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POP SURGERY REVIEW

Anterior vaginal compartment surgery

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Abstract
Aim To review the safety and efficacy of anterior vaginal compartment pelvic organ prolapse surgery.
Methods Every 4 years and as part of the Fifth International Collaboration on Incontinence we reviewed the English-language scientific literature after searching PubMed, Medline, Cochrane library and the Cochrane database of systematic reviews, published up to January 2012. Publications were classified as level 1 evidence (randomised controlled trials [RCT] or systematic reviews), level 2 (poor quality RCT, prospective cohort studies), level 3 (case series or retrospective studies) and level 4 case reports. The highest level of evidence was utilised by the committee to make evidence-based recommendations based upon the Oxford grading system. A grade A recommendation usually depends on consistent level 1 evidence. A grade B recommendation usually depends on consistent level 2 and/or 3 studies, or "majority evidence" from RCTs. A grade C recommendation usually depends on level studies or "majority evidence" from level 2/3 studies or Delphi processed expert opinion. A grade D "no recommendation possible" would be used where the evidence is inadequate or conflicting and when expert opinion is delivered without a formal analytical process, such as by Delphi.
Results Absorbable mesh augmentation of anterior compartment native tissue repair improves the anatomical outcome compared with native tissue repair alone with no increased complication rate in meta-analysis of 2 RCTS (grade B). Biological grafts in meta-analysis have improved anatomical outcomes with no change in subjective outcomes compared with native tissue repairs (grade B). There is conflicting level 1 evidence to support porcine dermis and a single RCT to support small intestine submucosa as graft agents in anterior compartment prolapse surgery (grade B). Consistent level 1 data support a superior anatomical outcome for polypropylene mesh compared with a biological graft in the anterior compartment. Mesh exposure rate was significantly higher in the polypropylene mesh group (grade A). Consistent level 1 evidence demonstrates *superior subjective and objective outcomes following anterior transvaginal polypropylene mesh as compared to anterior colporrhaphy (grade A)*. These outcomes did not translate into improved functional results using validated questionnaires or a lower reoperation rate for prolapse. The mesh group was also associated with longer operating time, greater blood loss and apical or posterior compartment prolapse as compared with anterior repair. Anterior polypropylene mesh had a mesh extrusion rate of 10.4 % with 6.3 % requiring a surgical correction (grade B). Single level 3 evidence does not support the use of transvaginal polypropylene mesh for recurrent anterior vaginal wall prolapse (grade C).
Conclusion Polypropylene anterior compartment mesh offers improved objective and subjective outcomes compared with native tissue repair; however, these benefits must be considered in the context of increased morbidity associated with anterior polypropylene transvaginal mesh.

Keywords Anterior colporrhaphy · Transvaginal mesh · Cystocele

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Introduction

Ahlfelt stated in 1909 that the only remaining problem in plastic gynaecology was the permanent cure of cystocele, and now, more than a century, later this problem persists [1]. Following high reported objective failure rates and reoperation rates after native tissue repairs and the success of *suburethral* tapes in continence surgery and mesh utilised abdominally at sacral colpopexy, the last decade has seen an unprecedented introduction of biological and permanent meshes into the management of anterior compartment prolapse.

Native tissue repairs

Historically, anterior colporrhaphy was the standard procedure in the management of anterior compartment prolapse with objective success rates ranging from 80 to 100 % in retrospective series [2–5]. White [6], as early as 1912, demonstrated the

Table 1 Anterior vaginal wall prolapse procedures

Reference	Number	Follow-up	Success rate (%)
Anterior colporrhaphy			
Stanton et al. [2]	54	Up to 2 years	85
Macer [3]	109	5–20 years	80
Walter et al. [4]	76	1.2 years	100
Porges and Smilen [5]	388	2.6 years	97
Colombo et al. [90]	33 AC	8–17 years	97
	35 colposuspension	8–17 years	66
Sand et al. [14]	70 AC	1 year	57 (complications)
			75 (no mesh)
Weber et al. [15]	57 AC	23 months	37
	26 AC + vicryl mesh	23 months	42 (no mesh complications)
Vaginal paravaginal repair			
White [6]	19	Up to 3 years	100
Shull et al. [31]	62	0.6 years	67
Grody et al. [32]	72	0.5–3 years	99
Elkins et al. [33]	25	0.5–3 years	92
Mallipeddi et al. [34]	45	0.6 years	97
Young et al. [35]	100	11 months	78
Morse et al. [91]	27 VPVR	13 months	54
	86 AC	24 months	45
Abdominal paravaginal repair			
Richardson et al. [7]	60	1.7 years	97
Richardson et al. [27]	213	0.5–6 years	95
Shull and Baden [28]	149	0.5–4 years	95
Bruce et al. [29]	27 APR and sling	17 months	93
	25 APR	17 months	76
Scotti et al. [30]	40	39 months	97
Sling type support			
Raz et al. [38]	107 AC and needle	2 years	98
Raz et al. [39]	50	2.8 years	90
Gardy et al. [40]	58 AC and needle	2 years	95
Benrizi et al. [41]	36 AC and vaginal wall sling	17 months	95
Dmochowski et al. [43]	47 Raz type	47 months	43
Cross	36 AC and sling	20 months	92
Safir et al. [42]	112 Raz + polyglactin mesh	21 months	92
Goldberg et al. [44]	53 AC and sling	1 year	81
	90 AC	1 year	58

Definitions vary among authors

APR abdominal paravaginal repair; *AC* anterior colporrhaphy; *VPVR* vaginal paravaginal repair

importance of paravaginal defects in anterior compartment prolapse (Table 1). Richardson et al. [7], in 1976, described a series of defects in the pubocervical fascia explaining why no single repair should be applied indiscriminately to all patients with anterior compartment defects. He also advocated the abdominal paravaginal repair, which has a 75–97 % success rate for cystoceles reported in case series (Table 1) [7, 27–30]. The surgical technique of the laparoscopic paravaginal repair is well described; however, little information is available on the efficacy of this approach. Shull et al. [31] also reported on the safety and efficacy of vaginal paravaginal repair in 1994. Although the success rates of the vaginal paravaginal repair for cystoceles in case series vary from 67 to 100 % [6, 31–35], significant complications have been reported recently. Mallipeddi et al. [34] reported on complications in a series of 45 patients including: 1 with bilateral ureteric obstruction, 1 with retropubic haematoma requiring surgery, 2 with vaginal abscesses and 2 with transfusions. In a series of 100 women Young et al. [35] reported 21 major complications and a 16 % transfusion rate.

No randomised controlled trials (RCT) have evaluated the abdominal or vaginal paravaginal repair in isolation. Benson et al. [36] and Maher et al. [37] have reported RCTs on upper vaginal prolapse comparing abdominal sacral colpopexy and vaginal sacrospinous colpopexy. Abdominal paravaginal repair was performed in the abdominal group if required and an anterior colporrhaphy with or without vaginal paravaginal laterally. Both authors reported the abdominal group to have a statistically lower rate of postoperative anterior vaginal prolapse than the vaginal group.

Raz et al. [38] popularised the needle suspension-type procedure for cystoceles and reported that success rates in case series may vary from 90 to 98 % [39–41]. The addition of polyglactin mesh to the repair appears to have little impact on the success [42]. Dmochowski et al. [43] reported a lower success rate using a stricter outcome definition of success.

Goldberg et al. [44] reported results from a case–control study of women with cystocele and stress urinary incontinence. He suggested that the addition of the pubovaginal sling to the anterior colporrhaphy significantly reduced the recurrence rate of cystocele from 42 % in the control group to 19 % in the anterior colporrhaphy and sling group ($P<0.05$).

In line with our surgical colleagues there has been a move towards the use of prosthesis to augment native tissue repair in reconstructive gynaecology. This movement took much of its impetus from two early papers. First, Olsen et al. [45] reported a reoperation rate of 29 % following prolapse and or continence surgery and Weber et al. [15] reported a 70 % failure rate of native tissue anterior compartment repair. Recent re-evaluation of Olsen's same demographic 10 years later revealed a significantly lower re-operation rate of 17 % [46] and the reader should be cautious in making conclusions even from these data, as the surgical interventions performed in 1995 are not representative of interventions performed today. More importantly, Weber et al. [15] and Sand et al. [14] in randomised control trials reported anterior colporrhaphy to be successful in the management of cystocele in only 30 % and 57 % respectively. Recent re-analysis of data from Weber's paper using the hymen as the threshold for objective success reported considerably better outcomes, with only 10 % of subjects developing anatomical recurrence beyond the hymen, 5 % of subjects developing symptomatic recurrence and less than 1 % re-operations at 23 months' follow-up [47].

During the decade between these initial and subsequent publications surgeons have introduced a plethora of biological and mesh grafts to improve the outcomes of anterior compartment prolapse surgery.

Synthetic grafts in anterior compartment surgery

As seen in Table 2, as early as 1996, Julian et al. [8] demonstrated in a prospective case control study that in women who had undergone at least 2 previous vaginal repairs, the overlaying of a Marlex (Bard) mesh to the anterior colporrhaphy reduced the recurrence rate of cystocele from 33 % to 0 %. The Marlex mesh was associated with a mesh erosion rate of 25 %. Flood et al. [10] in a retrospective review of 142 women with Marlex mesh augmentation of anterior colporrhaphy demonstrated a 100 % success rate for cystoceles at 3.2 years and a mesh erosion rate of only 2 %.

Absorbable meshes are an attractive option as an augmenting material as they offer increased strength during the early healing phase without the long-term complications of permanent mesh and have been evaluated in two randomised controlled trials. Weber et al. [15], in a randomized control trial, compared the anterior colporrhaphy [10], ultra-wide anterior colporrhaphy [43] or anterior colporrhaphy with absorbable polyglactin (Vicryl) 910 mesh [45] in the management of cystocele. The study size was too small to detect small differences in efficacy or adverse events. However, at a mean follow-up of nearly 2 years the groups had similar proportions of women experiencing satisfactory or optimal anatomical results, 30 %, 46 % and 42 % respectively.

Sand et al. [14], in a larger RCT, allocated cystoceles to anterior colporrhaphy alone ($n=70$) and to anterior colporrhaphy plus polyglactin mesh underlay ($n=73$). At 1 year the success rate in the mesh group was 75 % and significantly greater than the 57 % success rate in the anterior repair group alone ($P=0.02$). Concurrent paravaginal defects were present in 11 women and concomitant paravaginal repair was significantly associated with a lower recurrence of cystocele overall ($P=0.02$).

A variety of permanent polypropylene mesh overlays have been evaluated in case series for the management of anterior wall prolapse. The anatomical success rate varies from 76 to 100 % [8, 16–18]. Salvatore et al. reported worrying functional outcomes after a prolene mesh overlay,

Table 2 Synthetic meshes utilised in anterior compartment surgery

Reference	Type	Number	Review months	Success rate (%)	Complication
Julian [8]	Marlex	12	24	100	25 % mesh erosion, infection
	Control	12		66	
Nicita [9]	Prolene	44	14	100	3 uterine prolapse
Flood et al. [10]	Marlex	142	38	100	3 mesh erosions
Migliari and Usai [11]	Mixed fibre	15	23	93	
Migliari et al. [12]	Polypropylene	12	20	75	
Natale et al. [13]	Polypropylene	138	19	97	13 mesh erosions, 9 dyspareunia, 1 haematoma
Sand et al. [14]	Polyglactin	73	12	75	No mesh complications
	No mesh	70		57	
Weber et al. [15]	Polyglactin	26	23	42	No mesh complications
	No mesh	57	23	37	
Salvatore et al. [16]	Prolene	32	17	87	13 % mesh erosions
O'Reilly and Dwyer [17]	Polypropylene (Atrium)	81	28	88	No mesh erosions
Cervigni et al. [18]	Polypropylene	218	38	76	12.3 % erosions, 7 % vaginal stenosis
Jo et al. [19]	Polypropylene Gynemesh	38	18	94	0 erosions
Rodriguez et al. [20]	Polypropylene	98		85	0 erosions
Amrute et al. [21]	Polypropylene	76	30	95	3 % erosions
De Tayrac et al. [22]	Polypropylene	84	24	92	8.3 %
De Tayrac et al. [23]	Polypropylene	55	37	89	9.1 % mesh erosion, 5.5 % mesh shrinkage
					16.7 % dyspareunia
De Tayrac et al. [24]	Polypropylene	48	18	98	8.3 % erosions
De Tayrac et al. [23]	Low weight coated polypropylene	32	13	93	6.3 % erosion, 12.8 % de novo dyspareunia
Nieminen et al. [25]	RCT low weight self-styled armed polypropylene	104	36	87	19 % erosions, 24 % reoperations, 6 POP, 5 tapes, 14 mesh exposure
	AC	97	36	59	19 % reoperation, 10 POP, 9 tapes
Sivaslioglu et al. [26]	RCT: low weight, self-styled	43	12	91	6.9 % mesh erosions
	Polypropylene				4.6 % de novo dyspareunia
	Site-specific vicryl AC 4	42	12	72	

including a mesh erosion rate of 13 %, overactive bladder increasing from 28 to 56 % and dyspareunia increasing from 18 to 38 % postoperatively [16]. More recently, 3 years' follow-up after the polypropylene mesh overlay in the anterior compartment has been reported. Cervigni et al. reported 218 women and found a 76 % objective success rate at 3 years [18]. Mesh erosions were identified in 12.3 % and vaginal stenosis in 7.7 % [18]. De Tayrac et al. reported 55 women at 3-year review with an 89 % success rate, 9.1 % mesh erosions, 5.5 % mesh shrinkage and 16.7 % dyspareunia [24]. They concluded that lower weight and coated meshes were required to limit the rate of complications and duly reported 132 women, 12 months after low weight coated polypropylene mesh with a 92 % success rate [23]. Unfortunately, local problems remained with mesh erosions in 6.3 % and de novo dyspareunia in 12.8 %. Rane et al. provided a 5-year review of 376 consecutive women with grade 3 anterior compartment prolapse after Perigee (American Medical System, Minnetonka, MN, USA) and reported a 94 % success rate, 11.1 % mesh extrusion rate and deteriorating sexual function in 4 % [53].

Carey et al. [54] performed an RCT comparing anterior and posterior fascial plication and repair with self styled anterior and posterior polypropylene Gynemesh (Ethicon, Somerville, NJ, USA,) overlay and reported no significant advantage to adding a mesh overlay at 1 year. The morbidity in the mesh group was lower than that reported above with a mesh erosion rate of 6.5 % and no difference in dyspareunia and de novo dyspareunia rates between the groups.

Five randomised control trials have been published comparing armed or trans-obturator polypropylene mesh and traditional anterior colporrhaphy (Table 3). Nieminen et al. [25] compared 104 women undergoing anterior compartment prolapse repair with self-styled 6×11cm low-weight monofilament four-armed polypropylene mesh (Parietene light, Sofradim Co, Trevoux, France) with 97 undergoing traditional anterior colporrhaphy. Concomitant hysterectomy and posterior compartment prolapse surgery was allowed. At 3 years the objective

Table 3 Augmenting materials for anterior vaginal surgery (continued)

Reference	Type	Number	Review months	Success rate (%)	Complications
Nguyen and Burchette [48]	RCT	38	12	89	5 % erosion
	Armed polypropylene				9 % dyspareunia
	Perigee				16 % dyspareunia
	AC	38	12	55	5 % reoperations, 1 tape, 1 POP
Altman and Falconer [49]	Polypropylene	123	2	87	1.5 % mesh
					Erosions
	Prolift				3.2 % organ perforation
Altman et al. [50]	Multicentre RCT polypropylene Prolift (Ethicon) armed	191	12	82	Subjective failure rate greater AC
					Operating time, blood loss, cystotomy, mesh exposure, stress urinary incontinence
		182		47	De novo dyspareunia mesh group
Carey et al. [51]	RCT repair with polypropylene Gynemesh augmentation	69	12	81	6.5 % mesh erosion
					0 reoperation prolapse
	Anterior and posterior colporrhaphy	70	12	66	De novo dyspareunia equal both groups
Vollebregt et al [52]	RCT polypropylene Avulta Bard	56		91	4 % mesh exposure
					0 reoperations POP
					Baseline dyspareunia resolved 20 %
					de novo dyspareunia 15 %, rectocele 10 %
	Vicryl AC			41	de novo dyspareunia 9 %
					5 % reoperations POP, de novo rectocele 10 %
Rane et al. [53]	Retrospective review	376	60	93	11.1 % mesh exposure
	Perigee grade 3 cystocele				4 % deteriorating sexual function

success (stage 0 or 1 Aa and Ba) rate was 87 % in the mesh group and 59 % in the no mesh group ($P<0.001$). Awareness of a bulge was seen in 18 % in the repair group compared with 10 % ($p=0.07$) in the mesh group. The mesh exposure rate was 19 % with 66 % requiring surgical correction. The reoperation rate for prolapse was 10 % in the native tissue group with all but one of the recurrences in the anterior compartment. In the mesh group the prolapse reoperation was 6 % with all six recurrences occurring in the posterior or apical compartments.

Sivaslioglu et al. reported on 43 undergoing low-weight self-styled polypropylene mesh compared with 42 undergoing site-specific vicryl repair and at 12 months found the objective success rate to be significantly higher at 91 % in the mesh group than at 72 % in the non-mesh group [26]. The mesh erosion rate was 6.9 % and de novo dyspareunia was reported in 4.6 % in the mesh group. Quality of life assessment demonstrated no difference in outcomes between the groups and no patient in either group underwent further surgery for anterior compartment prolapse.

Nguyen and Burchette compared anterior polypropylene (Perigee, AMS) mesh ($n=37$) with anterior colporrhaphy ($n = 38$). At 1 year the objective success rate was higher in the mesh group (89 % vs 55 %). Functional outcomes, including quality of life, sexual activity and dyspareunia, were similar in both groups, with 5 % mesh erosion and 2 % unilateral leg pain that settled at 8 weeks following the mesh surgery (Table 3) [48].

Altman and colleagues reported on behalf of the Nordic transvaginal mesh group a multicentre study (funded by the Karolinska Institute and Ethicon unrestricted grants) comparing anterior colporrhaphy ($n=182$) with anterior transvaginal trocar mesh kit ($n=186$, Prolift; Ethicon) in women with symptomatic stage II or greater cystocele [50]. Although the need for concomitant prolapse and continence surgery were excluded an undetermined number of women with posterior and apical compartment prolapse well beyond the introitus were included. Reviewers were unblinded, surgeons were reviewers and conflict of interest statements were not available for authors or members of the Nordic transvaginal mesh group. At 1 year, the success rate (composite Point Ba<−1 and absence of vaginal bulging) was significantly greater after the mesh repair (61 %) compared with the colporrhaphy group (35 %). The subjective success rate was also significantly greater after the mesh repair (75 % vs 62 % $p=0.008$) compared with the native tissue repair, while no difference was detected on validated pelvic floor questionnaires (Urinary Distress Inventory) between the groups. The Prolift mesh procedure was associated with greater morbidity with a longer operating time, greater blood loss, higher rate of intraoperative cystotomy (3.5 vs 0.5 %), postoperative de novo

stress urinary incontinence (12.3 vs 6.0 %), and combined reoperation rate for USI, prolapse and mesh exposure (6 % vs 0.5 %). De novo dyspareunia was seen in 7.3 % after the mesh surgery compared with 2 % after anterior colporrhaphy (p=0.07); however, no difference was detected between the groups utilising the Pelvic organ Prolapse Urinary Incontinence Questionnaire (PISQ-12). The mesh exposure rate was 11.5 % (21 out of 183)

Last, Vollebregt and colleagues reported a multicentre randomised control trial from the Netherlands with blinded reviewers comparing anterior colporrhaphy (n=58) with a polypropylene trans-obturator mesh kit (n=56; Avulta Bard, Covington, LA, USA) for stage 2 primary anterior compartment prolapse [52]. Concomitant hysteropexy and posterior compartment surgery was allowed with hysterectomies being excluded. At 1 year the objective success rate was significantly greater in the mesh group than in the anterior colporrhaphy group (91 % versus 41 %). Reoperation for anterior compartment prolapse was performed in 5 % after native tissue repair and in no patients in the mesh group (p>0.05). No difference in awareness of prolapse or outcomes using validated questionnaires (Urogenital Distress Inventory and Incontinence Impact Questionnaire) was identified between the groups. The authors attributed the low mesh exposure rate of 4 % to not performing hysterectomy and/or the collagen coating on the polypropylene mesh. Resolution of preoperative dyspareunia occurred in 80 % in the repair group compared with 20 % in the mesh group. De novo dyspareunia was reported in 15 % following mesh and 9 % after native tissue repair and de novo rectocele in 23 % versus 10 % respectively. The authors concluded that despite the significantly improved anatomical outcome in the mesh arm when using a functional outcome as a definition of success that there was not enough evidence to support the use of trans-obturator mesh in primary anterior compartment prolapse surgery.

The 2012 Cochrane meta-analysis [55] found that trans-obturator meshes had a lower rate of recurrence on examination (59 out of 424, 14 %) compared with anterior colporrhaphy alone (200 out of 410, 49 %) RR 3.50, 95 % CI 2.71 to 4.52. This finding was consistent for both the self-styled (RR 3.41, 95 % CI 2.04 to 5.67) [25, 26] and the commercial trans-obturator polypropylene mesh kits (RR 3.53, 95 % CI 2.62 to 4.74) [48, 50, 52]. Three trials demonstrated that anterior colporrhaphy (94 out of 333, 28 %) also had a higher subjective failure rate than anterior transvaginal mesh repair (60 out of 344, 17 %; RR1.62, 95 % CI 1.22, 2.14) [25, 50, 52]. Further prolapse surgery was not significantly more common after anterior colporrhaphy (14 out of 459, 3 %) compared with 6 out of 470 (1.3 %) after trans-obturator polypropylene mesh (RR 2.18, 95 % CI 0.93 to 5.10). No difference was detected between individual studies in validated prolapse-specific questions and meta-analysis was not possible owing to variations in the questionnaires utilised. The operating time and blood loss were significantly greater in the mesh group and there was a tendency towards a lower cystotomy rate (0.4 % vs 2.7 %, RR.0.19, 95% CI 0.03, 1.07) [25, 50], de novo dyspareunia (4 % vs 8 %, RR 0.51, 95 % CI 0.21 to 1.23) and de novo stress urinary incontinence (7.3 % vs 11.4 %, RR 0.65, 95 % CI 0.4 to 1.07) [25, 26, 50] after anterior colporrhaphy. Further continence surgery was performed in 15 out of 368 women following anterior colporrhaphy and 12 out of 380 after the polypropylene mesh procedure (RR 1.29, 95 % CI 0.63 to 2.63). These data need to be interpreted with caution as there were variations in concomitant surgeries. Mesh erosions were reported in 10.4 % of women (41 out of 393) who had anterior compartment polypropylene mesh, and surgical intervention to correct mesh erosion was required in 6.3 % (34 out of 540).

Withagen et al., in an observational study of 150 women undergoing polypropylene mesh kit procedure (Prolift; Ethicon) found that after an isolated anterior polypropylene repair there was a 46 % incidence of stage 2 prolapse in the untreated compartment [56]. Altman et al., performed no concomitant surgery in the study and no difference in posterior compartment prolapse was identified between the groups or postoperatively within the mesh group when evaluating median Point Bp. However, meta-analysis of those studies [25, 52] that reported de novo prolapse in the apical or posterior compartment following anterior compartment mesh repair found a lower rate after the anterior colporrhaphy (14 out of 147, 9.5 %) compared with trans-obturator mesh (26 out of 148, 17.7 %; RR 0.49, 95 % CI 0.24 to 0.97) Both study protocols allowed concomitant posterior compartment prolapse surgery. Although the reoperation rate for prolapse was similar in Nieminen et al. between the two groups, all the reoperations in the AC group were anterior compartment failures and all in the trans-obturator mesh group were in the posterior or apical compartment [25]. This outcome is not surprising as we have seen previously that when the vaginal axis is significantly altered compensatory prolapse can develop in other compartments. Compensatory prolapse is described in the posterior compartment after colposuspension [57] or in the anterior compartment after sacrospinous colpopexy [58, 59].

In the eight trials evaluating 553 patients who underwent some form of transvaginal mesh surgery in the management of anterior compartment prolapse none of the patients underwent surgical intervention for vaginal pain or dyspareunia. This is in contrast to the Food and Drug Administration (FDA) transvaginal mesh alert where vaginal pain and dyspareunia accounted for 39 % of adverse events and was marginally more frequent than mesh erosions at 38 % of adverse event reports (http://www.fda.gov/MedicalDevices/Safety/AlertsandNotices/ucm262435.htm). While mesh exposure and its management remain well described, vaginal pain and dyspareunia associated with

anterior trans-obturator polypropylene mesh remain poorly characterised and will be fully evaluated in the complications and sexual function section of this article.

Given the relatively robust anatomical outcomes associated with trans-obturator mesh many clinicians were surprised that many mesh kit manufactures recently elected to introduce trocarless mesh kits and the majority have few or no data supporting their claims of superiority. Most recently, Moore et al. [60] described single-incision anterior elevate (American Medical Systems, Minnetonka, MN, USA) using a lightweight polypropylene graft (24 g/m^2) and reported a 92 % objective success rate at 13 months in 60 patients with anterior and/or apical prolapse. No mesh exposures were reported and the authors who reviewed the patients reported a financial relationship with the company manufacturing the product being evaluated.

Another new system involves a polypropylene mesh (Prosima; Ethicon) overlay with arms extending, but not secured to deeper structures. Patients use a vaginal support device that is removed in the outpatient setting 3–4 weeks postoperatively, to splint the mesh while it is being incorporated into the paravaginal tissues. On prospective evaluation performed by surgeons, all of whom have declared financial agreements with the manufacturing company, they reported a 77 % objective success rate (<stage 2 POP-Q) at 1 year [61] and 69 % at 2 years [62] with a mesh exposure rate of 9 % in women with stage 2 anterior and/or posterior compartment prolapse. Significant further prospective comparative trials with blinded independent reviewers are required for all mesh kits.

Biological graft anterior compartment surgery

As an alternative to synthetic prosthetic grafts autologous material may have a lower risk of host rejection or infection. Cosson et al. [63] described an autologous vaginal patch measuring 6–8 cm long and 4 cm wide suspended from the tendinous arches of the pelvic fascia and tucked under the anterior repair. The success rate (<grade 1 POP) was 93 % at a mean follow-up of 16 months.

Allografts from post-mortem tissue banks have been used for many years in orthopaedic surgery and decrease the risk associated with harvesting autologous rectus sheath or fascia lata. Cadaveric fascia lata with or without pubovaginal sling has been utilised to correct anterior compartment prolapse with a success rate varying from 81 to 100 % with acceptable complication rates [64–67]. Gandhi et al. have reported preliminary results of a randomised control trial comparing anterior colporrhaphy alone and augmented with fascia lata graft for cystoceles [68]. At 1 year they were not able to demonstrate that the addition of the fascial lata graft improved outcomes, with the success rate after anterior colporrhaphy alone being 71 % compared with 82 % in those augmented with the fascia lata graft (P=0.07). No complications were reported. Cadaveric dermis has been employed as a graft material in the anterior compartment with success rates varying from 42 to 84 % at 2 years [69–72]. Concerns regarding prion transmission causing infectious diseases [73] or residual antigenicity [74] that may cause host graft reactions have encouraged the use of porcine or bovine xenografts, as detailed in Table 4.

Leboeuf et al. retrospectively reviewed 24 women with native tissue four corner defect repair (FDR) and 19 FDR with porcine dermis [75]. At 15 months the success rate was 100 % in the FDR group and reduced to 84 % if porcine dermis overlay was utilised. Wheeler et al. reported on 36 women who all underwent high uterosacral vault suspension with anterior repair augmented with porcine dermis and at 17 months found a 50 % recurrence rate [78]. The authors highlighted that despite the high objective failure rate more that 90 % of the women were satisfied or somewhat satisfied with the repair and 83 % would undergo the surgery again. Handel et al. retrospectively compared anterior colporrhaphy (n=18), porcine dermis (n=56) and polypropylene graft (n=24) in those with cystocele [80]. The success rate at 13 months was 94 %, 64 % and 96 % respectively with a 21 % rate of vaginal extrusion of the porcine dermis graft. In contrast to these relatively disappointing results, a number of groups have reported satisfactory objective results utilising porcine dermis [77, 81].

Meschia et al., in a multicentre randomised clinical trial, compared anterior colporrhaphy (n=103) and anterior colporrhaphy augmented with 4-×7-cm piece of porcine dermis [79]. The success rate at 1 year was 93 % in the anterior colporrhaphy with porcine graft overlay group compared with 81 % in the anterior colporrhaphy alone group (P<0.001) with a 1 % rate of graft erosion.

Hviid et al. reported a smaller randomised controlled trial comparing polyglactin plication anterior colporrhaphy and a porcine dermis 4-×7-cm graft at 1 year [84]. The objective failure rate (defined as point Ba≥−1) was 2 out of 28 in the porcine dermis group compared with 4 out of 26 in the anterior colporrhaphy group and was not significantly different. Guerette et al. compared the anterior colporrhaphy group (n=17) and anterior colporrhaphy with bovine pericardium collagen (n=27) matrix graft reinforcement and reported no difference on objective examination with success rate of 63 % after the AC and 77 % with bovine pericardium collagen repair at 2 years [83]. The reoperation rate for prolapse was 37 % in the AC group and 23 % in the bovine pericardium group. De novo dyspareunia occurred in 5 % following AC only. There was no difference in quality of life outcomes between the groups utilising the Urinary Distress Inventory and the Pelvic Organ Prolapse and Incontinence Sexual Questionnaire.

Feldner et al. compared anterior colporrhaphy with a 7-×10-cm small intestine submucosa (SIS) graft in a randomised control trial and demonstrated reduced operating time in the AC group

Table 4 Use of biological grafts in anterior compartment prolapse

Reference	Graft	*n*	Months	Success rate (%)	Complications
Allografts					
Cosson et al. [63]	Autologous	47	16	93	None
	Vaginal patch				
Groutz et al. [64]	Cadaveric and pubovaginal sling	19	20	100	None
Kobashi et al. [65]	Cadaveric fascia lata and sling	132	12	87	1 osteitis pubis
Chung et al. [69]	Cadaveric dermis	19	24	84	1 infection removal
Clemons et al. [70]	Cadaveric dermis	33	18	59	1 incision breakdown
Powell et al. [66]	Cadaveric fascia lata	58	24	81	10 % graft erosion
					2 transfusions, 1 cystotomy
					3 ureteral kinking
Frederick and Leach [67]	Cadaveric fascia lata and sling	251	6	93	1 osteitis pubis
Gandhi et al. [68]	RCT	76	13	82	No graft complications
	AC and fascia lata (Tutoplasta) AC no graft	78	13	71	
Ward et al. [71]	Cadaveric dermis	39	24	42	1 de novo dyspareunia
					No graft erosions
Xenographs					
Leboeuf et al. [75]	FDR and Pelvicol	9	15	84	None
	PDR	24	15	100	None
Salomon et al. [76]	Porcine dermis trans-obturator	27	14	81	1 graft reoperation, vaginal pain
Gomelsky [77]	Porcine dermis	70	24	87	None
Wheeler et al. [78]	Porcine dermis	28	18	50	2 % granulation tissue
	Uterosacral repair				
Meschia et al. [79]	Porcine	98	12	93	1 % vaginal extrusion
	AC	103	12	81	
Handel et al. [80]	Porcine dermis	56	13	64	21 % vaginal extrusions
	Polypropylene	25	13	96	4 % mesh erosion
	AC	18	13	94	
Simsiman et al. [81]	Porcine graft	89	24	78	17 % erosions
Robles et al. [82]	Porcine dermis	90	8	85	No complications
	Polypropylene arm				
Guerette et al. [83]	AC	27	24	63	Reoperation POP surgery 37 %
	Bovine pericardium collagen	17		77	23 %
Hviid et al. [84]	AC	26	12	85	Recurrent POP surgery 8 %
	Porcine dermis graft	28		93	10 %
Feldner et al. [85]	AC	27	12	67	Dyspareunia 15 %
	Porcine small intestine	29		86	25 %
	Submucosa				
Natale et al. [86]	Porcine graft	94	24	58	Mesh erosion 0
	Self-styled polypropylene mesh	96		72	6.3 %
Menefee et al. [87]	AC	19	24	55	Mesh erosion 0
	Vaginal paravaginal porcine dermis	23		52	4 %
	Vaginal paravaginal polypropylene	25		86	14 %

Variable definitions of success were used

(30 min vs 46) compared with SIS (p=0.02) [85]. The objective failure rate of 33 % (9 out of 27) was significantly higher after the AC versus 14 % (4 out of 29) in the SIS group. The dyspareunia rate was similar in both groups (AC 4 out of 27 vs 5 out of 20 SIS) and no reoperations were reported. Prolapse quality of life assessment (P-QOL) improved postoperatively in both groups with no significant difference between the groups. In another RCT, Natale et al. compared polypropylene mesh (Gynemesh)

with porcine dermis (Pelvicol). At 2 years, significantly fewer women had anterior vaginal wall recurrence in the mesh group 28 % (27 out of 96) vs 44 % (41 out of 94) of the porcine graft group (RR 0.64, 95 % CI 0.43 to 0.96). Mesh erosion was seen in 6.3 % following mesh surgery. Although similar numbers of women reported dyspareunia (10 vs 12), the authors reported superior sexuality outcomes in the porcine graft group compared with polypropylene mesh (p=0.03) [86].

Finally, Menefee et al., in a randomised control trial, compared three operations, anterior colporrhaphy, vaginal paravaginal repair using porcine dermis graft and vaginal paravaginal with self-styled polypropylene mesh and also reported a higher objective success rate after the polypropylene mesh 86 % (25 out of 29) compared with 52 % (12 out of 23) in the porcine dermis arm [87] and 53 % (10 out of 19) in the AC arm. The subjective failure rate was not significantly different and was 3.4 %, 12 % and 13 % respectively. The graft erosion rate was 1 out of 23 (4.3 %) in the porcine dermis group and 4 out of 29 (13.8 %) in the mesh group.

The 2012 Cochrane meta-analysis concluded that when anterior colporrhaphy was compared with any biological graft the objective failure rate in the anterior compartment was significantly higher in the anterior colporrhaphy group (56 out of 222; 25 %) compared with the biological graft group (31 out of 218; 14 %) [55]. Results from three trials [68, 79, 83] demonstrated no difference in prolapse symptoms when native tissue repair was compared with biological graft repair (RR 1.03 0.61 to 1.75). The methodology and nature of the different biological grafts utilised in five trials [78, 79, 83, 84, 85, 87] were considered to be too dissimilar to combine with any other results in a meta-analysis, except to highlight that two RCTs [85, 87] demonstrated superior objective outcomes following polypropylene mesh compared with porcine graft overlay.

While many clinicians believe that the primary role of polypropylene mesh may be in complex or high-risk prolapse, such as recurrent prolapse, there is little evidence to support these proposals. Fayyad et al. prospectively evaluated 36 women with recurrent anterior compartment prolapse and reported an objective success rate (less than stage 2 anterior compartment prolapse) of 47 % with a mesh exposure rate of 19 % [88].

In a prospective multicentre Dutch RCT trial women who had undergone prior prolapse surgery were randomised between native tissue repairs and tension-free vaginal polypropylene mesh [89]. Allocation concealment was not confirmed and patient, surgeon and assessor were not blinded. Surgeons performed the reviews and all authors declared a financial relationship with the company manufacturing the commercial mesh product. Unfortunately, the two groups were significantly different preoperatively, pointing to a systematic failure in the randomisation process, which discredits the remaining findings of the manuscript.

The reported failure rate in the native tissue group using an unorthodox outcome definition (no prolapse in the treated compartment or reoperation) was 45 % AC vs 9 % mesh group at 1 year. Utilising the definition any grade 2 prolapse or subsequent prolapse surgery, the failure rate was 66 % in the conventional surgery group compared with 49 % (p=0.03) in the mesh group. The mesh exposure rate was 16.7 % with 6 % undergoing surgical intervention. Utilising the Patients' Global Impression of Improvement (PGII) and Urogenital Distress Inventory, both groups had similar outcomes.

The following conclusion can be made regarding surgical interventions for anterior vaginal compartment repairs:

- Absorbable mesh augmentation of native tissue repair improves the anatomical outcome compared with native tissue repair alone, with no increased complication rate in the meta-analysis of two RCTS (grade B)
- Biological grafts in meta-analysis have improved anatomical outcomes with no change in subjective outcomes compared with native tissue repairs (grade B). Conflicting level 1 evidence supports porcine dermis graft [81, 84, 87] and single RCT supports small intestine submucosa as a graft agent in anterior compartment prolapse surgery (grade B) [85].
- Consistent level 1 data support a superior anatomical outcome for polypropylene mesh compared with biological graft (Pelvicol) in the anterior compartment [85, 87]. The mesh exposure rate was significantly higher in the polypropylene mesh group (grade A)
- Consistent level 1 evidence demonstrates improved anatomical and subjective outcomes for polypropylene mesh compared with anterior colporrhaphy (grade A). These outcomes did not translate into improved functional outcomes using validated questionnaires or a lower reoperation rate for prolapse. The mesh group was also associated with longer operating time, greater blood loss and a non-significant tendency towards higher cystotomy, de novo dyspareunia and de novo stress urinary incontinence rate compared with AC. Apical or posterior compartment prolapse was significantly more common following polypropylene mesh and the mesh extrusion rate was 10.4 %, with 6.3 % undergoing surgical correction (grade B)
- Single level 3 evidence does not support the use of polypropylene mesh for recurrent anterior vaginal wall prolapse (grade C)

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