]		Adverse Events	
					Permanent Suture	Absorbable Suture	Permanent Suture	Absorbable Suture
Dangal, 2018[31]	NR	Right	1	1, 2	NA	32/38 (84)	NA	3/95 surgery for suture complication
Greisen, 2021[32]	2	NR	0	1, 2	NA	77/102 (75)	NA	NR
Chung, 2012[6]	2–4/side	1 or both sides	NR	1	NA	133/141 (94)	NA	7/141 suture exposure 0/141 surgery for suture complication
Jeffery, 2009[33]	3 on each side	Both	0	1, 2	NA	47/53 (89)	NA	NR
Wong, 2011[34]	2 on each side	Both	0	1, 2	NA	56/57 (98)	NA	1/57 suture exposure
Spelzini, 2017[35]	3	Both	0	1–3	NA	63/73 (86)	NA	5/73 dyspareunia
Schiavi, 2017[36]	NR	Both	0	1, 2	NA	133/146 (92)	NA	2/146 dyspareunia 3/146 granulation tissue
Rappa, 2016[37]	4 (2/side)	Both	NR	1, 3, 4	NA	289/360 (80)	NA	NR
Chill, 2021[38]	4 (2/side)	Both	2-0	1–3	NA	78/111 (70)	NA	NR

BMI, body mass index; RCT, randomized controlled trial; P: permanent; A: absorbable; POP-Q, pelvic organ prolapse quantification; NR: not reported; NA: not applicable.

Data are mean±SD unless otherwise specified.

* A single composite anatomic success proportion was determined by our content experts and was based on: 1) anatomic success (POP-Q stage, or grade), 2) subjective symptoms of bulge, 3) re-operations, and 4) re-treatments.

† Mean (range)

‡ Median (range).

was no difference in dyspareunia (Appendix 4, available online at http://links.lww.com/AOG/C974).

Thirty-nine studies with 3,349 patients met inclusion criteria for the sacrocolpopexy category. Three compared both suture types,[9,39,40] and 36 used one suture type (20 permanent[41–60] and 16 absorbable[8,61–75]); 2,045 patients underwent sacrocolpopexy with permanent suture, and 1,304 with absorbable suture. Overall, nine studies were RCTs, 12 were comparative (two prospective, nine retrospective, one unclear direction), and 18 were single-arm (six prospective, 12 retrospective). The average age of the study population ranged from 43 to 70 years, and average BMI was between 20 and 29. Most studies reported POP-Q stage. When reported, the majority of patients had at least stage 3 prolapse. Several studies reported mean POP-Q measurements. We assigned four studies a quality grade of A, 15 were assigned a grade of B, and 20 were assigned a grade of C. The mean follow-up was 18.2 months (Table 2).

Suture caliber was reported in 21 of 39 (53.8%) studies; there was diversity in suture choice, including 1-0, 2-0, 3-0, CV-2, and CV4. Nineteen studies reported suture number; this varied widely, with a range of 3–12 interrupted sutures placed on each side of the vaginal mesh attachment. Two studies also reported using one running suture. When placing sacral attachment sutures, most studies described using permanent suture (32/39, 82.0%).

Overall, at 18 months follow-up, there was no difference in permanent suture compared with absorbable suture in sacrocolpopexy (proportional anatomic success rate 94%, 95% CI 0.91–0.96). The proportional anatomic success rate of permanent suture for sacrocolpopexy (n=23) was 92% (95% CI 0.88–0.95); for absorbable suture for sacrocolpopexy (n=19), it was 96% (95% CI 0.92–0.99). There was considerable heterogeneity between groups (I^2=87.2%), with no difference in success rates across groups (Fig. 3) (Appendix 5, available online at http://links.lww.com/AOG/C974). On meta-analysis, there was no difference in relative risk (RR) of success compared with failure for permanent compared with absorbable suture for sacrocolpopexy (n=3) (RR 1.00, 95% CI 0.98–1.03), with low heterogeneity (I^2=0.03%). (Fig. 4)

Adverse events were reported in 33 of the 39 sacrocolpopexy studies (84.6%), with 12 studies reporting on the presence or absence of suture exposure, six studies reporting on surgery for suture and mesh complications, 28 studies reporting on mesh erosion, six studies reporting on dyspareunia, and no

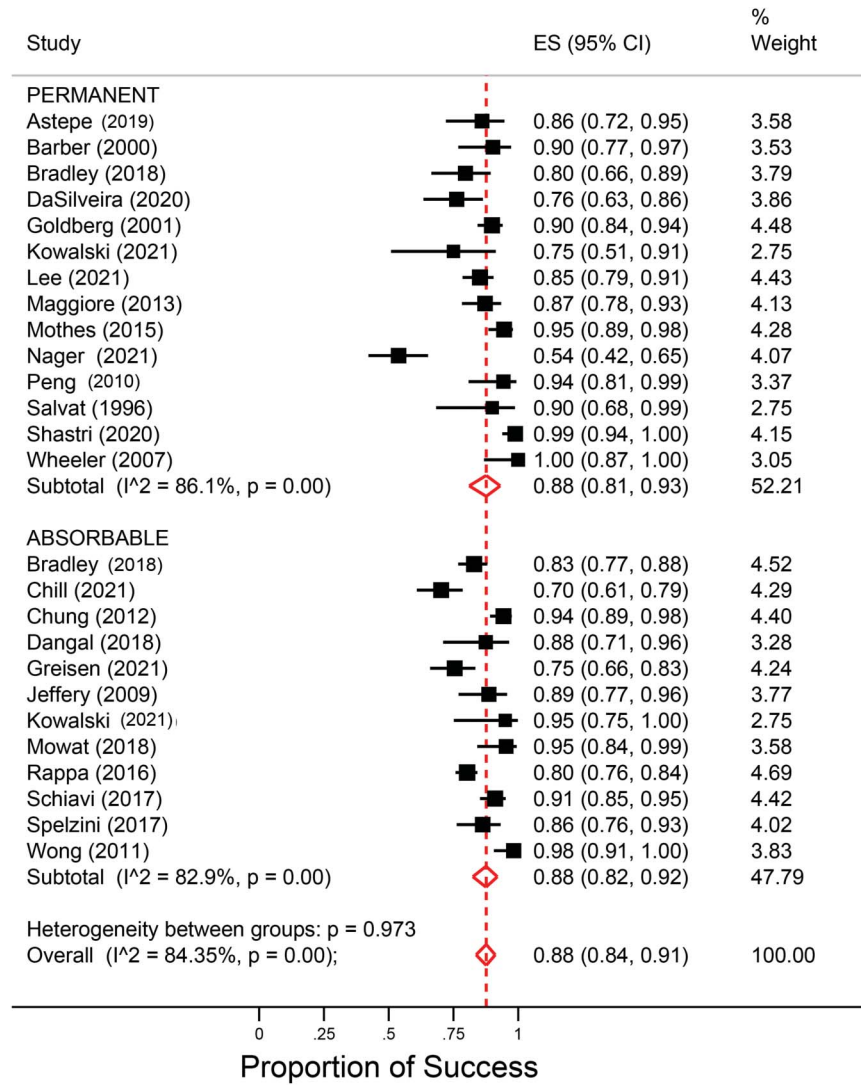

Fig. 2. Proportional outcome analysis of vaginal suspension surgeries (including uterosacral and sacrospinous) by suture type (permanent vs absorbable). ES, effect size.

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studies reporting on granulation tissue. There were more suture exposures in the permanent suture group compared with the absorbable suture group, with a 2.7% difference (95% CI 0.01–0.04). Permanent suture was 5.26 times more likely to become exposed than absorbable suture (RR 5.26, 95% CI 1.56–17.69) (Appendices 6 and 7, available online at http://links.lww.com/AOG/C974). There were more surgeries for suture and mesh complications in the permanent suture group compared with the absorbable suture group, with a 1.7% difference (95% CI 0.01–0.03). There was no difference in mesh erosion or dyspareunia between permanent and absorbable suture.

DISCUSSION

The choice of suture used in the surgical repair of apical prolapse traditionally has been rooted in institutional and personal preferences, not driven by data. A growing body of research has been developing to more appropriately guide these clinical decisions. Although intuitively many surgeons thought permanent suture would offer a more durable and long-lasting repair, and thus higher success rates, there is concern that there may be more adverse events associated with permanent suture. Interestingly, our data found no difference in anatomic outcomes between permanent and absorbable suture at moderate-length follow-up. We find this very reassuring because it supports the use of absorbable suture to minimize adverse events such as suture exposure, granulation tissue, and repeat surgery for suture or mesh complications, without sacrificing success.

Our data support the growing body of literature that absorbable suture is a safe and effective option for

Table 2. Summary of Sacrocolpopexy Studies

Study	Study Design (Quality)	Suture Type	No. of Participants	Age (y)	BMI (kg/m^2)	Preoperative Prolapse Severity	Follow-up Time (mo)
Powell, 2021[9]	Comparative, retrospective (C)	Polypropylene and polydioxanone	119	P: 62.1±13.4 A: 63.9±10	P: 28.8±6.8 A: 27.7±5.2	POP-Q mean P: C: −3.1 Ba: +2.1 Bp: +0.8 A: C: −3.7 Ba: +2.4 Bp: −0.2	P: 23 A: 10.4
Matthews, 2020[39]	RCT (A)	Polydioxanone and polytetrafluoroethylene	182	59±10	27.5±5	POP-Q stage 3–4: 72%	12
Tan-Kim, 2014[40]	Comparative, retrospective (B)	Polydioxanone and polypropylene	193	P: 61±9 A: 60±9	NR	POP-Q median stage: 3	18
Culligan, 2013[41]	RCT (B)	Polytetrafluoroethylene	58	56.2±8.5	25.6±3.6	POP-Q mean: C: −0.8 Ba: +1.8 Bp: −0.3	12
Elliot, 2006[42]	Single group, prospective (B)	Polytetrafluoroethylene	21	67 (47–83)†	NR	POP-Q stage 3–4: 100%	24
Ross, 2005[43]	Single group, prospective (B)	Polypropylene	51	67 (41–83)†	NR	POP-Q stage 3–4: 85%	12
Davila, 2020[44]	Comparative, retrospective (C)	Permanent (type not specified)	30	70	29	POP-Q stage 3–4: Ultrasound-assisted: 73% Standard: 80%	6
Culligan, 2005[45]	RCT (A)	Polytetrafluoroethylene	45	60.4±10.1	28.4±4.7	POP-Q mean: C: −2.3 Ba: +0.9 Bp: +0.5	12
Gracia, 2015[46]	Comparative, prospective (B)	Polypropylene	30	43.5±7.6	24.3±3.6	POP-Q stage 3–4: 62.6%	6
Nosti, 2016[47]	Comparative, retrospective (B)	Polytetrafluoroethylene	104	54.8‡	26.2‡	POP-Q stage 3–4: 65.9%	12
Benson, 2010[48]	Comparative, retrospective (C)	Polyglactin	33	62.8‡	NR	POP-Q stage 3–4: 100%	29 1,365
Culligan, 2020[49]	Single group, prospective (B)	Polytetrafluoroethylene	253	57.7±9.4	26±4.1	POP-Q stage 3–4: 59.5%	66
Salamon, 2013[50]	Single group, retrospective (C)	Polytetrafluoroethylene	64	54.4 (35–76)†	25.6 (19–35.8)†	POP-Q stage 3–4: 62.5%	12
Salamon, 2013[51]	Single group, prospective (B)	Polytetrafluoroethylene	118	56.63±7.85	26.02±3.98	POP-Q stage 3–4: 56%	12
Tate, 2011[52]	RCT (A)	Polytetrafluoroethylene	29	58±9	NR	NR	60
Martin, 2015[53]	Comparative, retrospective (C)	Polytetrafluoroethylene	181	55.8±9.7	27.4±4.8	POP-Q stage median: 3 (1–4)	3
Sato, 2021[54]	Single group, retrospective (C)	P (type not specified)	46	70.0±7.4	23.6±3	POP-Q stage 3–4: 32.6%	12
Kenton, 2016[55]	Comparative, prospective (B)	Polytetrafluoroethylene	66	59.5±9.9	27.7±5.7	POP-Q mean: C: +0.5 Ba: +2.5 Bp: −0.2	12
Belsante, 2013[56]	Single group, retrospective (C)	Polyglactin	35	65 (37–79)†	24.6 (18–30)†	POP-Q mean: C: −1.1	28
Elliot, 2007[57]	Single group, prospective (C)	Polytetrafluoroethylene	35	67 (47–83)†	NR	POP-Q stage 3–4: 100%	36

(*continued*)

Table 2. Summary of Sacrocolpopexy Studies (*continued*)

Study	Study Design (Quality)	Suture Type	No. of Participants	Age (y)	BMI (kg/m²)	Preoperative Prolapse Severity	Follow-up Time (mo)
Mueller, 2016[58]	Single group, retrospective (C)	Polytetrafluoroethylene	352	57.2±8.5	26.2±7.8	POP-Q stage 3–4: 80%	3
Van den Akker, 2019[59]	Single group, retrospective (C)	P (type not specified) plus staples	178	Median: 66 (59–71)[§]	Median: 26.4 (23.4–28.7)[§]	POP-Q stage 3–4: 31%	35
Giannini, 2022[60]	Single group, retrospective (C)	Polypropylene	60	62.2±7	24.8±2	POP-Q stage 2–4: 69%	24
Bazzi, 2019[61]	Comparative, retrospective (C)	A (type not specified)	131	64.5±10.1	28.5±5.2	POP-Q stage 3–4: 82%	12
Morciano, 2018[62]	RCT (B)	Polydioxanone	84	65 (58–72)[§]	25 (22–27)[§]	POP-Q median stage: 3 (2–4)	12
Tagliaferri, 2021[8]	RCT (A)	Polyglactin	150	59±8	26.4±4.1	POP-Q median: C: +3 Ba: +3 Bp: +1	12
Berger, 2020[63]	RCT (B)	A (type not specified)	46	60.7±8.8	27.5±4.6	POP-Q stage 3–4: 84.9%	12
Cvach, 2012[64]	Comparative, unclear direction (C)	Polydioxanone	9	50 (37–66)[§]	25.5 (21–29)[†]	POP-Q stage 3–4: 100%	19
Tan-Kim, 2015[65]	RCT (B)	Polydioxanone	64	58.7±9.4	25.6±3.9	POP-Q stage median: 3 (2–4)	12
Gilleran, 2008[66]	Single group, retrospective (C)	A (type not specified)	29	64±11	26±3.4	NR	23
Liu, 2020[67]	Single group, retrospective (C)	Glycolide, dioxanone, and trimethylene carbonate (V-Loc 90)	49	60.8±9.3	23.7±3.2	POP-Q stage 3–4: 94.8%	3
Borohay, 2014[68]	Single group, retrospective (C)	Barbed delayed absorbable (V-Loc 180)	20	54.3±11.4	29.1±4.7	POP-Q stage 3–4: 75%	17.3
Shepherd, 2010[69]	Comparative, retrospective (B)	Polydioxanone	415	60.7	NR	POP-Q stage 3–4: 69.2%	1.5
Stubbs, 2011[70]	Single group, retrospective (C)	Polydioxanone	36	70	27	POP-Q stage 3–4: 70%	3.8
Shekhar, 2020[71]	Single group, prospective (C)	Delayed absorbable	20	42.3±15.9	24.7±3.3	POP-Q mean: C: +2 Ba: 0 Bp: −3	16
Balsamo, 2018[72]	Comparative, retrospective (B)	Polyglycolic	73	69±10	20.9 (15.6–32.7)[§]	POP-Q stage 3–4: 86.3%	94
Kallidonis, 2017[73]	Single group, retrospective (C)	Trimethylene carbonate (V loc)	20	63 (50–79)[‡]	26.7 (22.1–31.3)[†]	POP-Q stage 3–4: 25%	13.6
Liu, 2018[74]	Single group, retrospective (C)	Trimethylene carbonate (V loc)	15	63.9 (39–80)[‡]	27 (18.4–32.4)[†]	POP-Q stage 3–4: 60%	3
Reisenauer, 2022[75]	RCT (B)	Polyglycolic acid	195	65.1±9.2	25.5±3.3	POP-Q stage 3–4: 30%	6

Study	Sacral Suture Type	No. of Sutures on Vaginal Mesh Attachment	Suture Caliber	Definition of Treatment Success*	Anatomic Success [n/N (%)]		Adverse Events	
					Permanent Suture	Absorbable Suture	Permanent Suture	Absorbable Suture
Powell, 2021[9]	NR	NR	NR	1	49/49 (100)	70/70 (100)	9/49 suture exposure 2/49 surgery for suture complication	2/70 suture exposure 0/70 surgery for suture complication

(*continued*)

Table 2. Summary of Sacrocolpopexy Studies (*continued*)

Study	Sacral Suture Type	No. of Sutures on Vaginal Mesh Attachment	Suture Caliber	Definition of Treatment Success*	Anatomic Success [n/N (%)]		Adverse Events	
					Permanent Suture	Absorbable Suture	Permanent Suture	Absorbable Suture
Matthews, 2020[39]	Permanent	4 or more on each side	2-0 (both)	1,2,4	88/95 (93)	83/87 (95)	2/95 suture exposure 1/95 surgery for suture complication 5/95 mesh erosion	0/87 suture exposure 0/87 surgery for suture complication 7/87 mesh erosion
Tan-Kim, 2014[40]	NR	Ant: 6 or more Post: 6 or more	2–0	1	143/148 (97)	43/45 (96)	4/148 suture exposure 25/148 mesh erosion	0/45 suture exposure 6/45 mesh erosion
Culligan, 2013[41]	Permanent	Ant: 6–10/side	NR	1	50/58 (86)	NA	0/58 suture exposure 3/58 dyspareunia	NA
Elliot, 2006[42]	Permanent	NR	1–0	1	18/20 (90)	NA	2/20 mesh erosion	NA
Ross, 2005[43]	Permanent	Ant: 5–6 Post: 3–5	NR	1	43/51 (84)	NA	4/51 mesh erosion 4/51 dyspareunia	NA
Davila, 2020[44]	Permanent	NR	NR	1 and 4	29/30 (97)	NA	NR	NA
Culligan, 2005[45]	Permanent	Ant: 9–5 Post: 6–12	NR	1	41/45 (91)	NA	2/45 mesh erosion	NA
Gracia, 2015[46]	Permanent	NR	NR	1	21/30 (70)	NA	0/30 mesh erosion 0/30 dyspareunia	NA
Nosti, 2016[47]	Permanent	Ant: 4–6 Post: 4–6	CV-2	1 and 2	93/104 (89)	NA	2/104 suture exposure 4/104 mesh erosion	NA
Benson, 2010[48]	Permanent	Ant: 6–8 Post: 6–8	2–0	3	31/33 (94)	NA	0/33 mesh erosion 0/33 dyspareunia	NA
Culligan, 2020[49]	Permanent	NR	CV-4	1 and 2	226/253 (89)	NA	0/253 mesh erosion	NA
Salamon, 2013[50]	Permanent	NR	CV-4	1	57/64 (89)	NA	1/64 mesh erosion	NA
Salamon, 2013[51]	Permanent	NR	CV-4	1 and 2	105/118 (89)	NA	0/118 mesh erosion 2/118 dyspareunia	NA
Tate, 2011[52]	Permanent	NR	CV-4	1–3	26/29 (90)	NA	3/29 mesh erosion	NA
Martin, 2015[53]	Permanent	NR	NR	3,4	160/165 (97)	NA	5/165 suture exposure 2/165 surgery for suture complication	NA
Sato, 2021[54]	Permanent	5 on each side	Ant: 3-0 Post: 2-0	1	43/46 (93)	NA	NR	NA
Kenton, 2016[55]	Permanent	NR	NR	1 and 2	65/66 (98)	NA	1/66 suture exposure 0/66 mesh erosion	NA
Belsante, 2013[56]	Permanent	NR	NR	1	35/35 (100)	NA	1/35 mesh erosion	NA
Elliot, 2007[57]	Permanent	NR	NR	1	34/35 (97)	NA	0/35 suture exposure 0/35 surgery for suture complication 2/35 mesh erosion	NA
Mueller, 2016[58]	Permanent	6–10 on both sides	CV-2	1	312/352 (89)	NA	5/458 mesh erosion	NA
Van den Akker, 2019[59]	Tacks or sutures (type NR)	NR	NR	1	62/118 (59)	NA	4/178 surgery for mesh complication	NA
Giannini, 2022[60]	Permanent	Ant: 6 Post: 6	NR	1	57/60 (95)	NA	0/60 mesh erosion	NA
Bazzi, 2019[61]	NR	NR	NR	1	NA	99/125 (79)	NA	6/125 mesh erosion

(*continued*)

Table 2. Summary of Sacrocolpopexy Studies (*continued*)

Study	Sacral Suture Type	No. of Sutures on Vaginal Mesh Attachment	Suture Caliber	Definition of Treatment Success*	Anatomic Success [n/N (%)]		Adverse Events	
					Permanent Suture	Absorbable Suture	Permanent Suture	Absorbable Suture
Morciano, 2018[62]	A	Ant: 6 Post: 5 or running locking	3–0	1	NA	82/84 (98)	NA	NR
Tagliaferri, 2021[8]	Permanent	Ant: 5–10 Post: 4–6	2–0	1	NA	75/75 (100)	NA	0/75 mesh erosion
Berger, 2020[63]	Permanent	Minimum 4/side	NR	1, 2, 3	NA	41/46 (89)	NA	NR
Cvach, 2012[64]	Permanent	NR	2–0	1	NA	5/8 (63)	NA	2/8 mesh erosion
Tan-Kim, 2015[65]	Permanent	Ant: 6–8 Post: 6–8	NR	1	NA	50/55 (91)	NA	2/55 mesh erosion
Gilleran, 2008[66]	Permanent	NR	NR	1,3	NA	29/29 (100)	NA	1/29 suture exposure 1/29 dyspareunia
Liu, 2020[67]	Permanent	"2–3 rows horizontally"	2–0	1,2	NA	49/49 (100)	NA	3/49 mesh erosion
Borohay, 2014[68]	Permanent	NA	3–0	1	NA	20/20 (100)	NA	0/20 suture exposure 0/20 mesh erosion
Shepherd, 2010[69]	1 absorbable	Ant: 3 Post: 6	2–0	1	NA	254/254 (100)	NA	0/254 suture exposure 2/254 mesh erosion
Stubbs, 2011[70]	Permanent	1 running suture on each side	1–0	1	NA	33/36 (92)	NA	NR
Shekhar, 2020[71]	Permanent	4–6 sutures on each side	NR	1	NA	19/20 (95)	NA	0/20 mesh erosion
Balsamo, 2018[72]	A	Ant: 4 Post: 4	1–0	1	NA	67/73 (92)	NA	1/73 mesh erosion
Kallidonis, 2017[73]	A or permanent (titanium tack)	1 running suture on each side	3–0	1	NA	16/20 (80)	NA	0/20 mesh erosion
Liu, 2018[74]	Permanent	NR	2–0	1	NA	15/15 (100)	NA	NR
Reisenauer, 2022[75]	Permanent	NR	NR	1	NA	94/96 (98)	NA	0/96 suture exposure 0/96 surgery for suture complication 0/96 mesh erosion

BMI, body mass index; P: permanent; A: absorbable; POP-Q, pelvic organ prolapse quantification; RCT, randomized controlled trial; NR: not reported; Ant, anterior; Post, posterior; NA: not applicable.
Data are mean±SD unless otherwise specified.
* A single composite anatomic success proportion was determined by our content experts and was based on: 1) anatomic success (POP-Q stage, or grade), 2) subjective symptoms of bulge, 3) re-operations, and 4) re-treatments.
† Mean (range)
‡ No SD because two groups combined.
§ Median (range).

POP repair. For native tissue repair, a recent RCT found that absorbable suture was not inferior to permanent suture for uterosacral ligament suspension when comparing point C on the POP-Q 12 months postoperatively.[18] In a 2020 systematic review looking at surgical success rates and mesh-related complications for absorbable suture compared with permanent suture in uterosacral ligament suspension, Peng et al found similar surgical success and failure rates. Furthermore, they found lower rates of suture exposure and erosion and need for suture removal with absorbable suture.[76] The existing data regarding suture choice for sacrocolpopexy have been similar. In a recent randomized noninferiority trial, Taglieferri et al found that, at 12 months postoperatively, delayed absorbable suture was noninferior to permanent suture when used for vaginal mesh attachment.[8] Matthews et al[39] found no difference in suture and mesh erosion when comparing delayed absorbable suture and permanent suture in a large, multicenter RCT.

Our systematic review was performed using rigorous extraction methodology, and a composite definition of anatomic success verified by three experts was used when evaluating studies, despite significant

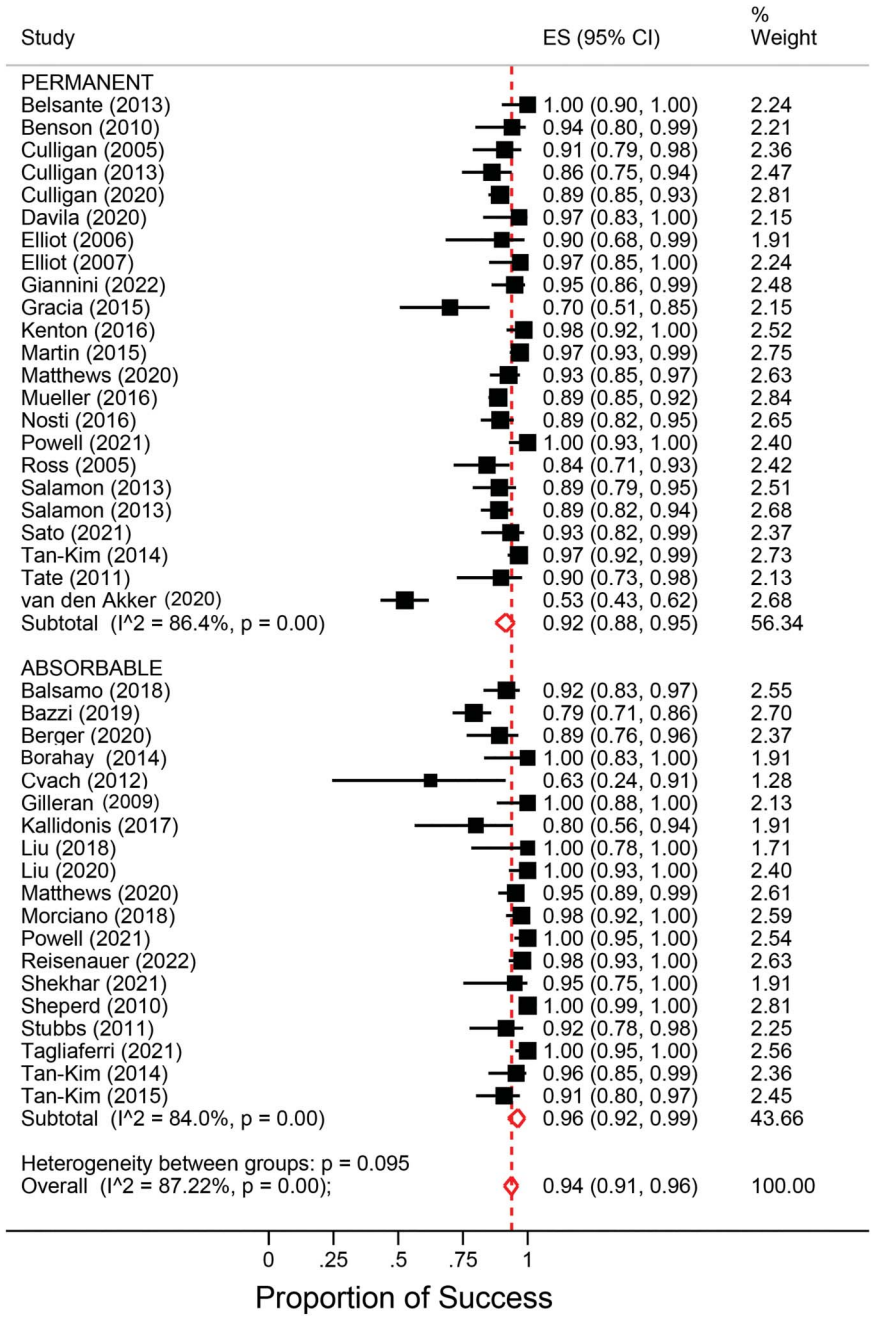

Fig. 3. Proportional outcome analysis of sacrocolpopexy vaginal mesh attachment by suture type (permanent vs absorbable). ES, effect size.

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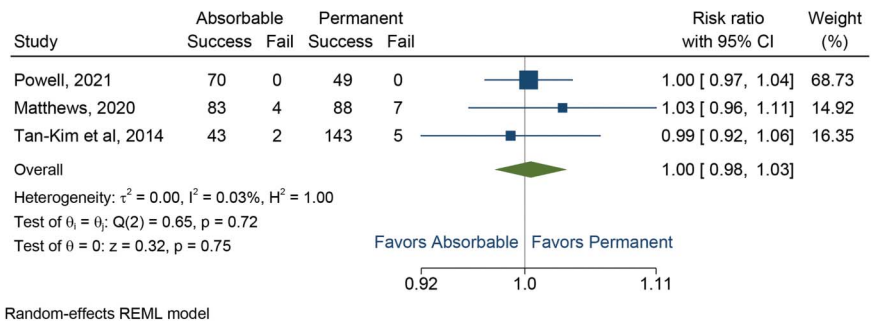

Fig. 4. Forest plot of sacrocolpopexy vaginal mesh attachment by suture type (permanent vs absorbable). REML, restricted maximum likelihood.

Pollack. Suture Type in Apical Prolapse Surgery. Obstet Gynecol 2023.

heterogeneity in the study populations. Further, we had a mean follow-up of 1–2 years. It is important to note a number of limitations. The majority of the studies included were level B and C evidence. Additionally, considering the limited data that exist on this topic, we used studies with significant heterogeneity. The studies included represent a wide age range and diverse populations. Although this heterogeneity may actually make these data more applicable to a wider scope of patients that we encounter, this may also account for differences in the outcomes. Finally, a benefit of meta-analysis is that more patients are factored into the analysis, but our findings for sacrocolpopexy (Fig. 4, Appendix 7 [Appendix 7 is available online at http://links.lww.com/AOG/C974]) are primarily driven by the Powell study (weight 68.73).[9]

Our data should reassure surgeons using absorbable suture for apical prolapse surgery, specifically vaginal suspensions, including uterosacral ligament suspension and sacrospinous ligament suspension and sacrocolpopexy. Absorbable suture and permanent suture (excluding braided polyester) have similar success rates when used for apical prolapse repair. Further, it is likely that absorbable suture will lead to fewer suture exposures and complications and fewer repeat surgeries for suture complications.

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