

# Long-term Outcomes Following Abdominal Sacrocolpopexy for Pelvic Organ Prolapse

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**P**ELVIC ORGAN PROLAPSE (POP) occurs when the uterus or vaginal walls bulge into or beyond the vaginal introitus. It is a common occurrence and 7% to 19% of women receive surgical repair.<sup>1,2</sup> Abdominal sacrocolpopexy is the most durable operation for advanced POP and serves as the criterion standard against which other operations are compared.<sup>3</sup> Abdominal sacrocolpopexy involves attaching the vaginal apex to the sacral anterior longitudinal ligament reinforced with a graft, usually synthetic mesh.<sup>4</sup>

Little is known about long-term durability, complications, and pelvic floor symptoms after abdominal sacrocolpopexy. The few studies assessing outcomes beyond 2 years are limited by small sample sizes, inconsistent outcome assessment, potentially biased examiners, and non-standardized follow-up.<sup>5</sup> Determining the long-term outcomes for sacrocolpopexy in treating POP is important because 225 000 women in the United States undergo POP surgeries annually. The direct

For editorial comment see p 2045.

Author Audio Interview available at [www.jama.com](http://www.jama.com).

**Importance** More than 225 000 surgeries are performed annually in the United States for pelvic organ prolapse (POP). Abdominal sacrocolpopexy is considered the most durable POP surgery, but little is known about safety and long-term effectiveness.

**Objectives** To describe anatomic and symptomatic outcomes up to 7 years after abdominal sacrocolpopexy, and to determine whether these are affected by concomitant anti-incontinence surgery (Burch urethropexy).

**Design, Setting, and Participants** Long-term follow-up of the randomized, masked 2-year Colpopexy and Urinary Reduction Efforts (CARE) trial of women with stress continence who underwent abdominal sacrocolpopexy between 2002 and 2005 for symptomatic POP and also received either concomitant Burch urethropexy or no urethropexy. Ninety-two percent (215/233) of eligible 2-year CARE trial completers were enrolled in the extended CARE study; and 181 (84%) and 126 (59%) completed 5 and 7 years of follow-up, respectively. The median follow-up was 7 years.

**Main Outcomes and Measures** Symptomatic POP failure requiring retreatment or self-reported bulge; or anatomic POP failure requiring retreatment or Pelvic Organ Prolapse Quantification evaluation demonstrating descent of the vaginal apex below the upper third of the vagina, or anterior or posterior vaginal wall prolapse beyond the hymen. Stress urinary incontinence (SUI) with more than 1 symptom or interval treatment; or overall UI score of 3 or greater on the Incontinence Severity Index.

**Results** Of 215 women enrolled in the extended CARE study, 104 had undergone abdominal sacrocolpopexy plus Burch urethropexy and 111 had undergone abdominal sacrocolpopexy alone. Pelvic organ prolapse and urinary incontinence failure rates gradually increased during 7 years of follow-up.

	Estimated Probability of Failure From Parametric Survival Models 7 Years After Abdominal Sacrocolpopexy (SD)		Treatment Difference (95% CI)
	Urethropexy	No urethropexy	
Pelvic organ prolapse			
Symptomatic failure	0.29 (0.043)	0.24 (0.038)	0.049 (−0.060 to 0.162)
Anatomic failure	0.27 (0.099)	0.22 (0.049)	0.050 (−0.161 to 0.271)
Composite (symptomatic or anatomic) failure	0.48 (0.092)	0.34 (0.054)	0.134 (−0.096 to 0.322)
Urinary incontinence			
Stress	0.62 (0.052)	0.77 (0.034)	−0.153 (−0.268 to −0.030)
Overall	0.75 (0.043)	0.81 (0.032)	−0.064 (−0.161 to 0.032)

Probability of mesh erosion at 7 years (estimated by the Kaplan-Meier method) was 10.5% (95% CI, 6.8% to 16.1%).

**Conclusions and Relevance** During 7 years of follow-up, abdominal sacrocolpopexy failure rates increased in both groups. Urethropexy prevented SUI longer than no urethropexy. Abdominal sacrocolpopexy effectiveness should be balanced with long-term risks of mesh or suture erosion.

**Trial Registration** [clinicaltrials.gov](http://clinicaltrials.gov) Identifier: NCT00099372

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costs for these procedures exceed \$1 billion per year. As the population ages, it is anticipated that POP and urinary in-

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continence will become more frequently seen in primary care practices.<sup>6-9</sup>

The Pelvic Floor Disorders Network (PFDN), which is funded by the National Institutes of Health, conducted a multicenter, randomized, masked trial in women without stress urinary incontinence (SUI) undergoing abdominal sacrocolpopexy for POP between 2001 and 2006 (Colpopexy and Urinary Reduction Efforts trial; CARE trial) to study whether adding a prophylactic anti-incontinence procedure (Burch urethropexy) effects de novo SUI, a common adverse event after POP surgery.<sup>10</sup> At 2 years, the incidence of SUI was 32.0% (47/147) after urethropexy vs 45.2% (70/155) after no urethropexy ( $P=.03$ ).<sup>11</sup> To understand the balance between positive and negative outcomes and the effect of a Burch urethropexy over time, we invited women that completed their final 2-year visit in the CARE trial to participate in the extended CARE study.

The primary aims of the extended CARE study were to compare the long-term anatomic success rates, stress continence rates, and overall pelvic floor symptoms and pelvic floor-specific quality of life (QOL) and to describe mesh-related adverse events in women undergoing abdominal sacrocolpopexy who were or were not randomized to undergo urethropexy.

## METHODS

Institutional review boards at individual sites approved the extended CARE study. Written informed consent was obtained from all study participants. CARE enrollment occurred between March 2002 and February 2005. Funding decisions made by the National Institutes of Health limited extended CARE in-person visits to fully funded PFDN sites, whereas only QOL follow-up occurred at nonfunded sites and there was no research follow-up for participants at subcontracted sites. Women completing the in-person 2-year CARE visit were recruited into extended CARE beginning May 2004 and were followed up to 9 years after abdominal sacrocolpopexy. However, years 8 and 9 were excluded from the

analyses because of small numbers. Extended CARE included annual in-person examinations and centralized QOL telephone interviews at fully funded sites and only QOL telephone interviews for participants from sites that did not continue in the PFDN after July 2007. We contacted all participants mid-year from index surgery to update information.

## Outcome Measures

Outcome measures were similar to the CARE trial.<sup>12</sup> At in-person visits, research personnel conducted vaginal examinations to identify mesh erosion and assess vaginal support using the Pelvic Organ Prolapse Quantification (POP-Q) evaluation, in which the lowest level of vaginal descent during strain is measured relative to its distance in centimeters from the hymen; points above the hymen are negative and those below the hymen are positive.<sup>13</sup> While performing checks on POP-Q responses, we discovered several discrepant values. Because data collection had ended and it was not possible to contact investigators to correct data entry, an adjudication committee consisting of 3 principal investigators performed independent data reviews. The investigators at RTI International reconciled the reviews and made manual data adjustments when appropriate.

At visits or by telephone, we asked about surgical complications, comorbidities, and interval treatments for pelvic floor disorders and reviewed pertinent operative reports. Trained interviewers from a centralized facility administered by telephone a battery of instruments including the 46-item Pelvic Floor Distress Inventory (PFDI), which assesses symptom distress in women with pelvic floor disorders, and the Incontinence Severity Index, a 2-item index in which numerical responses for incontinence frequency and volume are multiplied to yield a score between 0 and 12.<sup>14,15</sup> The PFDI has 3 scales: urinary distress, colorectal-anal distress, and POP distress (eTable at <http://www.jama.com>). Telephone interviewers administered the 10-item Short Portable

Mental Status Questionnaire to women aged 75 years or older and withdrew women with scores of 5 or higher, indicating moderate to severe cognitive impairment.

## POP Outcome Definitions

The POP outcome definitions for extended CARE include anatomic failure: reoperation or pessary for POP or POP-Q measurements (FIGURE 1) as follows:  $C > (-2/3 \times \text{total vaginal length})$  (ie, the vaginal apex descends below the upper third of the vagina) or one of points Ba or Bp greater than 0 cm (ie, the anterior [Ba] or posterior [Bp] vaginal wall prolapses beyond the hymen). This updated definition differs from our original definition because in the decade since planning extended CARE, emerging data revealed that symptoms increase and satisfaction decreases once prolapse descends past the hymen (ie,  $> 0$  cm).<sup>16-18</sup>

Therefore, after approval by the steering committee and the data and safety monitoring board, and before any data analysis, we planned analyses for both the above updated anatomic failure definition as well as for the original definition:  $C > (-\text{total vaginal length} - 2 \text{ cm})$  (ie, vaginal apex descends  $\geq 2$  cm) or Ba or Bp greater than +1 cm (ie, anterior or posterior vaginal wall descends  $> 1$  cm beyond the hymen).

A patient with symptomatic failure had a positive response to 1 or more questions on the Pelvic Organ Prolapse Distress Inventory (referring to seeing or feeling a bulge), or reoperation or pessary for POP. A patient with composite failure met criteria for anatomic (updated definition) or symptomatic failure. We defined SUI failure as 1 or more SUI symptoms reported on the PFDI; and failure of SUI prevention as 1 or more SUI symptoms reported on the PFDI, receipt of interval anti-incontinence surgery, or receipt of an urethral bulking agent injection for SUI. Overall urinary incontinence was defined as an Incontinence Severity Index score of 3 or greater. Erosion was defined as exposed suture or mesh material in the vagina or viscera.

**Sample Size**

The CARE sample size and analyses were described in the primary report from that study.<sup>11</sup> We assumed that at least 250 women would enroll in ex-

tended CARE with approximately 100 in the smallest randomization group, which would provide sufficient power (>80%) to detect treatment differences between randomized groups up

to 20% in dichotomous outcomes and an SD of 0.4 in continuous outcomes.

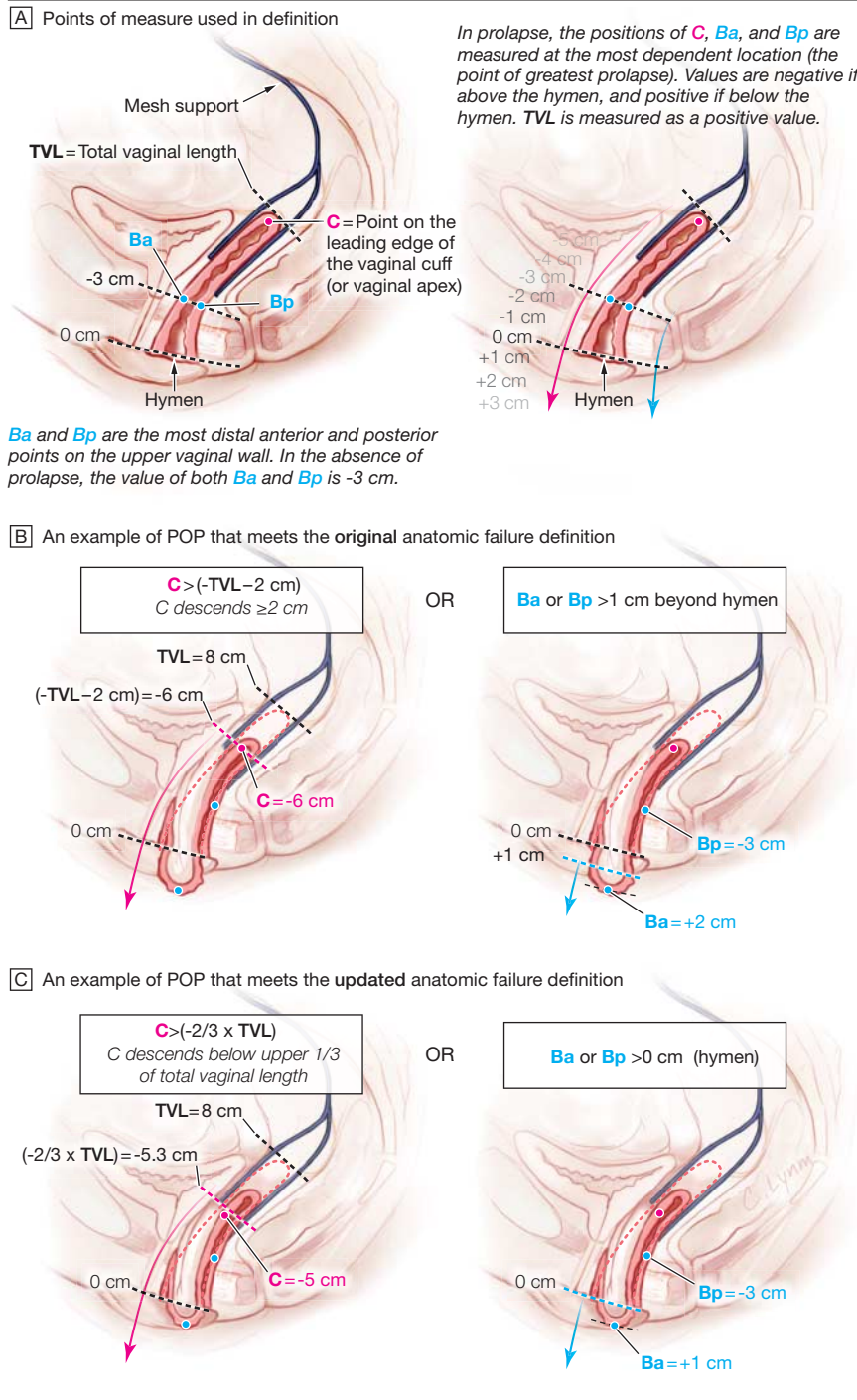
**Statistical Analysis**

We compared demographic characteristics between groups using *t* tests and  $\chi^2$  tests as appropriate. We calculated cumulative POP rates for each year of follow-up, classifying women who experienced POP as treatment failures. Numerators included all treatment failures up to the follow-up time point, and denominators included all treatment failures and known successes at that time point (women lost to follow-up without previously experiencing a treatment failure were censored).

We analyzed differences between treatment groups as change from baseline of symptom bother scores using general linear mixed models adjusted for 21 unique surgeons and intent-to-perform paravaginal procedures. Interactions between visit and treatment group were tested. Model fit was assessed using log likelihood and the Akaike information criterion. To ensure that we did not enhance results of the index surgery, we conducted sensitivity analyses replacing posttreatment scores with the last pretreatment data (if worse) for women undergoing treatment for POP or SUI.

To test for differences in treatment failure rates between groups, accounting for interval censoring (in which failure times were known to have occurred during a certain interval; eg, between 2 clinic visits, but the exact failure date was unknown) and stratification by surgeon, we used frailty parametric survival models (the survival data analog to regression models with frailty being analogous to random effects). When appropriate, interval censoring was used to account for uncertainty about exact treatment failure times. Data from women not known to have experienced a treatment failure were right censored at the last known time of treatment success. Best model fit and the need to include frailty (to account for unmeasured sources of variation between surgeons in the model) were determined through graphical in-

**Figure 1.** Definition of Anatomic Failure Following Surgical Repair of Pelvic Organ Prolapse (POP) in the Extended Colpopexy and Urinary Reduction Efforts Trial



formation, the Akaike information criterion, and the Deviance Information Criterion for model selection.

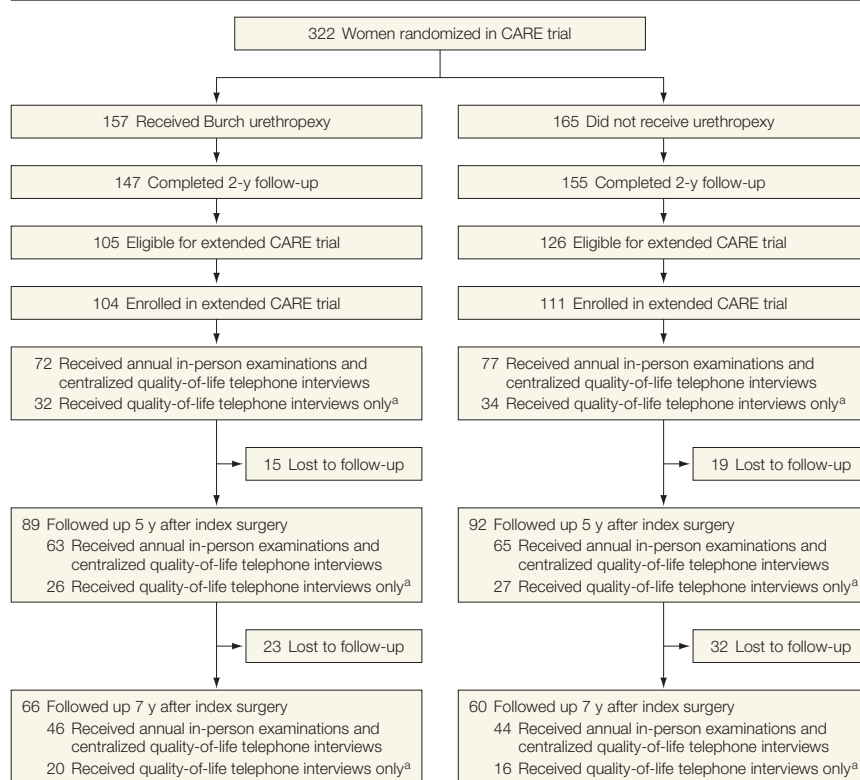
We excluded intent-to-perform paravaginal repair from final survival models because this variable was not statistically significant in the preliminary survival models, and the number with planned paravaginal procedures in the subset of women with in-person examinations was small. Parametric survival models were created using WinBUGS software version 1.4.3 (Imperial College and Medical Research Council, UK), and corresponding survival curves were graphed in R using the survival package version 2.36-14 (R Foundation for Statistical Computing). Kaplan-Meier curves were created with R software for selected outcomes; these did not account for surgeon variation or interval censoring (interval midpoints were used). We estimated the rate of mesh erosion over time in all women enrolled in CARE and in extended CARE using the Kaplan-Meier method in SAS version 9.3 (SAS Institute Inc). All other analyses were implemented in SAS. Two-sided *P* values of less than .05 were considered statistically significant.

## RESULTS

Of 322 women randomized to the CARE trial (*n*=157 to urethropexy vs *n*=165 to no urethropexy), 302 completed 2-year follow-up; 20 dropped out. Of the 302 women, 231 were from sites participating in the extended CARE trial (*n*=105 in urethropexy group vs *n*=126 in no urethropexy group). Seventy-one women were not eligible for extended CARE because they were participants from 2 subcontract sites and 1 original PFDN site that did not participate in the extended CARE study.

Ninety-two percent (215/233) of eligible participants were enrolled in the extended CARE study of whom 84% (181 women) completed 5-year outcome assessments; 2 were excluded from ongoing participation based on cognitive impairment. Study participation is summarized in FIGURE 2.

**Figure 2.** Colpopexy and Urinary Reduction Efforts (CARE) and Extended CARE Participant Flow



<sup>a</sup>Underwent index study surgery at 3 sites that did not continue into the next National Institutes of Health funding cycle after completion of the CARE study so in-person examination was not available.

The POP-Q measurements were adjudicated in 57 instances. Baseline demographic and clinical characteristics and 2- to 5-year follow-up rates did not differ by original randomization assignment and were similar between women who did or did not participate in extended CARE (TABLE 1). The extended CARE participants who participated only in QOL telephone interviews were older (mean [SD], 64.3 [10.6] years vs 60.8 [9.6] years; *P*=.02) and more likely to be married (83.8% vs 69.8%; *P*=.03) compared with women completing interviews and in-person examinations.

The POP and UI treatment failure rates gradually increased during the follow-up period (TABLES 2-3 and FIGURES 3-4) (eFigures 1-2 at <http://www.jama.com>). By year 7, the estimated probabilities of treatment failure for the urethropexy group and the no urethropexy group, respectively,

were 0.27 and 0.22 for anatomic (updated) POP (treatment difference of 0.050; 95% CI, -0.161 to 0.271), 0.29 and 0.24 for symptomatic POP (treatment difference of 0.049; 95% CI, -0.060 to 0.162), and 0.48 and 0.34 for composite POP (treatment difference of 0.134; 95% CI, -0.096 to 0.322).

Of the 31 women with anatomic POP, 11 involved the vaginal apex. Half (16/31) of the women with anatomic POP denied having symptoms and were not retreated. Similarly, about half (27/49) with symptomatic POP were not retreated and did not meet anatomic treatment failure criteria.

The estimated probability of SUI was 0.62 for the urethropexy and 0.77 for the no urethropexy group (treatment difference of -0.153; 95% CI, -0.268 to -0.030). The median time to treatment failure for the SUI outcome in the urethropexy group vs the no urethro-

**Table 1.** Baseline Characteristics of Colpopexy and Urinary Reduction Efforts (CARE) Study Population

	Extended CARE Trial, No./Total (%) <sup>a</sup>		P Value <sup>b</sup>
	Enrolled (n = 215)	Not Enrolled (n = 107)	
Age, mean (SD), y	61.9 (10.0)	60.3 (10.6)	.20
Race <sup>c</sup>			
White	198/215 (92.1)	101/107 (94.4)	.38 <sup>d</sup>
Black	13/215 (6.0)	4/107 (3.7)	
Other	4/215 (1.9)	2/107 (1.9)	
Hispanic ethnic group	8/215 (3.7)	1/107 (0.9)	.15
Married or living as married	160/215 (74.4)	79/107 (73.8)	.91
Education level			
<High school	19/215 (8.8)	8/107 (7.5)	.69
High school degree or equivalent	80/215 (37.2)	45/107 (42.1)	
≥College degree	116/215 (54.0)	54/107 (50.5)	
No. of previous deliveries, median (range)			
Vaginal	3 (0-8)	3 (1-11)	.26
Cesarean	0 (0-5)	0 (0-2)	.77
No. of previous births, median (range)	3 (1-10)	3 (1-11)	.24
Prior surgery			
Incontinence	16/215 (7.4)	6/107 (5.6)	.54
Pelvic organ prolapse	84/215 (39.1)	42/107 (39.3)	.97
Prior hysterectomy	159/215 (74.0)	69/107 (64.5)	.08
Pelvic Organ Prolapse Q stage			
2 <sup>e</sup>	24/215 (11.2)	20/107 (18.7)	.11
3 <sup>f</sup>	153/215 (71.2)	65/107 (60.7)	
4 <sup>g</sup>	38/215 (17.7)	22/107 (20.6)	
Body mass index <sup>h</sup>			
Mean (SD)	26.7 (4.4)	27.7 (4.6)	.05
≥30 (obesity)	45/215 (20.9)	29/107 (27.1)	.21

<sup>a</sup>Unless otherwise indicated.  
<sup>b</sup>Obtained through 2-sample t tests for continuous variables and  $\chi^2$  tests for categorical variables.  
<sup>c</sup>Race was self-reported.  
<sup>d</sup>Omits the category of other.  
<sup>e</sup>The vagina is prolapsed between 1 cm above the hymen and 1 cm below the hymen.  
<sup>f</sup>The vagina is prolapsed more than 1 cm beyond the hymen but is less than totally everted.  
<sup>g</sup>The vagina is everted to within 2 cm of its length.  
<sup>h</sup>Calculated as weight in kilograms divided by height in meters squared.

pexy group was 3.11 years vs 0.94 years, respectively (eFigure 2).

Patient reported outcomes are summarized in the eTable. There were no significant interactions between treatment and visit. Averaged over time points to 5 years postsurgery, scores on the Urinary Distress Inventory for the stress and irritative subscales were lower, reflecting better outcomes with abdominal sacrocolpopexy and urethropexy vs abdominal sacrocolpopexy without urethropexy. There were no significant differences between groups for the obstructive subscale or for the PFDI or Colorectal Distress Inventories. Sensitivity analyses produced results consistent with the initial analyses.

By year 2, 3 of the 322 women enrolled in CARE had suture erosion and 17 had mesh erosion.<sup>19</sup> There were 6 additional cases of mesh erosion and 1 suture erosion in the extended CARE population by year 7. Erosions occurred with all mesh types placed. The estimated probability of mesh erosion in the CARE and extended CARE trials at the time of the last known treatment failure (6.18 years) was 10.5% (95% CI, 6.8%-16.1%) when the right censoring time of women without known mesh erosion was the last clinic visit (FIGURE 5).

When the right censoring time was either the last clinic visit or last telephone interview (whichever came

later), the estimated probability of mesh erosion was 9.9% (95% CI, 6.5%-15.0%). Of the 23 women with mesh erosions (11 in the urethropexy group and 12 the no urethropexy group) in the CARE and extended CARE populations, 15 underwent excision in the operating room (13 via the vaginal route and 2 via the abdominal route), 4 were given estrogen cream, and 4 were asymptomatic. All suture erosions were managed by excision in the office.

Seven and 13 women in the urethropexy and no urethropexy groups, respectively, underwent either surgery or received an urethral bulking agent injection for SUI surgery. Seven and 5 women in the urethropexy and no urethropexy groups, respectively, underwent either surgery or pessary for POP. By year 7, at least 36 of 215 women (16.7%) in the extended CARE trial had additional surgery related to pelvic floor disorders, 11 for recurrent POP, 14 for SUI, and 11 for mesh complications.

## DISCUSSION

Three key points emerge from these data. First, as a criterion standard for the surgical treatment of POP, abdominal sacrocolpopexy is less effective than desired. There is no consensus on defining cure after POP surgery and depending on definition, 2-year cure rates for abdominal sacrocolpopexy range from 19% (perfect anatomic support) to 97% (no retreatment for POP).<sup>20</sup>

For this study, we chose a clinically relevant definition of anatomic failure that some would argue is still not stringent enough, yet by 5 years, nearly one-third of women met our composite failure definition. However, 95% had no retreatment for POP.

Despite progressive loss of anatomic support, abdominal sacrocolpopexy generally provides relief of POP symptoms. The low reoperation rate for POP may imply that women found the treatment adequate; however, for older women, other health and social concerns may assume primacy over vaginal bulge symptoms. Our ability to interpret the increased anatomic failure rate between 2 and 7 years is limited,

**Table 2.** Estimated Probability of Pelvic Organ Prolapse Failure After Abdominal Sacrocolpopexy

	Pelvic Organ Prolapse Failure After Abdominal Sacrocolpopexy <sup>a</sup>					
	2 y	3 y	4 y	5 y	6 y	7 y
Symptomatic <sup>b</sup>						
Burch urethropexy <sup>c</sup>	15/104 0.14 (0.026)	16/101 0.18 (0.031)	19/94 0.21 (0.034)	25/91 0.24 (0.038)	27/86 0.27 (0.041)	27/73 0.29 (0.043)
No urethropexy <sup>c</sup>	16/111 0.12 (0.023)	19/108 0.15 (0.027)	20/103 0.18 (0.031)	21/96 0.20 (0.034)	21/90 0.22 (0.036)	22/71 0.24 (0.038)
Treatment difference (95% CI)	0.026 (-0.032 to 0.087)	0.032 (-0.040 to 0.108)	0.038 (-0.046 to 0.124)	0.042 (-0.051 to 0.139)	0.046 (-0.056 to 0.151)	0.049 (-0.060 to 0.162)
Anatomic (original) <sup>d</sup>						
Burch urethropexy <sup>c</sup>	6/69 0.08 (0.027)	9/61 0.12 (0.39)	10/49 0.16 (0.049)	12/47 0.20 (0.059)	15/44 0.23 (0.068)	15/33 0.26 (0.075)
No urethropexy <sup>c</sup>	9/76 0.10 (0.029)	10/67 0.13 (0.034)	12/63 0.16 (0.039)	13/59 0.19 (0.043)	14/47 0.21 (0.047)	14/37 0.23 (0.050)
Treatment difference (95% CI)	-0.017 (-0.098 to 0.061)	-0.010 (-0.112 to 0.093)	-0.001 (-0.123 to 0.125)	0.009 (-0.133 to 0.154)	0.019 (-0.140 to 0.182)	0.029 (-0.148 to 0.208)
Anatomic (updated) <sup>d</sup>						
Burch urethropexy <sup>c</sup>	5/69 0.09 (0.036)	8/60 0.13 (0.052)	10/48 0.16 (0.066)	14/46 0.20 (0.078)	18/44 0.24 (0.089)	18/35 0.27 (0.099)
No urethropexy <sup>c</sup>	8/76 0.09 (0.028)	10/66 0.12 (0.033)	12/63 0.15 (0.037)	12/59 0.17 (0.041)	13/48 0.20 (0.045)	13/38 0.22 (0.049)
Treatment difference (95% CI)	-0.005 (-0.093 to 0.087)	0.005 (-0.110 to 0.131)	0.016 (-0.125 to 0.170)	0.028 (-0.139 to 0.207)	0.039 (-0.150 to 0.240)	0.050 (-0.161 to 0.271)
Composite						
Burch urethropexy <sup>c</sup>	14/70 0.22 (0.056)	16/63 0.29 (0.066)	19/52 0.34 (0.074)	27/51 0.39 (0.081)	30/49 0.44 (0.087)	30/42 0.48 (0.092)
No urethropexy <sup>c</sup>	15/76 0.13 (0.038)	18/66 0.23 (0.042)	19/62 0.26 (0.046)	20/59 0.29 (0.049)	21/51 0.32 (0.052)	21/45 0.34 (0.054)
Treatment difference (95% CI)	0.035 (-0.101 to 0.164)	0.060 (-0.102 to 0.207)	0.082 (-0.101 to 0.244)	0.102 (-0.099 to 0.276)	0.119 (-0.098 to 0.304)	0.134 (-0.096 to 0.322)

<sup>a</sup>Based on the parametric survival models.

<sup>b</sup>Symptom of bulge on Pelvic Floor Distress Inventory, interval prolapse surgery, or pessary used after index surgery.

<sup>c</sup>The values are expressed as numerator/denominator and probability (standard deviation). The numerators and denominators at each time point include prior failures and exclude prior dropouts who had not yet met failure criteria. The standard deviations are from Bayesian posterior distributions using vague priors, so the intervals are like typical 95% confidence intervals.

<sup>d</sup>The original and updated versions could have different denominators for the same time point because a prior anatomic failure means the patient is assigned a failure in all subsequent visits regardless of whether the patient had completed the visits.

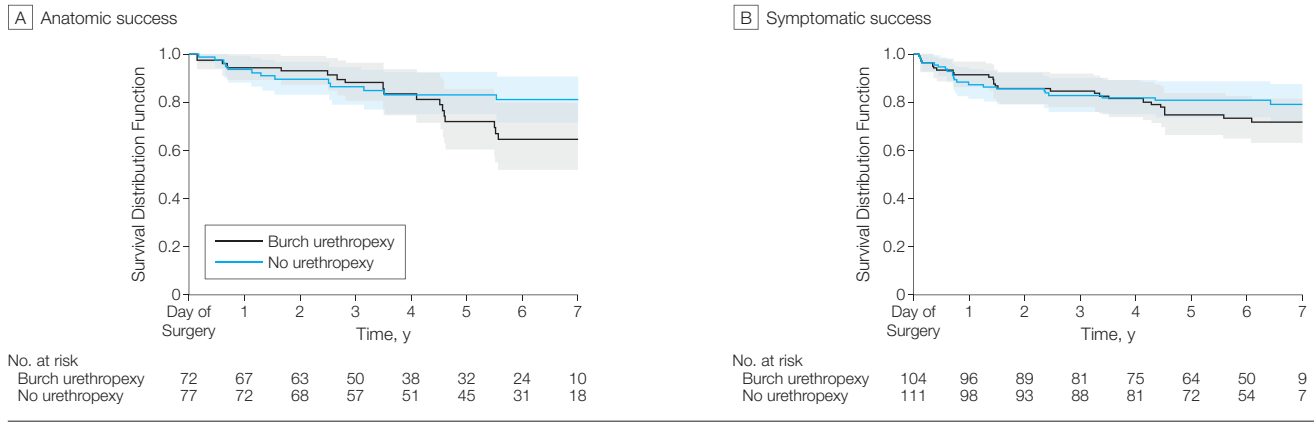
**Table 3.** Estimated Probability of Urinary Incontinence (UI) Failure After Abdominal Sacrocolpopexy

	UI Failure After Abdominal Sacrocolpopexy <sup>a</sup>					
	2 y	3 y	4 y	5 y	6 y	7 y
Overall UI						
Burch urethropexy <sup>b</sup>	48/104 0.59 (0.050)	52/101 0.65 (0.048)	55/99 0.68 (0.047)	58/98 0.71 (0.045)	59/97 0.73 (0.044)	62/91 0.75 (0.043)
No urethropexy <sup>b</sup>	66/111 0.67 (0.039)	70/109 0.72 (0.038)	70/105 0.76 (0.036)	72/104 0.78 (0.035)	73/102 0.80 (0.033)	73/92 0.81 (0.032)
Treatment difference (95% CI)	-0.082 (-0.203 to 0.041)	-0.077 (-0.192 to 0.038)	-0.073 (-0.183 to 0.036)	-0.070 (-0.174 to 0.034)	-0.067 (-0.168 to 0.033)	-0.064 (-0.161 to 0.032)
Stress UI prevention failure						
Burch urethropexy <sup>b</sup>	39/104 0.44 (0.052)	47/102 0.50 (0.053)	49/99 0.54 (0.053)	53/98 0.57 (0.052)	55/95 0.60 (0.052)	57/89 0.62 (0.051)
No urethropexy <sup>b</sup>	63/110 0.61 (0.039)	69/109 0.67 (0.038)	76/107 0.71 (0.037)	77/105 0.73 (0.036)	78/105 0.75 (0.035)	79/96 0.77 (0.034)
Treatment difference (95% CI)	-0.175 (-0.296 to -0.043)	-0.172 (-0.291 to -0.042)	-0.168 (-0.284 to -0.041)	-0.163 (-0.278 to -0.039)	-0.158 (-0.271 to -0.038)	-0.154 (-0.266 to -0.037)
Stress UI						
Burch urethropexy <sup>b</sup>	39/104 0.44 (0.053)	47/102 0.49 (0.054)	49/99 0.54 (0.054)	53/98 0.57 (0.053)	55/95 0.60 (0.053)	57/89 0.62 (0.052)
No urethropexy <sup>b</sup>	63/110 0.61 (0.039)	68/109 0.67 (0.038)	75/107 0.70 (0.037)	76/105 0.73 (0.036)	78/105 0.75 (0.035)	79/96 0.77 (0.034)
Treatment difference (95% CI)	-0.173 (-0.298 to -0.035)	-0.170 (-0.295 to -0.034)	-0.166 (-0.288 to -0.033)	-0.161 (-0.281 to -0.032)	-0.157 (-0.275 to -0.030)	-0.153 (-0.268 to -0.030)

<sup>a</sup>Based on the parametric survival models.

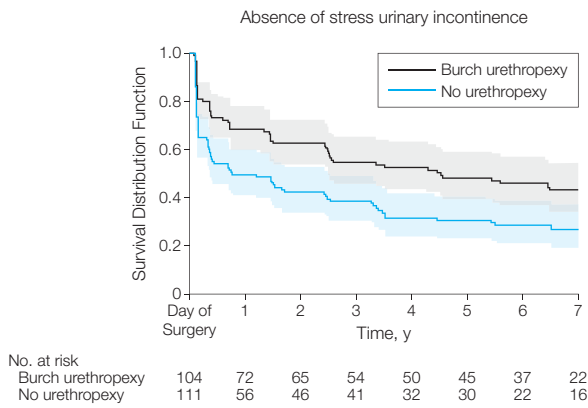
<sup>b</sup>The values are expressed as numerator/denominator and probability (standard deviation). The numerators and denominators at each time point include prior failures and exclude prior dropouts who had not yet met failure criteria. The standard deviations are from Bayesian posterior distributions using vague priors, so the intervals are like typical 95% confidence intervals.

**Figure 3.** Kaplan-Meier Survival Curves for Success of Abdominal Sacrocolpopexy in Treating Pelvic Organ Prolapse Through Year 7, Using Anatomic and Symptomatic Definitions of Success



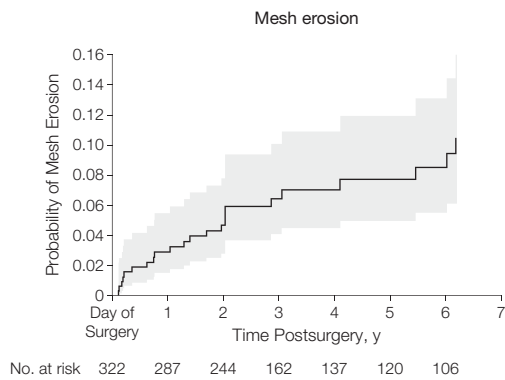
The blue and gray shading indicate pointwise 95% confidence intervals.

**Figure 4.** Kaplan-Meier Survival Curve for Absence of Stress Urinary Incontinence Through Year 7



The blue and gray shading indicate pointwise 95% confidence intervals.

**Figure 5.** Kaplan-Meier Failure Curve for Mesh Erosion Using Last Clinic Visit as Right Censoring Date



The point estimate for probability of mesh erosion at the time of the last reported erosion (6.18 years) was 0.105 (95% CI, 0.068-0.161). The gray shading indicates pointwise 95% confidence intervals.

given scant information about the natural history of vaginal support and our poor understanding of the pathophysiology of POP.

Second, surgical prevention of SUI at the time of abdominal POP surgery involves no clinically significant trade-offs identified to date. Our study is one of the few available that examined a surgical preventive strategy using a level 1 study design.<sup>21,22</sup>

In addition, we found that complications related to synthetic mesh continue to occur over time. Long-term follow-up is mandatory to understand the long-term patient burden associated with surgical materials and devices.

Generalizability of our findings is supported by the fact that 21 surgeons from 7 sites performed the study surgeries. Our 2-year anatomic failure and reoperation rates are consistent with those of a large body of literature,<sup>5,23</sup> although our 5-year failure rates are higher than cited in the few smaller longer-term studies.<sup>20,24</sup>

We were surprised by the magnitude of treatment failure rates after abdominal sacrocolpopexy. The lower success rate may in part be explained by the rigor of our data collection, with unbiased outcome assessment and use of validated outcome measures, or by nonstandardized aspects of surgical technique. In addition, knowledge about the natural history of POP would

allow us to further refine our concepts of surgical failure vs progression of underlying POP disorder.

The strengths of this study include the randomized design, which consisted of masking both participants and outcome assessors to randomization assignment, the 5-year or longer follow-up, the multicenter nature of the study, and the use of validated measures to assess anatomic and symptomatic outcomes. Additionally, all validated outcomes were assessed by trained study personnel and not by the surgeon.

The limitations of this research include the challenges seen in many longer-term studies. Because of the nature of typical National Institutes of Health network funding cycles, some sites were not renewed during the course of the extended CARE study and a decision was made not to continue follow-up at those sites. This decreased our follow-up rate and limited the number of participants that could undergo physical examination after 2 years, but patient-reported outcomes in the other participants contributed to deflecting the lack of physical examinations in all participants. Many observed differences were smaller than 15%, which our study was not powered to detect. We standardized the urethropexy procedure in which women were randomized, but the surgical techniques used for the abdominal sacrocolpopexy reflected the variability of clinical practice.

Conceivably, types, sizes, and configurations of mesh types and numbers of sutures, and other variations in techniques may influence success rates. With the shifting of contemporary clinical practice to midurethral slings and to abdominal sacrocolpopexy performed using laparoscopic or robotic approaches, it is unclear to what degree these results can be extrapolated to the newer procedures because we only evaluated open abdominal sacrocolpopexy and Burch urethropexy. However, short-term POP success rates were similar in a

case series of open vs minimally invasive approaches.<sup>25</sup> Our findings also cannot be extrapolated to other surgical techniques for POP.

Placing synthetic mesh transabdominally to treat POP requires balancing a need for greater effectiveness with the probability for more complications. As evidenced by our results, patients who have received procedures in which mesh is placed transabdominally have problems that become apparent long after the time of surgery.

We anticipate that continued research in mesh development will lead to new materials and applications with fewer adverse events, but our data highlight the importance of careful long-term evaluation of new devices. Comparative effectiveness trials with long-term follow-up of at least 5 years are needed to compare abdominal sacrocolpopexy that we described in this report with vaginal prolapse procedures that include and do not include mesh augmentation.

Based on our results, women considering abdominal sacrocolpopexy should be counseled that this procedure effectively provides relief from POP symptoms; however, the anatomic support deteriorates over time. Adding an anti-incontinence procedure for women continent preoperatively decreases, but does not eliminate, the risk of de novo SUI. Surgical counseling about the ongoing risk of mesh-related events even for abdominal sacrocolpopexy is critical. Women should be aware that symptoms such as vaginal bleeding, discharge, and pain may be due to mesh erosion and should seek help accordingly.

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**Administrative, technical, or material support:** Zyczynski.

**Study supervision:** Nygaard, Richter, Gantz, Fine, Menefee, Meikle.

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