Int Urogynecol J (2009) 20:1265–1271
DOI 10.1007/s00192-009-0933-7

ORIGINAL ARTICLE

Arcus-anchored acellular dermal graft compared to anterior colporrhaphy for stage II cystoceles and beyond

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Received: 5 January 2009 / Accepted: 28 May 2009 / Published online: 17 June 2009

Abstract
Introduction and hypothesis The aim of this study is to compare acellular dermal matrix to standard colporrhaphy for cystocele repair.
Methods One hundred two patients with greater than or equal to stage II anterior prolapse (Aa or Ba 0) who underwent anterior colporrhaphy with acellular dermal implant attached to the arcus between October 2003 and February 2007 were compared to 89 controls who received standard anterior colporrhaphy. Objective recurrence was defined as greater than or equal to stage II (Aa or Ba −1).
Results The dermal graft and colporrhaphy groups were comparable in age, parity, body mass index, and concomitant surgeries except hysteropexy and hysterectomy. Regression was performed for possible confounders. Postoperatively, 14 (19%) recurrences were identified in the dermal graft group vs. 26 (43%) in the colporrhaphy group (p=0.004). Two patients underwent reoperations for cystocele recurrence in the study group vs. four in the control group. Time to normal voiding, subjective stress urinary incontinence, estimated blood loss, and length of hospital stay did not differ between groups.
Conclusion Dermal acellular matrix provides benefit over standard colporrhaphy.

Keywords Cystocele repair · Anterior colporrhaphy · Graft materials · Prolapse repair · Acellular dermal graft

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Introduction

The management of advanced anterior compartment prolapse continues to represent a considerable challenge. "Traditional" anterior colporrhaphy is associated with disappointing rates of anatomic failure, according to studies that have conducted careful long-term follow-up. Weber et al. [1] reported objective recurrence of anterior compartment prolapse in up to 56% of women after midline plication. Similarly, a prospective randomized controlled trial from our center identified anatomic failure after anterior colporrhaphy in 43% of cases [2].

These limitations have prompted various efforts to augment ordinary suture-based repairs with graft and mesh materials. For anterior compartment prolapse, both synthetic and biologic adjuvant materials have been proposed. In recent years, trocar-based polypropylene mesh "kits" have achieved commercial success but have raised significant concern over the potential for postoperative mesh erosion, dyspareunia, and other adverse events. Biological grafts carry the advantage of lower rates of erosion and wound-healing complications when compared to synthetic mesh, but these risks vary according to which particular biological graft is being discussed [3-5]. Additionally, questions exist regarding the longevity, best anchoring method, and costs of these materials. Among the various biological graft

materials currently available, acellular cadaveric dermis appears to be particularly well tolerated. Acellular cadaveric dermis has been utilized for a variety of general surgery indications including hernia repair [6, 7], burn management [8, 9], head and neck reconstruction [10], and plastic surgery [11] and has been approved by the Food and Drug Administration for use in vaginal reconstructive surgery. As an acellular material, it is considered to be nonantigenic with no discernable risk of rejection, and application in various surgical settings has demonstrated a consistent ability to fully integrate into native tissues and stimulate repopulation with native cells and neovascularization [12]. Despite the aforementioned characteristics, the effectiveness of acellular cadaveric dermis in decreasing prolapse recurrences and improving functional outcomes remains uncertain.

The purpose of this study is to describe an anterior–apical graft repair technique using acellular human cadaveric dermis and report on the medium-term outcomes in women undergoing the procedure for stage II–IV anterior vaginal wall prolapse. We hypothesize that participants who receive the graft-augmented anterior repair will have less recurrence than standard colporrhaphy.

Materials and methods

This is a retrospective cohort study with evaluation of subjects who underwent surgery from October 2003 to February 2007 at our tertiary referral center. Study subjects with anterior compartment prolapse extending to the hymeneal ring or beyond were included and underwent midline anterior colporrhaphy plication in addition to an acellular dermal implant (Repliform Tissue Regeneration Matrix; Boston Scientific, Marlborough, MA, USA). Only subjects with point Aa or Ba ≥0 preoperatively were included in the analysis.

Controls for this study consisted of subjects identified from our surgical database who also had anterior compartment prolapse extending to the hymeneal ring or beyond preoperatively. These subjects underwent pelvic organ prolapse surgery during the same time frame as the study group. They did not, however, receive the graft but underwent the midline anterior colporrhaphy plication alone or with imbrication of Polyglactin 910 mesh. This technique has been previously described [2] and was selected because prior work has suggested that it may offer improved efficacy over midline anterior colporrhaphy. All controls were operated on by a different surgeon (PKS) than those who received the anchored dermal graft repair (RPG). Subjects in both the study and control groups were excluded from the analysis if they received a permanent synthetic mesh, had preoperative point Aa or Ba <0, had concomitant surgery for gynecologic malignancies, or had bladder neck slings placed for stress urinary incontinence (SUI).

Sample calculation identified that 91 participants in each arm were necessary for a study powered to 80% to detect a 20% difference between groups with group 1 having a 60% success rate and group 2 having an 80% success rate.

Prolapse staging was performed using the Pelvic Organ Prolapse Quantification System preoperatively and postoperatively. Examinations were performed supine in the dorsal lithotomy position with an empty bladder, as well as standing. Subjects were instructed to Valsalva or cough during a portion of the exam to determine the maximal extent of their prolapse. All subjects underwent multichannel urodynamics testing preoperatively. To evaluate for potential SUI, the prolapse was temporarily reduced with proctoswabs or a speculum blade during cough urethral closure pressure profiles at maximum cystometric capacity. Quality of life questionnaires including the Pelvic Floor Distress Inventory (PFDI), Pelvic Impact Sexual Questionnaire (PISQ-12), and Incontinence Impact Questionnaire (IIQ-6) were administered preoperatively and postoperatively. Subjects were asked to return for postoperative evaluation at 2, 6, 12, and 52 weeks and yearly thereafter.

Concomitant vaginal hysterectomy, hysteropexy, sacrospinous vaginal vault suspensions, midurethral slings, and anterior and posterior colporrhaphy procedures were performed, and the rates for each group are summarized in Table 1. Anterior colporrhaphy was performed using 0-vicryl horizontal mattress sutures in the ultralateral technique described by Ann Weber [2]. For cases involving descent of the vaginal apex in the study group, one of two different vault suspensions were performed consistent with RPG's standard surgical practice: [1] For operations including vaginal hysterectomy, before closure of the peritoneum, a bilateral high uterosacral suspension was performed with two 0-PDS sutures affixing each vaginal apex corner to the proximal ipsilateral uterosacral ligament within 2 cm of the ischial spines [2]. The graft was not part of or incorporated into the vault suspension. For operations not involving hysterectomy, the apex was suspended with a bilateral anterior sacrospinous ligament fixation not involving entry into the peritoneal cavity which did include the vault in the graft fixation. For patients who did not require hysterectomy or apical suspension, an apical suspension was not performed. The control patients underwent modified McCall culdeplasties following hysterectomy or unilateral sacrospinous vaginal vault suspensions if apical defects were identified, as is consistent with PKS's standard surgical practice.

Objective recurrence was defined as greater than or equal to stage II (Aa or Ba at or beyond −1). Secondary outcomes included subjective stress and/or urge urinary incontinence (UUI), dyspareunia, estimated blood loss

Table 1 Sociodemographic and preoperative characteristics

	Arcus graft (n=102), mean (SD)	Controls (n=89), mean (SD)	p value
Age, years	60.2 (12.9)	63.1 (10.7)	0.09
BMI (n=26 missing)	27.5 (5.3)	26.4 (4.9)	0.19
Parity (n=16 missing)	2.7 (1.3)	2.6 (1.1)	0.66
Length of follow-up, months (range)	17.9 (9–49)	15.7 (9–36)	0.21
Prior hysterectomy, n (%)	23(23)	19 (21)	0.84
Prior anterior repair, n (%)	9 (9)	6 (7)	0.59
Preoperative UUI (n=7 missing), n (%)	55 (56)	46 (54)	0.84
Preoperative SUI (n=9 missing), n (%)	53 (54)	46 (55)	0.93
Preoperative point Aa or Ba to 0, n (%)	102 (100)	89 (100)	–
Preoperative point Aa or Ba beyond 0, n (%)	57 (58)	62 (70)	0.07
Preoperative point C, mean (SD)	−2.4 (4.4)	−2.1 (4.5)	
Preoperative point D, mean (SD)	−4.2 (4.2)	−2.7 (5.5)	

(EBL), length of hospital stay, and quality of life questionnaire score changes from preoperatively to postoperatively. Subjective SUI and UUI were measured with previously validated Likert scales. Dyspareunia was also measured with a Likert scale. EBL was obtained from the operative record and time to normal voiding was obtained from the subject's outpatient chart. Length of hospital stay was obtained from the subject's hospital record. Chi square and t tests were used for comparisons between groups. Potential predictors of recurrence, including age, body mass index (BMI), parity, past hysterectomy, concomitant hysterectomy, posterior repair, tension-free vaginal tape (TVT), transobturator tape, preoperative stage 4 prolapse, SUI, UUI, and dyspareunia, were evaluated using logistic regression. The difference between groups in concomitant hysterectomy and hysteropexy were adjusted for with logistic regression. Comparison within the control group between patients who received Polyglactin 910 and those who did not was performed to identify a potential source of confounding. All analyses were performed using SAS software version 9.1 (SAS Institute, Cary, NC, USA). Institutional review board and ethical approval for this study was obtained from Evanston Northwestern Healthcare.

Surgical technique of graft placement

After a dilute solution of vasopressin (6 U in 30 cc of 0.9% injectable saline) was injected beneath the midline of the anterior wall, a vertical incision was extended from the level of the bladder neck to the vaginal apex. The endopelvic connective tissue was dissected away from the vaginal skin flaps using Metzenbaum scissors and sharp dissection was continued until the descending pubic ramus could be palpated on each side. While sustaining digital pressure against the pelvic sidewall, blunt dissection was carried laterally and posteriorly until the paravaginal tissues were swept from their lateral insertion along the surface of the obturator muscle. With further blunt dissection, the ischial spine and sacrospinous ligaments were palpated. During this anterior approach to the sacrospinous ligament, significant bleeding may occur if these tissues are bluntly dissected too medially with the finger pushing into the loose paravesical tissues rather than firmly against the fixed sidewall musculature.

For all subjects undergoing anterior compartment augmentation, we utilized a 5×10-cm acellular dermal graft, configured into a trapezoid shape with specific dimensions illustrated in Fig. 1, to approximate the normal dimensions of endopelvic connective tissue in the anterior compartment. Each acellular cadaveric dermal graft (5×10 cm) was rehydrated for approximately 10 min until soft. The acellular dermal grafts were suspended using three pairs of permanent fixation sutures—which we refer to as

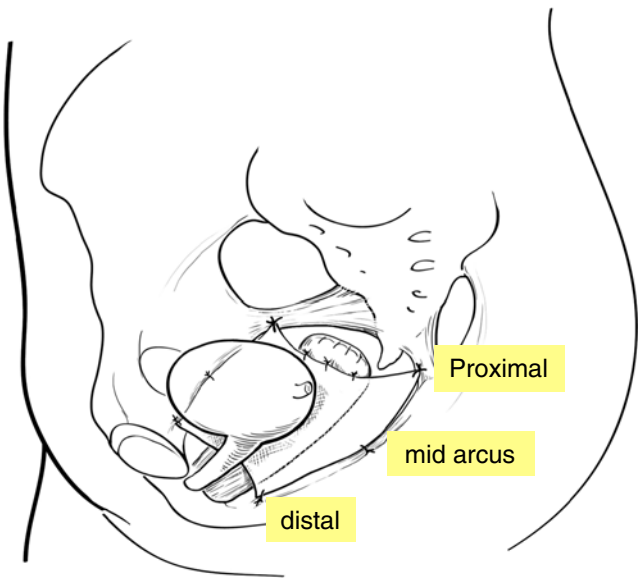

Fig. 1 Arcus to arcus dermal graft in place

"proximal," "mid-arcus," and "distal" (Fig. 1). We used a minimally invasive push-and-catch suturing device (Capio; Boston Scientific, Marlborough, MA, USA) and permanent 00 Gore Tex monofilament sutures. For the placement of "proximal" sutures, the bladder and paravesical tissues are retracted medially using an index finger. The targeted portion of the midsacrospinous ligament is then palpated. With the free hand, the suturing device is advanced to the ligament and deployed. The suspension suture is placed on average 1.5 fingerbreadths medial to the ischial spine, safeguarding against injury to the pudendal vessels. For cases involving pure anterior defects with no apical descent or for cases involving a foreshortened posthysterectomy vagina, we occasionally place the "proximal" anchoring sutures into the arcus tendineus fascia pelvis (ATFP) and underlying obturator muscle within close proximity lateral to the ischial spine, rather than into the sacrospinous ligament.

After the placement of the apical sutures, the right-sided and left-sided "mid-arcus" sutures were placed into the obturator internus fascia and ATFP, if palpable, equidistant between the ischial spine and pubic tubercle. Finally, the "distal" anchoring sutures were placed into the ATFP and obturator muscle in close proximity to the pubic bone with absorbable suture.

With respect to graft tension, the grafts were purposefully placed under a mild degree of tension; this differs from the loose tensioning recommended for synthetic mesh augmentation where postoperative mesh contraction is anticipated. Beneath the bladder neck, however, care was taken to not overtighten the graft material, so as to avoid bladder outlet obstruction leading to urinary retention.

For cases involving both graft placement and correction of vaginal apical descent, the sacrospinous ligament sutures were passed through the proximal graft corner and then immediately into the ipsilateral vaginal apex—resulting in dual fixation of graft corner and vaginal apex. These deep (sacrospinous) sutures were tied first, resulting in suspension of each graft corner and each vaginal apex corner, to the ipsilateral sacrospinous ligament. The mid-arcus and then distal arcus sutures were subsequently tied down. In rare cases, if the apical graft was too narrow to comfortably span from one anchoring site to the other, the proximal portion of the graft was incised at its base.

Cystoscopy was performed in all cases to ensure ureteral patency. Excess vaginal epithelium was trimmed and sutured with 2.0 vicryl in a continuous locking fashion. All subjects were observed overnight with an indwelling Foley catheter and underwent a voiding trial on the first postoperative day. Beyond the single perioperative antibiotic dose, no postoperative antibiotics were prescribed.

Results

Postoperatively, a 9-month or greater follow-up was obtained on 72 out of 102 (71%) of the acellular dermal graft group and 61out of 89 (69%) of the control group. Demographic, preoperative characteristics, and concomitant surgeries were found to be comparable between subjects who completed follow-up and those who were lost to follow-up. The acellular dermal graft and colporrhaphy groups were comparable with regards to mean age, median parity, BMI, prior surgery, preoperative stage of anterior compartment, prior procedures for prolapse, mean length of follow-up (17.9 vs. 15.7 months; Table 1), and concomitant procedures including anterior repair, posterior repair, and midurethral slings. They differed with regard to certain concomitant procedures including hysterectomy and hysteropexy (see Table 2).

Fourteen (19%) recurrences of the anterior compartment were identified in the human dermis graft group vs. 26 (43%) in the control group ($p=0.004$). Recurrent prolapse to the hymeneal ring was observed in seven (10%) vs. 14 (23%) in the graft and colporrhaphy groups, respectively ($p=0.037$).

Table 2 Concomitant surgeries

	Arcus graft ($n=102$)	Controls ($n=89$)	p value
Hysterectomy, *n* (%)	35 (34)	55 (62)	<0.001
McCall's	10	51	
Uterosacral	25	4	
Hysteropexy, *n* (%)	33 (32)	9 (10)	<0.001
Apical suspensions, *n* (%)			
Iliococcygeous	2 (2)	4 (4)	
Sacrospinous vault	19 (19)	15 (17)	0.85
None, *n* (%)	13 (12)	6 (7)	0.23
Compartment repair—posterior, *n* (%)	88 (86)	79 (89)	0.61
Compartment repair—anterior, *n* (%)	102 (100)	89 (100)	–
Incontinence operation—TVT, *n* (%)	10 (10)	13 (15)	0.31
Incontinence operation—TOT, *n* (%)	42 (41)	34 (38)	0.68

Recurrent prolapse beyond the hymeneal ring was observed in three (4%) vs. two (3%), respectively (p=1.0). No difference was found between groups for the rates of recurrence in the posterior or apical compartments (Table 3). Four patients in the study group underwent reoperation for recurrent prolapse, two of which underwent reoperation for recurrent cystocele. The other two underwent reoperation for apical prolapse. Four subjects in the control group had reoperation for recurrent cystoceles and a fifth one is scheduled. A sixth subject from the control group is using a pessary for symptomatic recurrent cystocele and a seventh subject is contemplating reoperation for recurrent apical prolapse.

Median time to normal voiding, hospital stay, mean EBL, and presence of subjective SUI did not differ between groups. Presence of subjective UUI differed significantly between groups with higher rates of UUI in the dermal graft group (see Table 3).

No vaginal erosions were observed in either group. Four patients in the arcus group required urethrolysis of concomitant midurethral slings and one patient required division of the distal portion of the graft due to retention. Three patients in the control group required urethrolysis. Two patients in the arcus group required removal of one sacrospinous suture due to persistent buttock pain. Two patients in the arcus group required ureteral catheterization or stent placement due to obstructing sutures from concomitant surgeries. One patient in the control group had inadvertent suture placement in the bladder, a second required ureteral stent placement, and another had groin pain radiating to her thigh. One patient had extrusion of the Gore-Tex sutures bilaterally. No significant hemorrhage was encountered with placement of the sacrospinous ligament sutures, and no patients required transfusion.

Regression analysis performed to adjust for possible confounding of differences in concomitant procedures found that none of the characteristics that were unbalanced between the two groups were significantly related to recurrence nor did their adjustment alter the effect of arcus on outcome (unadjusted odds ratio [OR] for arcus graft vs. control=0.32; adjusted ORs ranged from 0.31 to 0.39). Regression analysis to identify predictors of recurrence did not identify any predictors. Of the 89 controls, 55 (62%) had Polyglactin 910 mesh imbricated into the colporrhaphy, the presence of which did not affect the recurrence rate in the control group.

Subjects in both the arcus graft and control groups had significant improvement in the PFDI scores, and subjects in the arcus graft group had improvement in PISQ scores (Table 4).

Discussion

It has been estimated that up to 11% of women will undergo surgery in their lifetime for pelvic organ prolapse, and one third of them will undergo repeat surgery [13]. In many cases, addressing these recurrences may introduce greater surgical challenges than those associated with the primary repairs. Demographic projections indicate that the public health burden of pelvic organ prolapse will increase considerably over the next several decades, such that by 2030, up to seven million women may require surgery [14]. With that trend in mind, it is clear that operations combining high rates of "first time" success with an attractive safety profile could potentially benefit a large and increasing population of women seeking our care.

We found that patients who received the dermal implant in addition to anterior colporrhaphy had significantly less

Table 3 Postoperative outcomes

	Arcus graft (n=72)	Controls (n=61)	p value
Anterior recurrence (Aa or Ba to −1), n (%)	14(19)	26 (43)	0.004
Anterior recurrence (Aa or Ba to 0), n (%)	7 (10)	14 (23)	0.04
Anterior recurrence (Aa or Ba beyond 0), n (%)	3 (4)	2 (3)	1.0
Posterior recurrence (Ap or Bp to −1), n (%)	9 (13)	4 (7)	0.25
Posterior recurrence (Ap or Bp to 0), n (%)	4 (6)	3 (5)	1.0
Apical recurrence (c or d to −1), n (%)	6 (8)	6 (10)	0.69
Postoperative UUI[a], n (%)	26 (41)	11 (22)	0.04
Postoperative SUI[a], n (%)	14 (22)	5 (10)	0.10
Postoperative dyspareunia[a] (n=21 missing), n (%)	7 (14)	8 (19)	0.49
EBL (ml) (n=11 missing), mean (SD)	246 (161)	288 (182)	0.10
Length of hospital stay, days (n=3 missing), median (range)	1 (0–11)	1 (1–4)	0.24

[a] n=64 arcus graft and 50 controls with subjective follow-up

Table 4 Quality of life questionnaires

	Arcus				Controls			
	Preoperative, mean (SD)	Follow-up, mean (SD)	Change, mean (SD)	*p* value	Preoperative, mean (SD)	Follow-up, mean (SD)	Change, mean (SD)	*p* value
PFDI	*n*=54	*n*=30	*n*=26		*n*=26	*n*=12	*n*=10	
POPDI	28.6 (21.5)	11.9 (16.7)	−13.4 (26.9)	0.018	35.6 (23.2)	4.9 (9.7)	−24.1 (27.3)	0.021
CRADI	20.6 (18.2)	14.4 (17.9)	−8.4 (24.1)	0.087	18.5 (18.6)	6.4 (6.6)	−8.9 (25.2)	0.295
UDI	26.9 (22.6)	14.6 (18.3)	−11.6 (26.7)	0.036	36.4 (21.2)	12.7 (18.3)	−9.4 (18.0)	0.157
Total	77.0 (50.6)	40.9 (48.0)	−33.4 (68.1)	0.019	86.7 (46.0)	24.0 (30.8)	−29.3 (34.8)	0.036
PISQ	*n*=43	*n*=19	*n*=21		*n*=17	*n*=7	*n*=4	
Total	24.5 (11.2)	37.7 (4.7)	7.9 (8.5)	0.004	33.1 (7.7)	38.3 (4.3)	1.8 (4.8)	0.518

recurrence rates to the hymeneal ring than those who underwent standard colporrhaphy alone.

Vaginal graft augmentation techniques vary widely with respect to many factors, including choice of material and its basic healing and regenerative properties, delivery system used to anchor the graft, tensioning of material, and anatomic fixation points. Regarding material type, a recent Cochrane review indicated that Polyglactin mesh and porcine dermis inlays improved anatomic outcomes in the anterior compartment, but suggested that not enough information was available to recommend the use of other mesh or graft materials for the repair of cystoceles [15]. We still have scant understanding of how most graft materials "behave" when implanted beneath the vaginal epithelium and which characteristics would optimize long-term form and function. Acellular cadaveric dermis represents an open matrix of connective tissue that becomes rapidly populated with (and eventually replaced by) native cells, blood vessels, and connective tissue [16], but as a noncross-linked and fairly supple material, its ability to promote long-term pelvic floor support has been questioned. In contrast, certain porcine dermal grafts have a sturdier cross-linked structure, which is intended, in theory, to safeguard against the graft being replaced by native tissue deposition. However, in the vagina, these materials demonstrate little histological evidence of neovascularization and cell repopulation, and the response of host tissues is mainly characterized by foreign body reaction [17]. Debate exists regarding whether biological materials need to "permanently" persist as a non-native barrier or whether it may be preferable to implant materials that provide a temporary "scaffolding" to trigger deposition of the patient's own native tissues. Obtaining these answers will require careful clinical follow-up that addresses safety, functional outcomes, and anatomic support. One of the limitations of our study is that we have short-term to medium-term follow-up in our cohort and, therefore, cannot address the question of long-term durability of the acellular dermis, but hope to continue to follow-up these subjects to obtain long-term follow-up.

Regarding anchoring sites and fixation methods, key differences can be found between graft-augmented repairs performed at one surgical center vs. another. Some prior studies, including one from our center [18], have described securing an anterior graft as a "patch" overlying the cystocele without actually anchoring to fixed points along the muscular pelvic sidewall. Other techniques, including the one described in this current study, emphasize attachment of the graft to fixed anchoring sites along multiple levels of the pelvic sidewall and apical musculature. Thus, although some studies of biological graft-augmented vaginal repairs have supported their benefit and others have not [19], most techniques differ too widely to allow us to extrapolate the "success" or "failure" of one technique to other graft techniques.

Two observational series have been published using human cadaveric dermis in the anterior compartment with conflicting outcomes. Chung et al. [20] evaluated 19 patients using a technique that attempted to configure a single graft to achieve both sling and cystocele coverage. Only a 3×7-cm graft was used, clearly suggesting that full anterior compartment and apical coverage was most likely not achieved. Nonetheless, the authors reported no cystocele recurrences at long-term follow-up. One patient developed an acute infection and required removal of the graft—a complication that we have not observed. The second study by Clemons et al. [19] evaluated 33 patients undergoing a vaginal–paravaginal repair with a 4×7-cm acellular cadaveric dermal graft attached with absorbable suture to the ATFP. They reported a subjective success rate of 97% and an objective success rate of 59%, although only one patient developed recurrent prolapse beyond the hymeneal ring. It is important to note that, according to their description of technique, the graft covered only up to 3 cm from the proximal base of the repair—an important difference from our technique. We describe extending the

graft from the sacrospinous ligaments proximally to the level of the pubic tubercle distally providing full coverage of the anterior compartment. Encouragingly, both of the two prior studies found that human dermis was associated with few complications and favorable subjective outcomes, as we have also found.

Specific potential risks associated with sacrospinous ligament fixation include pain or paresthesias, possibly due to peripheral nerve trauma. These symptoms are nearly always transient and self-limited, but may occasionally persist for a period of several weeks postoperatively. We had to remove sutures in two patients who received the graft due to persistent buttock pain. Vascular and neurological injuries are rare complications of sacrospinous ligament suspension, and familiarity with the surrounding anatomical landmarks is essential [21].

The strength of this study includes its relatively large sample size. To our knowledge, this is the largest published cohort involving dermal graft for anterior compartment prolapse repair. In addition, there are few studies of grafts that include control groups [15]. Limitations of the current study include its observational rather than randomized controlled design. One surgeon performed all the graft-augmented repairs. This is a strength with regards to consistency of technique, but is a weakness in that it limits the generalizability of our results. Second, our control group is mixed with regard to the addition of Polyglactin 910 mesh in the plication. We recognize that this is not ideal for a control group, but feel that the addition of the mesh would dilute our results rather than the opposite, since it has been shown to provide benefit over standard colporrhaphy. Another limitation is the poor response of the quality of life questionnaires. We have listed the data obtained in Table 4 and it looks promising, in that the patients who did respond improved, but this may be biased with such a low response rate. Additionally, the benefit of graft augmentation needs to be balanced against other considerations including lack of longer-term follow-up and cost. A randomized controlled trial, as well as long-term follow-up of this observational cohort, is ongoing at our center.

In conclusion, the anterior graft technique we described in this paper demonstrated a 56% reduction in all cystocele recurrences and a 46% reduction in recurrences reaching the hymeneal ring when compared to midline anterior colporrhaphy at a mean follow-up of 17 months. This reduction in anterior prolapse recurrence, and the lack of complications specific to this material and delivery method, is promising.

Acknowledgments No research support was used for this study.

Conflicts of interest Roger P. Goldberg and Peter K. Sand are both consultants, speakers, and have research support from Boston Scientific.

References

1. Weber AM, Walters MD, Piedmonte MR, Ballard LA (2001) Anterior colporrhaphy: a randomized trial of three surgical techniques. Am J Obstet Gynecol 185:1299–1304
2. Sand PK, Koduri S, Lobel RW, Winkler HA, Tomezsko J, Culligan PJ, Goldberg R (2001) Prospective randomized trial of polyglactin 910 mesh to prevent recurrence of cystoceles and rectoceles. Am J Obstet Gynecol 184:1357–1362
3. Lazarou G, Powers K, Pena C, Bruck L, Mikhail MS (2005) Inflammatory reaction following bovine pericardium graft augmentation for posterior vaginal wall defect repair. Int Urogynecol J Pelvic Floor Dysfunct 16:242–244
4. Le TH, Kon L, Bhatia NN, Ostergard DR (2007) Update on the utilization of grafts in pelvic reconstruction surgeries. Curr Opin Obstet Gynecol 19:480–489
5. Herschorn S (2007) The use of biological and synthetic materials in vaginal surgery for prolapse. Curr Opin Urol 17:408–414
6. Espinosa-de-los-Monteros A, de la Torre JI, Marrero I, Andrades P, Davis MR, Vásconez LO (2007) Utilization of human cadaveric acellular dermis for abdominal hernia reconstruction. Ann Plast Surg 58:264–267
7. Buinewicz B, Rosen B (2004) Acellular cadaveric dermis (AlloDerm): a new alternative for abdominal hernia repair. Ann Plast Surg 52:188–194
8. Wainwright DJ (1995) Use of an acellular allograft dermal matrix (AlloDerm) in the management of full thickness burns. Burns 21:243–248
9. Wainwright D, Madden M, Luterman A et al (1996) Clinical evaluation of an acellular allograft dermal matrix in full-thickness burns. J Burn Care Rehabil 17:124–136
10. Constantino PD, Govindaraj S, Hiltzik DH et al (2001) Acellular dermis for facial soft tissue augmentation. Arch Facial Plast Surg 3:38–43
11. Jones FR, Schwartz BM, Silverstein P (1996) Use of a non-immunogenic acellular dermal allograft for soft-tissue augmentation: a preliminary report. Aesthet Surg Q 16:196–201
12. Abenavoli FM, Corelli R (2001) About AlloDerm. Plast Reconstr Surg 108:2175–2176
13. Olsen AL, Smith VJ, Bergstrom JO, Colling JC, Clark AL (1997) Epidemiology of surgically managed pelvic organ prolapse and urinary incontinence. Obstet Gynecol 89:501–506
14. Shull BL (1999) Pelvic organ prolapse: anterior, superior, and posterior vaginal segment defects. Am J Obstet Gynecol 181:6–11 Review
15. Maher C, Baessler K, Glazener CM, Adams EJ, Hagen S (2008) Surgical management of pelvic organ prolapse in women: a short version Cochrane review. Neurourol Urodyn 27:3–12 Review
16. Wong AK, Schonmeyer BH, Singh P, Carlson DL, Li S, Mehrara BJ (2008) Histologic analysis of angiogenesis and lymphangiogenesis in acellular human dermis. Plast Reconstr Surg 121:1144–1152
17. Gandhi S, Kubba LM, Abramov Y, Botros SM, Goldberg RP, Victor TA, Sand PK (2005) Histopathologic changes of porcine dermis xenografts for transvaginal suburethral slings. Am J Obstet Gynecol 192:1643–1648
18. Gandhi S, Goldberg RP, Kwon C, Koduri S, Beaumont JL, Abramov Y, Sand PK (2005) A prospective randomized trial using solvent dehydrated fascia lata for the prevention of recurrent anterior vaginal wall prolapse. Am J Obstet Gynecol 192:1649–1654
19. Clemons JL, Myers DL, Aguilar VC, Arya LA (2003) Vaginal paravaginal repair with an AlloDerm graft. Am J Obstet Gynecol 189:1612–1619
20. Chung SY, Franks M, Smith CP, Lee JY, Lu SH, Chancellor M (2002) Technique of combined pubovaginal sling and cystocele repair using a single piece of cadaveric dermal graft. Urology 59:538–541
21. Verdeja AM, Elkins TE, Odoi A et al (1995) Transvaginal sacrospinous colpopexy: anatomic landmarks to be aware of to minimize complications. Am J Obstet Gynecol 173:1468–1469