Vaginal Mesh for Prolapse

A Randomized Controlled Trial

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OBJECTIVE: To present 3-month outcomes of a double-blind, multicenter randomized controlled trial comparing traditional vaginal prolapse surgery without mesh with vaginal surgery with mesh.

METHODS: Women with pelvic organ prolapse quantification prolapse stages 2–4 were randomized to vaginal colpopexy repair with mesh or traditional vaginal colpopexy without mesh. The primary outcome measure was objective treatment success (pelvic organ prolapse quantification stage 1 or lower) at 3 months. Secondary outcome measures included quality-of-life variables and complication rates.

RESULTS: Sixty-five women were recruited from January 2007 to August 2009, when the study was halted due to predetermined stopping criteria for vaginal mesh erosion at a median follow-up of 9.7 months (range, 2.4–26.7 months). Thirty-two women underwent mesh colpopexy (24 anterior mesh, eight total mesh), and 33 women had vaginal colpopexies without mesh (primarily uterosacral ligament suspension) and concurrent colporrhaphy. There were no statistically significant baseline differences between the mesh and no-mesh groups with respect to demographics, menopausal status, and race. Analysis of the mesh and no-mesh women found no difference with respect to overall recurrence (mesh: 19 [59.4%] compared with no mesh: 24 [70.4%], P=.28). There were five (15.6%) vaginal mesh erosions. Two cystotomies and one blood transfusion occurred in the mesh group only. Subjective cure of bulge symptoms was noted in 93.3% of mesh patients and 100% of no-mesh patients. Furthermore, subjective quality-of-life measurements did not differ between the two groups at baseline or 3 months postoperatively.

CONCLUSION: At 3 months, there is a high vaginal mesh erosion rate (15.6%) with no difference in overall objective and subjective cure rates. This study questions the value of additive synthetic polypropylene mesh for vaginal prolapse repairs.

CLINICAL TRIAL REGISTRATION: Clinicaltrials.gov, www.clinicaltrials.gov, NCT00475540.

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LEVEL OF EVIDENCE: I

Interpositional synthetic vaginal mesh was first approved by the U.S. Food and Drug Administration in 2004, following the long-term success of synthetic retropubic and transobturator slings. Since then, hundreds of thousands of synthetic mesh systems have been implanted in women in hopes of improving success rates of pelvic organ prolapse (POP) procedures, particularly for advanced and recurrent prolapse. However, very few randomized clinical trials have been conducted comparing subjective and objective cure rates of mesh-augmented repairs with traditional repairs. A few published studies have shown some benefit of synthetic mesh–augmented procedures over traditional repairs, particularly for the anterior compartment. However, significant trade-offs exist due to mesh-related complications from vaginal and visceral erosion, de novo pain, dyspareunia, vaginal retraction and worsening stress incontinence.[1–9] The primary objective of this multicenter randomized controlled trial (RCT) was to test the hypothesis that the addition of a standardized technique of interpositional synthetic polypropylene mesh placement improves objective anatomical outcomes of vaginal reconstructive surgery for POP

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compared with traditional vaginal reconstructive surgery without mesh. Secondary objectives were to compare patient satisfaction, quality-of-life variables, short-term and long-term complications, and morbidity related to graft use (erosions) between the two arms of the trial. The 3-month outcomes of this RCT are presented in this article.

MATERIALS AND METHODS

This multicenter, double-blind RCT was conducted by six surgeons at three academic sites: Washington Hospital Center, Stanford University, and Yale University. A data safety and monitoring board consisting of two experienced gynecologic surgeons, a biostatistician, and a maternal fetal medicine specialist with experience in the conduct of network clinical trials also was involved in this study, and members were notified of interim analysis results and any adverse events. Because of the potential for significant complications with vaginal mesh, two interim analyses were planned after one third and two thirds of patients had reached the 3-month mark. Stopping criteria included more than 15% observed Prolift mesh (Ethicon Women's Health & Urology, Somerville, NJ) erosion rate, more than 1% mesh infection rate, more than 1% fistula formation, more than 5% rate of de novo dyspareunia, and statistically significant superiority of one arm over another.

Institutional review board approval was obtained at each site, and all women provided written informed consent to participate. The study population consisted of women aged 21 or older diagnosed with pelvic organ prolapse quantification (POP-Q) stage 2–4 uterovaginal or vaginal prolapse who desired vaginal reconstructive surgery and who were available for at least 12 months of follow-up and able to complete study questionnaires.

Women were excluded from trial participation for any of the following reasons: 1) medical contraindications (eg, current urinary tract, vaginal or pelvic infection, history of pelvic irradiation, history of lower urinary tract malignancy, chronic steroid use, or a compromised immune system); 2) current intermittent catheterization; 3) pregnancy less than 12 months postpartum or desire for future fertility; 4) uterus more than 12 weeks' size; 5) presence of an adnexal mass; 6) shortened vagina or other known Mullerian anomaly (eg, uterine didelphys); 7) other laparoscopic or abdominal/pelvic surgery in the previous 3 months; 8) known neurologic or medical condition affecting bladder function (eg, multiple sclerosis, spinal cord injury); or 9) need for concurrent surgery requiring an abdominal incision.

The design of the trial is depicted in Figure 1. Patients with stage 2–4 prolapse were approached for recruitment only after they had made the decision to undergo vaginal surgery. All patients with a uterus underwent a concurrent vaginal hysterectomy with anterior and posterior colporrhaphy when indicated. Specific details of the compartment repairs will be discussed on page 296.

Preoperative urodynamics with the prolapse reduced to assess for urinary incontinence in accordance with study protocol was also performed. The decision to conduct a concurrent stress incontinence operation was by surgeon preference. Enrollment and disposition of the trial are summarized in Figure 2.

Randomization occurred with computer-generated random numbers, stratified for presence or absence of a uterus. Opaque sealed envelopes were opened in the operating room after the patient received anesthesia. The research study nurse–coordinator at each site, other research staff, and the patient were masked to the treatment assignment. To maintain masking, Steri-Strips (thin adhensive strips, 3M, St. Paul, MN) were placed on the vulva postoperatively (to mimic dressings placed after Prolift) regardless of treatment assignment. Additionally, all operating room, inpatient, and office personnel were instructed not to disclose treatment assignment to the patient. Inpatient and outpatient charts were marked as "VAMP RCT trial participants" to prevent unintentional review by nurses and physicians during postoperative visits. Postoperative examinations at 3 months and 12 months were conducted by a blinded evaluator (fellow or research nurse coordinator or other surgeon masked to the initial operation). Every effort was made to keep the patient and research staff masked for as long as possible without endangering the patient's safety. All patients will remain masked for the first 12 months and those willing will remain masked until study completion (36 months). Unmasking occurred if medically necessary for the evaluation of bleeding, infection, or any other condition requiring patient knowledge of treatment arm. The mesh devices were donated by the manufacturer so that patients randomized to the mesh arm would not be charged and masking could be maintained without notification based on surgical billing. Only one patient assigned to the mesh group received no mesh and underwent a uterosacral suspension because the surgeon felt the vaginal caliber was inadequate for mesh. That patient was analyzed as a member of the no-mesh arm. All other patients received their assigned surgeries.

The techniques for the procedures were standardized for uniformity, including choice of sutures for

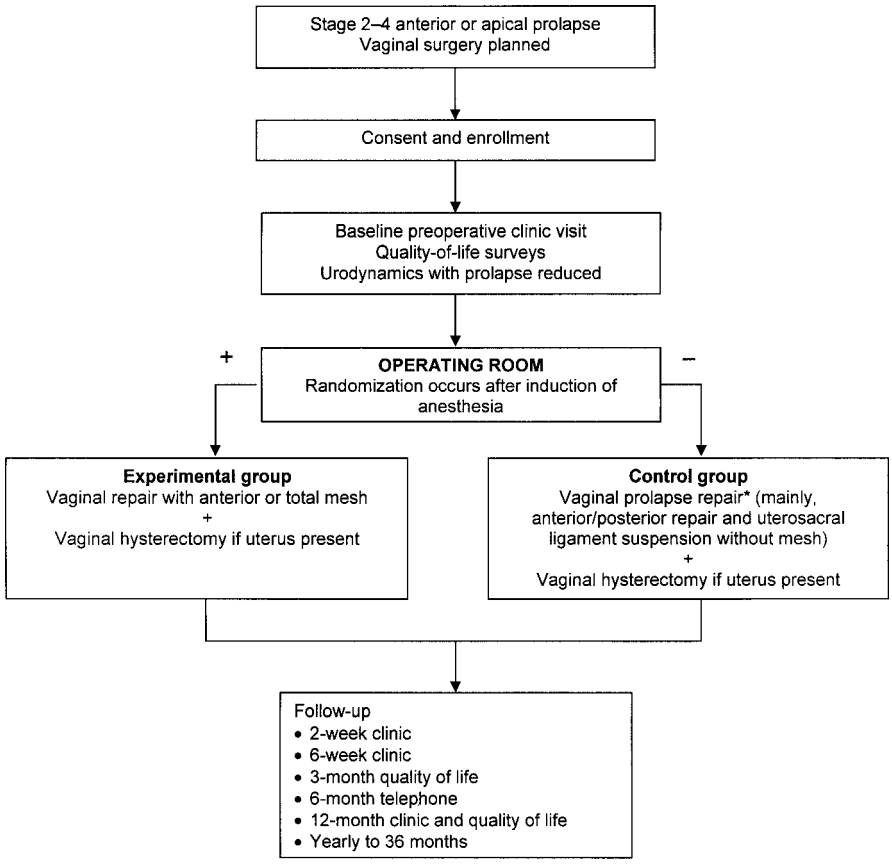

Fig. 1. Trial design. *Apical suspension at surgeon's discretion required for C -3 cm or more.
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uterosacral ligament suspension or sacrospinous fixation (combination delayed absorbable polydioxanone [Ethicon, Somerville, NJ] and permanent polytetrafluoroethylene [Gore-tex; W.L. Gore & Associates, Flagstaff, AZ] and choice of vaginal mesh kit [Prolift (Ethicon Women's Health & Urology)]). The uterosacral ligament suspension was conducted in the manner previously described by Shull et al.[10] After the hysterectomy or entry into the peritoneal cavity, the bowel is packed out of the field, retractors are placed, and a long-handled Allis clamp is used to grasp the high and intermediate portions of the uterosacral ligaments. Three sutures are placed through each uterosacral ligament. The most cephalad polytetrafluoroethylene suture is placed most medially on the uterosacral ligament and then through the pubocervical and recto-

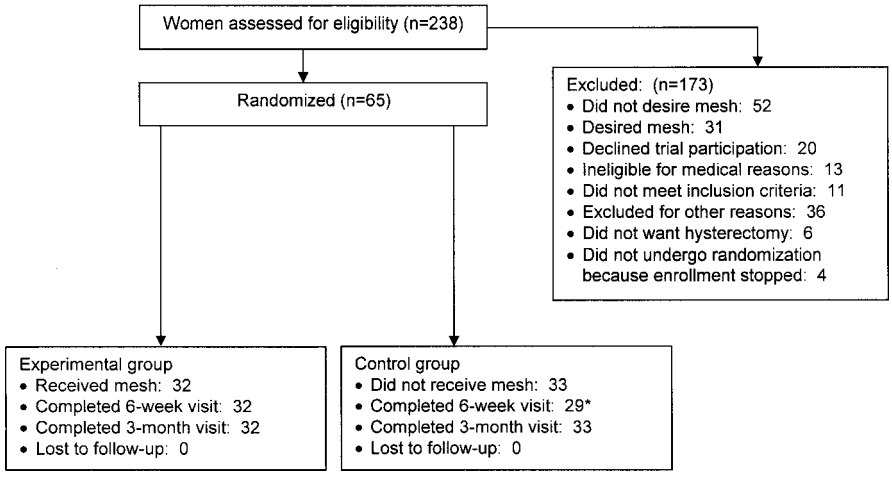

Fig. 2. Enrollment and disposition of the trial. *Four patients were not seen at 6±2 weeks, but all patients did make the 3-month visit.
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vaginal muscularis. A second polytetrafluoroethylene suture is placed caudally through the ligament and lateral on the cuff. A polydioxanone suture is placed most distally on the ligament and most laterally along the cuff. Cystoscopy was performed to ensure ureteral patency with tensioning of the sutures. Sacrospinous ligament suspension using Gore-tex sutures was performed if uterosacral ligaments were not deemed usable because of scarring or inaccessibility. All surgeons were fellowship trained and had performed more than 30 vaginal colpopexy procedures with uterosacral and sacrospinous ligaments before enrolling patients in the trial.

A synthetic monofilament polypropylene interpositional mesh system was used. In this trial, patients in the experimental group underwent interpositional multi-armed mesh placement using trocars for transobturator and ischiorectal fossa placement at the level of the ischial spine. Incisions were made full-thickness through the vaginal walls to the true vesicovaginal and rectovaginal spaces, after hydrodissection with local anesthetic/epinephrine and injectable saline solution. Colpotomy incisions were started approximately 4 cm from the external meatus anteriorly and perineal body posteriorly. These incisions were also stopped 1–2 cm from the cuff, with no T-incisions and extensions made to the cuff. Interpositional mesh was placed without transverse or site-specific plication of the muscularis, and mesh was attached to the apex using 2-0 polydioxanone delayed-absorbable suture. The mesh was trimmed based on vaginal caliber to avoid folding. Incisions were closed with absorbable sutures in a running fashion. An apical suspension using total vaginal mesh or modification (anterior vaginal mesh repair with insertion of the posterior arms through the sacrospinous ligament) was performed in women randomized to the mesh arm if points C (cervix or apex if hysterectomy has been performed) or D (posterior fornix) were at least −3 or if the surgeon felt the need for additional apical support. Anterior vaginal mesh repair only was inserted in patients with anterior prolapse and point C or D less than −3 (cuff or posterior fornix greater than 3 cm proximal to the hymenal remnant). A transvaginal apical procedure (primarily uterosacral ligament suspension) was performed in women randomized to the nonmesh arm also if point C was at least −3. All surgeons had to perform a minimum of 10 Prolift procedures before initial patient enrollment in this trial.

Uniformity of surgical procedure was ensured through surgical conference call meetings, biannual face-to-face meetings, and review of sample dictated operative reports at orientation.

The primary outcome measure for objective treatment success was overall POP-Q stage 1 or lower (descent at more than 1 cm proximal to the hymen) at 3 months. The need for additional surgical treatment or pessary placement for recurrent prolapse at any time after the initial procedure also constituted treatment failure. These definitions conform to the recommendations from the National Institutes of Health Terminology Workshop for Researchers in Female Pelvic Floor Disorders.[11]

The secondary outcome measures for objective treatment success consisted of anterior, apical, and posterior prolapse of stage 1 or lower (Ba [point 3 cm from the external urethral meatus/hymen], Bp [point of maximal prolapse of the anterior wall], and C [cervix or apex if hysterectomy has been performed] more than −1) at 1 year. POP-Q measurements were obtained at 3 months, at 12 months, and yearly thereafter. For the secondary outcomes, each compartment was analyzed separately for cure. Socioeconomic characteristics, risk factors, and severity of illness were investigated as possible factors influencing the outcome in each arm. Effect on quality of life was assessed using validated questionnaires. Preoperative quality-of-life questionnaires were completed at enrollment, and at 3 months, at 12 months, and yearly thereafter. The research nurse coordinator performed a 6-month telephone interview to update contact information, medical history, and other information. Instruments used for data collection included SF-12[12] with both Physical Component Summary (PCS) and Mental Component Summary (MCS), short forms of Pelvic Floor Distress Inventory (PFDI) including subscales of Pelvic Organ Prolapse Distress Inventory (POPDI-6), Colorectal Anal Distress Inventory (CRADI-8), Urogenital Distress Inventory (UDI-6), and Pelvic Floor Impact Questionnaire (PFIQ) and corresponding Colorectal Anal Impact Questionnaire (CRAIQ-7), and Pelvic Organ Prolapse Impact Questionnaire (POPIQ-7) and Urinary Impact Questionnaire (UIQ-7),[13] Prolapse and Incontinence Sexual Questionnaire (PISQ),[14] Patient Global Impression of Improvement (PGI-I),[15] and Patient Global Impression of Severity (PGI-S).[15]

Perioperative morbidity was recorded at the completion of surgery, at hospital discharge, and at the 6-week postoperative visit. Perioperative measures of morbidity included operative time, estimated blood loss, and intraoperative and postoperative complications. Complications were categorized using a modification of the Dindo classification.[16] For the purposes of this analysis, long-term complications, such as the development of de novo stress incontinence, detrusor

overactivity, persistent voiding dysfunction (more than 6 weeks) or other lower urinary tract abnormality and the development of symptomatic pelvic organ prolapse, pelvic pain or dyspareunia, were excluded from postoperative complications and will be discussed with 1-year outcomes.

Serious adverse events were defined as any untoward medical occurrence that resulted in death, was life-threatening, required inpatient hospitalization (with the exception of hospitalization for prolapse or stress incontinence surgery), prolonged existing hospitalization, resulted in persistent or significant disability or incapacity, or resulted in another medically important condition. Three members of the data safety and monitoring board reviewed serious adverse events to determine which events might have plausibly been related to the surgical intervention. Serious adverse events were reported within 24 hours to the data safety monitoring board.

We conducted a sample size calculation based on the primary aim of the study comparing objective cure rates for vaginal reconstructive pelvic surgery with and without mesh. In the literature and from our experience, the objective cure rate for the traditional vaginal reconstructive procedures is approximately 70% (ie, 30% failure) and the cure rate from mesh repairs is 90%.[2,17] With type I error of 0.05 and type II error of 0.20 (power 80%), we needed 45 patients in each arm, assuming 15% loss to follow-up, to detect a 20% difference in the outcomes. The sample size calculation assumed the recurrence times for the two groups to be exponentially distributed with patients uniformly accruing over a 2-year period and followed for 3 years. The exponential maximum likelihood test of equality of survival curves was used to compare the failure curves for the two groups. The statistical software nQuery Adviser 5 (Statistical Solutions, Saugus, MA) was used to obtain the sample size calculations.

Data were initially analyzed with respect to the objective and subjective outcomes between the overall groups (mesh compared with no-mesh). SPSS for Windows 16 (SPSS Inc., an IBM Company, Chicago, IL) was used for data management and statistical analysis. Because the data were not normally distributed, nonparametric statistical methods were used. In addition, survival analysis methods were used to analyze times to recurrence, because these variables had censored data. The Mann-Whitney test was done to compare independent groups with respect to noncategorical variables. The χ^2 test of association and Fisher exact test were used to compare independent groups with respect to percentages. Fisher exact test was done when the expected frequencies were too small to permit use of the χ^2 test. The McNemar test was used to compare paired percentages. The log-rank test and Cox proportional hazards regression were used to compare independent groups with respect to recurrence and erosion. A 0.05 significance level was used for all statistical tests. No one-sided tests were done. Means are presented as mean plus or minus standard deviation, and medians are presented as median (range).

RESULTS

Recruitment began on January 3, 2007, and continued until August 1, 2009, when the study was halted because of predetermined criteria for vaginal mesh erosion at a median follow-up of 9.7 months (2.4–26.7 months). Analysis was carried out after 65 patients had approximately 3 months of follow-up or more: 32 (49.2%) patients had mesh surgery with 14 (44%) of them having had prior hysterectomy and 33 (50.8%) patients had no-mesh surgery with 12 (36%) of them having had previous hysterectomy. Baseline characteristics did not differ significantly between these two groups (Table 1). Concurrent surgery is listed in Table 2. There was no statistically significant difference between the mesh and no-mesh groups with respect to the length of follow-up (P=.38). There were no statistically significant differences between the mesh and no-mesh groups with respect to the preoperative overall POP-Q stage or the preoperative POP-Q stage by points Ba, Bp, or C (Mann-Whitney test, P=.12–.63).

No statistically significant difference was found between the mesh and no-mesh groups for overall recurrence (postoperative overall POP-Q at least stage 2; Fig. 3). A total of 43 (66.2%) patients had an objective recurrence of at least stage 2 prolapse: 19 (59.4%) of the mesh patients compared with 24 (72.7%) of the no-mesh patients (P=.28). Of the 43 recurrences, 33 (77%) were at or proximal to the hymenal remnant, and 10 (23%) were distal to the hymenal remnant. Only one patient had an apical recurrence (postoperative POP-Q point C at stage 2 or greater). This patient was in the previous hysterectomy group and had a postoperative stage 4 prolapse at point C at 2.1 months after a total vaginal mesh procedure. No significant differences were found between the mesh and no-mesh groups with respect to anterior wall recurrence (postoperative POP-Q at least stage 2 at point Ba) or posterior wall recurrence (postoperative POP-Q at least stage 2 at point Bp). Fifteen (46.9%) of the mesh patients compared with 20 (60.6%) of the no-mesh patients had an anterior

Table 1. Baseline Characteristics of Study Participants

Characteristic	Mesh Group	No-Mesh Group	*P*
Age (y)	64.4 ± 10.8	63.5 ± 8.9	.61
Race			.70*
White	20 (62.5)	22 (66.7)	
African American	8 (25.0)	7 (21.2)	
Hispanic	3 (9.4)	3 (9.1)	
Asian	1 (3.1)	0 (0)	
Other	0 (0)	1 (3.0)	
Menopausal status			1
Postmenopausal	30 (93.8)	31 (93.9)	
Marital status			.92
Married	20 (62.5)	21 (63.6)	
Educational level			.40
Less than high school	0 (0)	2 (6.1)	
Completed high school	10 (31.3)	11 (33.3)	
Some college or college graduate	22 (68.8)	20 (60.6)	
Health insurance			.54
Private	15 (46.9)	18 (54.5)	
Medicare	17 (53.1)	15 (45.5)	
Parity	2.4 ± 1.1	2.6 ± 0.9	.30
Number of previous vaginal deliveries	2.3 ± 1.2	2.5 ± 0.8	.28
Previous hysterectomy	14 (43.8)	12 (36.4)	.54
Previous surgery for prolapse	4 (12.5)	0 (0)	.053
Previous surgery for incontinence	2 (6.3)	1 (3.0)	.61
BMI (kg/m^2)	27.4 ± 5.1	27.8 ± 6.4	.71
BMI at least 30	8 (25.0)	9 (27.3)	.84
POP-Q stage			.51
II	7 (21.9)	4 (12.1)	
III	20 (62.5)	24 (72.7)	
IV	5 (15.6)	5 (15.2)	
POP-Q measurements (cm)			
Ba	3.0 (0.0–13.5)	4.0 (−0.5–9.0)	.29
Bp	−1.0 (−3.0–13.5)	−1.0 (−3.0–8.0)	.75
C	−0.8 (−7.5–13.5)	2.0 (−8.0–9.0)	.26
GH	5.0 (2.0–8.0)	5.0 (2.5–8.0)	.27
PB	4.0 (2.0–5.0)	3.5 (1.0–5.5)	.15
Total vaginal length (cm)	9.0 (6.5–13.5)	9.0 (7.0–11.5)	.50

BMI, body mass index; POP-Q, pelvic organ prolapse quantification; Ba, point 3 cm from the external urethral meatus/hymen; Bp, point of maximal prolapse of the anterior wall; C, cervix or apex if hysterectomy has been performed; GH, genital hiatus; PB, perineal body.

Data are mean±standard deviation, n (%), or median (range) unless otherwise specified.

* Based on white and African-American groups only.

wall recurrence (*P*=.28), and seven (21.9%) compared with seven (21.2%) who had a posterior wall recurrence (*P*=.96). The median point Ba, however, was significantly higher for the mesh group although overall anterior POP-Q stage recurrence did not differ. A summary of overall objective anatomical outcomes at mean follow-up of 9.5 months and quality-of-life outcomes of 3 months is listed in Table 3. A Kaplan-Meier survival curve for the mesh compared with no mesh arms is depicted in Figure 3, with no difference noted between groups.

The mesh group had significantly lower overall distress as indicated by lower preoperative POPDI-6 scores than the no-mesh group: 43.8 (0, 91.7) compared with 58.3 (16.7, 100) (Mann-Whitney test, *P*=.021). No other significant differences were found between the mesh and no-mesh groups with respect to the preoperative or postoperative (3-month) SF-12 PCS, SF-12 MCS, PISQ, POPDI-6, CRADI-8, UDI-6, PFDI, UIQ-7, CRAIQ-7, POPIQ-7, PFIQ, PGI-I, or PGI-S scores, with patients overall having very high subjective satisfaction in both groups. A summary of overall subjective outcomes at 3 months is listed in Table 3, and a summary of quality-of-life scores is listed in Table 4.

Of the 32 mesh patients, five (15.6%) developed erosions. One erosion occurred in the concurrent hysterectomy group and four occurred in the previous hysterectomy prolapse group. The difference between the concurrent hysterectomy and previous hysterec-

Table 2. Concurrent Procedures

Procedure	Mesh Group	No-Mesh Group	*P*
Transvaginal hysterectomy	18 (56.3)	21 (63.6)	.54
Vaginal colpopexy	—	—	—
Uterosacral ligament	—	29 (87.9)	—
Sacrospinous fixation	—	3 (9.1)	—
Ileococcygeus	—	1 (3.0)	—
Anterior mesh	24 (75.0)	—	—
Total mesh	8 (25.0)	—	
Anterior colporrhaphy	0 (0)	33 (100)	<.001
Posterior colporrhaphy	18 (56.3)	27 (81.8)	.026
Perineoplasty	16 (50.0)	21 (63.6)	.27
TVT or TOT sling	10 (31.3)	8 (24.2)	.53
Oophorectomy (bilateral or unilateral)	4 (12.5)	6 (18.2)	.73

TVT, tension-free vaginal tape; TOT, transobturator tape.
Data are n (%) unless otherwise specified. — indicates not applicable or comparison not performed because not applicable.

tomy group with respect to erosion was not statistically significant (log-rank test, *P*=.080). Erosions occurred at 2 weeks, 6 weeks (two patients), 7 weeks, and 2.1 months and were located along incision lines in the anterior compartment in three cases, posterior compartment in one case, and apical compartment in one case. Erosions were noted only with propylene mesh and not with sling mesh. Three of the five erosions required additional procedures in the operating room to remove the mesh, whereas the other two erosions were small with one resolved after in-office trimming and local estrogen use and one persistent but not symptomatic enough to require intervention for removal. During the second interim analysis (when two thirds of patients reached the 3-month mark), the data safety and monitoring board notified the investigators that the mesh erosion rate had surpassed the predetermined stopping criteria of 15% and further enrollment in the trial was halted.

There were no intraoperative injuries (enterotomies or urethral or rectal injuries) other than two cystotomies in the mesh group, one incurred during dissection and one during trocar insertion. Both patients with cystotomies had had previous hysterectomies, and the cystotomies were repaired and mesh placed without complication or subsequent postoperative sequelae. None of the following complications occurred: deep vein thrombosis, pulmonary embolism, major infection requiring use of postoperative antibiotics, return to the operating room, ileus, small bowel obstruction, ureteral injury, myocardial infarction or other cardiac complications, pulmonary complications, abscesses, cuff cellulitis, neurologic complications, mesh infections, or vesicovaginal, urethrovaginal, or rectovaginal fistulae. One patient in each group had a febrile illness while hospitalized. One patient in the mesh group with concurrent hysterectomy received a postoperative blood transfusion. There were no significant differences between the mesh and no-mesh groups with respect to estimated blood loss, preoperative or postoperative hematocrit, hospital length of stay (Mann-Whitney test, *P*=.082–1), or 2-week urinary tract infection rate (Fisher exact test, *P*=.20–.59).

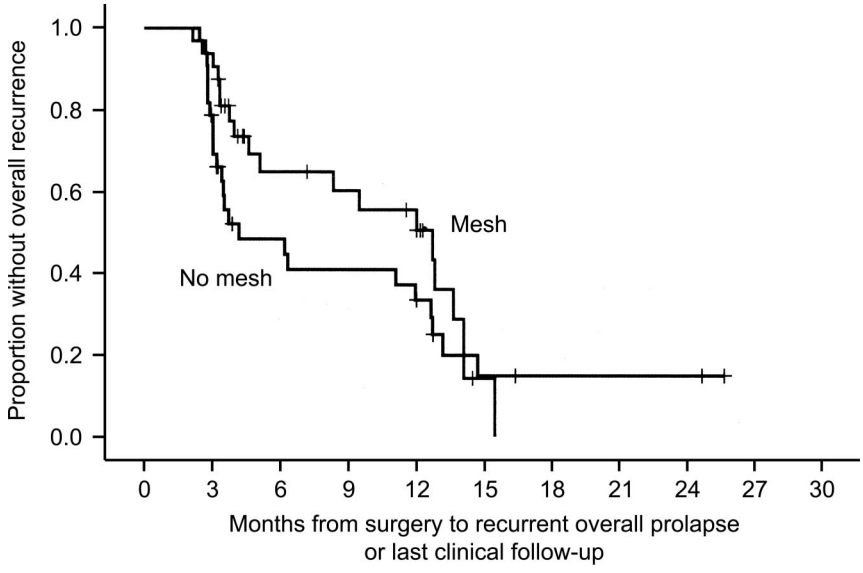

Fig. 3. Kaplan-Meier overall recurrence curves for mesh and no-mesh groups: all patients.
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Table 3. Anatomic Outcomes at Median 9.7 Months (Range 2.4–26.7 Months) and Quality-of-Life Evaluation at 3 Months After Surgery

Variable	Mesh	No Mesh	*P*
NIH optimal prolapse by POP-Q stage 1 or lower	13 (40.6)	9 (27.3)	.28
Prolapse by symptoms (bulge)*	2 (6.37)	0 (0)	.22
Prolapse at or above the hymen	14 (73.7)	19 (79.2)	—
Prolapse beyond the hymen	5 (26.3)	5 (20.8)	—
Reoperation for prolapse (10 mo)	2 (6.3)	0 (0)	.18
Total reoperation for prolapse and mesh or suture erosion or other	5 [4 patients] (12.5)	0 (0)	.048
Point Ba postoperative value (cm)	−2.0 (−3.0–8.0)	−1.5 (−3.0–2.0)	.026
Point Bp postoperative value (cm)	−2.8 (−3.0–8.0)	−3.0 (−3.0–−0.5)	.41
Point C postoperative value (cm)	−6.3 (−9.0–8.0)	−6.5 (−9.0–−3.0)	.96
Total vaginal length (cm)	8.3 (5.5–10.0)	8.0 (5.0–10.0)	.088
Patient Global Impression of Improvement	1.6 ± 0.9	1.4 ± 1.2	.18
Very much better	17 (58.6)	23 (76.7)	
Much better	10 (34.5)	5 (16.7)	
A little better	1 (3.4)	1 (3.3)	
A little worse	1 (3.4)	0 (0)	
Very much worse	0 (0)	1 (3.3)	
Patient Global Impression of Severity	1.4 ± 0.8	1.2 ± 0.4	.26
Normal	20 (69.0)	24 (80.0)	
Mild	6 (20.7)	6 (20.0)	
Moderate	2 (6.9)	0 (0)	
Severe	1 (3.4)	0 (0)	
De novo dyspareunia†	Insufficient data	Insufficient data	
De novo SUI‡	6 (40.0)	3 (15.8)	.14

NIH, National Institutes of Health; POP-Q, pelvic organ prolapse quantification.
Data are n (%), median (range), or mean±standard deviation unless otherwise specified.
* Bulging sensation present by Pelvic Floor Distress Inventory (PFDI) item 3.
† Prolapse and Incontinence Sexual Questionnaire item 5 response=usually or always.
‡ Stress urinary incontinence present by PFDI item 17.

DISCUSSION

Our study revealed no difference in overall objective and subjective outcomes, but suggests a benefit of synthetic mesh augmentation for the anterior vaginal wall at point Ba at a median follow-up of 9.7 months; however, longer-term follow-up is necessary. This trial was halted early after enrolling 72% of intended patients because of an unacceptably high rate of vaginal mesh erosion (15.6%).

Table 4. Health-Related Quality-of-Life Variables

	Preoperative		3-Mo Postoperative		*P* Within Group		*P* Between Groups	
Variable	Mesh	No Mesh	Mesh	No Mesh	Mesh	No Mesh	Preoperative	3-Mo Postoperative
PFDI-20	100.0 (0–235.4)	140.6 (16.7–284.4)	42.9 (0–131.3)	26.4 (0–189.6)	<.001	<.001	.084	.32
POPDI-6	43.8 (0–91.7)	58.3 (16.7–100)	0 (0–41.7)	8.3 (0–50.0)	<.001	<.001	.021	.72
CRADI-8	14.1 (0–75.0)	34.4 (0–84.4)	9.4 (0–56.3)	7.1 (0–65.6)	.001	.002	.15	.88
UDI-6	37.5 (0–100)	45.8 (0–100)	16.7 (0–75.0)	8.3 (0–83.3)	.023	<.001	.58	.17
PFIQ-7	23.8 (0–285.7)	38.1 (0–233.3)	4.8 (0–228.6)	9.5 (0–42.9)	.002	<.001	.81	.28
POPIQ-7	2.4 (0–95.2)	9.5 (0–100)	0 (0–76.2)	0 (0–23.8)	.074	.001	.48	.31
CRAIQ-7	4.8 (0–95.2)	4.8 (0–85.7)	0 (0–76.2)	0 (0–28.6)	.012	.003	.89	.26
UIQ-7	14.3 (0–100)	19.0 (0–100)	4.8 (0–95.2)	0 (0–14.3)	.072	<.001	.98	.14
PISQ-12	31.0 (19.0–43.6)	32.0 (16.0–42.0)	36.0 (25.0–39.0)	31.5 (0–42.0)	.26	.70	1	.35
Dyspareunia*	9 (52.9)	10 (55.6)	6 (66.7)	7 (70.0)	1	1	.88	1

PFDI, Pelvic Floor Distress Inventory; POPDI, Pelvic Organ Prolapse Distress Inventory; CRADI, Colorectal Anal Distress Inventory; UDI, Urogenital Distress Inventory; PFIQ, Pelvic Floor Impact Questionnaire; POPIQ, Pelvic Organ Prolapse Impact Questionnaire; CRAIQ, Colorectal Anal Impact Questionnaire; UIQ, Urinary Impact Questionnaire;[16] PISQ, Prolapse and Incontinence Sexual Questionnaire.[12]
Data are median (range) or n (%) unless otherwise specified.
For PFDI and PFIQ, lower scores represent better outcome. For PISQ, higher score represents better outcome.
* PISQ item 5 response=usually or always.

Quality RCTs reporting both anatomical and functional outcomes are needed to improve treatment of patients with pelvic organ prolapse. Feiner et al reviewed 30 studies totaling 2,653 women and noted objective success rates of 87% to 95% from commercially available mesh kits. Reoperations occurred in 0.4% to 6.0%, with a follow-up between 26 and 78 weeks. Mesh erosion was the most common complication, occurring in 4.6% to 10.7% of patients.[2] Diwadkar et al conducted a systematic review of apical vaginal procedures and found that surgical mesh kits had the highest cure rate with the shortest follow-up compared with traditional vaginal and open procedures; however, the total reoperation rate was highest (8.5%) with the vaginal mesh kits compared with procedures performed vaginally (5.8%) and abdominally (7.1%).[5] Jia et al found that for anterior repair, there was short-term evidence that graft or mesh significantly reduced objective prolapse recurrence rates compared with no interpostional mesh but suggested that "rigorous long-term RCTs are required to determine the comparative efficacy of using mesh/graft."[1] Few RCTs have been published (Table 5), but several more studies are still recruiting on the clinical trials.gov web site.

Our objective cure rate appears to be lower and our erosion rate higher than other published case series as listed in Table 5. This could result from the use of more stringent objective outcome criteria and closer monitoring for complications, along with postoperative examinations by investigators masked to the procedures. These measures significantly reduced surgeon bias. Indeed, when blinded exams are performed, as in the Wetta et al study, cure rates for synthetic mesh proce-

Table 5. Summary of Synthetic Vaginal Mesh Studies

Study	Type	n	Follow-up	Outcome	Complications
Nguyen and Burchette 2008[21]	RCT	38 anterior repair 37 anterior mesh (Perigee)	12 mo	POP-Q less than stage 2 55% cure no mesh 87% cure mesh, *P*=.005	Dyspareunia 16% no mesh 9% mesh 5% mesh extrusion
Hiltunen et al 2007[20]	RCT	97 anterior repair 104 anterior repair + mesh patch overlay	12 mo	POP-Q less than stage 2 61.5% cure no mesh 93.3% cure mesh, *P*<.001	10% SUI no mesh 23% SUI (mesh), *P*=.02 17% mesh exposure Less dyspareunia in the mesh group, *P*=.015
Fatton et al 2007[9]	Case series	110	12 wk	Failure 4.7%	Erosion 4.7% Granuloma 2.7% Hematoma 2.8% Cystotomy (1 case)
Abdel-Fattah et al 2008[8]	Case series	289	12 wk	Cure 95%	Bladder injury 1.6% Rectal injury 1.1% Vaginal erosion 10% Necrotizing fasciitis (1 case) Serious vascular injury (2 cases)
Gauruder-Burmester et al 2007[22]	Case series	120	1 y	93% less than grade 2	Vaginal erosion 3%
van Raalte et al 2008[23]	Case series	97	19 mo	86.6% less than stage 2	Vaginal erosion 0%
Wetta et al 2009[24]	Prospective cohort	68	1 y	2% failed (ie, required reoperation) 52% less than stage 2 for anterior, posterior, or total mesh	Graft exposure 2% Granulation tissue 6% Dyspareunia 4%
Altman et al 2008[18]	Case series	123	2 mo	87–91% less than stage 2	Visceral injury 3.2%
Aungst et al 2009[19]	Case series	335	8 mo	5.2% failure rate	Visceral injury rate 6.6% Mesh exposure 3.8% De novo stress urinary incontinence 24.3% Pelvic muscle symptoms 18%

RCT, randomized controlled trial; POP-Q, pelvic organ prolapse quantification; SUI, stress urinary incontinence.

dures have been reported to be as low as 43.7% at lower than stage 2 and erosion rates in other randomized trials are reported as high as 9–17%.[20–24] Strengths of this trial include its design as a proper multicenter, double-blind, RCT with strict inclusion criteria and outcome measures that minimize bias. Weakness include the short follow-up and lack of statistical power due to premature stopping as a result of reaching predetermined mesh erosion rates of more than 15%. The possibility of a type II error exists and differences in the outcomes may not have been found because we did not reach the intended number of patients in each group. Also, the population is heterogeneous and included women with previous hysterectomy and no previous hysterectomy as well as multiple concurrent surgical procedures. Because all women in the mesh arm did not undergo total vaginal mesh procedures, due to inclusion criteria of total mesh for apical prolapse below −3 cm, more recurrences along the anterior and apical compartments may have been detected in this study. However, if more total vaginal mesh had been used, the erosion rates may have been even higher.

In October 2008, the FDA issued a notification on reported complications from mesh use including mesh erosion, infection, pain, incontinence, as well as rare but serious visceral injury, dyspareunia, scarring, and decreased quality of life.[25] Mesh manufacturers have recognized complications from mesh use and have developed lighter weight and mixed composite (synthetic and partially absorbable) meshes for vaginal graft augmentation procedures, including the next generation Prolift +M (Ethicon Women's Health & Urology, Somerville, NJ). Additionally, newer trocarless mesh kits have been developed to minimize risks of visceral injury and groin pain, but long-term data are not yet available on any of these newer procedures.

Synthetic interpositional polypropylene mesh may have some benefit for the anterior compartment; however, there remains a high vaginal mesh erosion rate (15.6%) with no difference in overall objective or subjective cure rates. This study questions the value of additive synthetic polypropylene mesh for prolapse repairs considering that there are no statistically significant differences in subjective or objective cure rates. Long-term follow-up is needed in adequately powered studies to better clarify the role of synthetic mesh for vaginal prolapse repairs. One-year to 3-year outcomes from this trial will be reported as well.

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