Current Urology Reports
https://doi.org/10.1007/s11934-019-0939-8

LOWER URINARY TRACT SYMPTOMS & VOIDING DYSFUNCTION (J SANDHU, SECTION EDITOR)

Prolapse Repair Using Non-synthetic Material: What is the Current Standard?

Ricardo Palmerola [1] · Nirit Rosenblum [1]

Abstract

Purpose of Review Due to recent concerns over the use of synthetic mesh in pelvic floor reconstructive surgery, there has been a renewed interest in the utilization of non-synthetic repairs for pelvic organ prolapse. The purpose of this review is to review the current literature regarding pelvic organ prolapse repairs performed without the utilization of synthetic mesh.

Recent Findings Native tissue repairs provide a durable surgical option for pelvic organ prolapse. Based on recent findings of recently performed randomized clinical trials with long-term follow-up, transvaginal native tissue repair continues to play a role in the management of pelvic organ prolapse without the added risk associated with synthetic mesh.

Summary In 2019, the FDA called for manufacturers of synthetic mesh for transvaginal mesh to stop selling and distributing their products in the USA. Native tissue and non-synthetic pelvic organ prolapse repairs provide an efficacious alternative without the added risk inherent to the utilization of transvaginal mesh. A recent, multicenter, randomized clinical trial demonstrated no clear advantage to the utilization of synthetic mesh. Furthermore, transvaginal native tissue repairs have demonstrated good long-term efficacy, particularly when anatomic success is not the sole metric used to define surgical success.

Keywords Pelvic organ prolapse · Cystocele · Enterocele · Rectocele · Synthetic mesh · Transvaginal mesh · Uterosacral ligament suspension · Sacrospinous ligament fixation · Native tissue prolapse repair

Introduction

Pelvic organ prolapse (POP) is a pelvic floor disorder (PFD) characterized by the descent of the anterior vaginal wall, posterior vaginal wall, and/or the apex of the vagina [1]. Amongst other PFDs (stress urinary incontinence, fecal incontinence, etc.), POP is prevalent throughout the general population affecting up to 50% of women based on anatomic criteria on physical examination [2]. Despite its negative impact on several quality of life domains, only 3 to 8% of women report their symptoms [3–7]. Women with POP often present with a symptomatic vaginal bulge, vaginal pressure, and bothersome lower urinary tract symptoms (urinary urgency, frequency, urinary hesitancy, incomplete bladder emptying). Additionally, if the prolapsed organ(s) progresses beyond the hymenal ring, patients may notice vaginal bleeding as a result of erosions on the vaginal wall or cervix. As a result, these women may experience pelvic pain, embarrassment, social isolation, and sexual dysfunction, and may avoid activities such as exercise that can exacerbate these symptoms. Defecatory dysfunction may also be present including difficulty with rectal evacuation, fecal urgency, and/or fecal incontinence. Multiple risk factors have been identified that contribute to POP including age, menopause, parity, vaginal delivery, operative vaginal delivery, and body mass index [8–10]. Non-operative management of POP includes pelvic floor muscle training, pessaries, and observation [11–14]. Non-operative management may initially be chosen as a treatment option; however, many women seek definitive treatment in order to resolve prolapse symptoms. The lifetime risk for women undergoing POP surgery is estimated at approximately 12.6%, and with an aging population in the USA, the number of

This article is part of the Topical Collection on *Lower Urinary Tract Symptoms & Voiding Dysfunction*

✉ Ricardo Palmerola
ricardopalmerola@gmail.com

Nirit Rosenblum
nirit.rosenblum@nyulangone.org

[1] Departments of Urology and Obstetrics & Gynecology, New York University School of Medicine, 222 East 41st Street, 11th Floor, New York, NY 10017, USA

Published online: 14 October 2019

surgeries for POP is projected to rise substantially [11, 15, 16]. In general, surgical intervention for POP can be divided into obliterative procedures and reconstructive procedures. Furthermore, reconstructive procedures can be subdivided into vaginal approaches and abdominal approaches.

Non-synthetic, or native tissue, prolapse repairs have been the cornerstone of vaginal prolapse repairs; however, historical reports demonstrating high reoperation rates for native tissue repairs prompted surgeons to being utilizing synthetic grafts for POP repair [17]. However, following reports of mesh-specific complications in transvaginal POP surgery, the Food and Drug Administration (FDA) issued safety communications regarding the safety of vaginal mesh in prolapse repair in 2008 and 2011. Finally in 2019, the FDA called for remaining manufacturers of synthetic mesh products for transvaginal repair of POP to stop selling and distributing their products within the USA [18]. As a result of these notifications and subsequent reduction in transvaginal repairs utilizing synthetic grafts, native tissue prolapse repairs have become an important part of the armamentarium for pelvic surgeons [19].

Surgical Outcomes

Outcomes data for POP surgery are largely dependent on the definition of surgical success used. Success rates in the literature have been based on several end points including anatomical success (based on pelvic organ prolapse quantification [POPQ] stage 0 or 1), reoperation rates, subjective patient-reported outcomes, and questionnaire-based assessments [20]. In general, anatomic outcomes for native tissue repairs have been inferior to those reported by investigators utilizing mesh-augmented grafts. However, when surgical success is defined using patient-reported outcomes, absence of vaginal bulge or reoperation rates surgical success for native tissue repairs is comparable. Overall treatment success in the literature is variable as a result of the criteria defining surgical success. Barber et al. found that when strict anatomical criteria are applied and success is defined largely by anatomic points lying proximal to the hymen, native tissue repairs demonstrate low success rates (19–57%) [21]. However, when clinically relevant criteria including the absence of prolapse beyond the hymen, subjective cure defined by the absence of vaginal bulge symptoms and reoperation rates are used to define surgical success; greater than 90% of patients achieve success. When interpreting surgical outcomes for native tissue repairs, clinicians should focus on more clinically relevant definitions which reflect patient's subjective improvement in conjunction with anatomic outcomes, rather than strict anatomic criteria alone that have less clinical relevance for most surgeons. Given the recent controversy regarding transvaginal mesh for POP and subsequent removal from the market, native tissue repairs have become the mainstay of vaginal reconstruction.

Anatomical Considerations

Anterior Compartment

Prolapse involving the anterior compartment of the vagina is generally referred to as cystocele. Richardson et al. described that the presence of an anterior defect, or cystocele, may be due to a midline, transverse, or paravaginal defect [22]. Most anterior compartment repairs aim to correct the defective pubocervical fascia and the lateral attachments to the arcus tendineus fascia pelvis (ATFP), or both. Midline defects are due to pubocervical fascial deficiency or separation. Paravaginal defects result from connective tissue detachment from the ATFP, while transverse defects result from detachment of the pubocervical fascia from the cervix. Although the term pubocervical fascia is used to refer to the connective tissue between the bladder and the vagina, it is important to note this is a misnomer and refers to a fibromuscular layer and adventitia which underlie the vaginal epithelium. Surgical repairs in the anterior compartment aim to recreate this layer of support.

Native tissue surgical repair of a cystocele can be accomplished by performing an anterior colporrhaphy. The procedure was originally described in 1913 and since that time has undergone several modifications ranging from excision and reanastamosis of vaginal epithelium to plication of pubocervical fascia with or without synthetic and biologic grafts [23, 24]. Currently, most surgeons perform anterior colporrhaphy by making a midline incision through the prolapsed anterior vaginal epithelium through which lateral flaps are created bilaterally to expose the underlying fibromuscular layer. Central plication is performed by placing sutures consecutively through the fibromuscular layer and adventitial layer to reapproximate both sides of the central defect. This step has been described in different configurations as well as utilizing different suture types. We typically utilize delayed absorbable suture (polydioxanone); however, many surgeons prefer polyglactin synthetic braided sutures. Historically, this anterior repair can also be performed concomitantly with a Kelly plication as a means to perform a concomitant anti-incontinence procedure or provide additional support to the suburethral portion of the anterior vaginal wall. Currently, many surgeons prefer a mid-urethral sling for treatment of either clinical or occult stress urinary incontinence at the time of prolapse repair.

Defects in the anterior compartment are commonly a combination of both central and lateral defects. In order to address lateral defects as a result of the detachment of the pubocervical fascia to the ATFP, a paravaginal repair can be performed from

a vaginal or abdominal approach. Despite the presence of both defects in the anterior compartment, widespread utilization of this repair has been limited by its higher complication rate as well as the technical challenge of performing the operation vaginally [24–26]. In our experience, the operation can be performed in its entirety through a vaginal approach and suture placement is facilitated with the use of a Capio Suture Capturing Device (Boston Scientific). The initial dissection is performed similar to an anterior colporrhaphy; however, lateral dissection is taken to the endopelvic fascia which is perforated either sharply using Metzenbaum scissors or sometimes with blunt dissection. Identification of the ATFP is facilitated by identifying the ischial spine. We utilize two 1-0 polydioxanone sutures through the ATFP. The other end of each suture is brought through the lateral edge of the pubocervical fascia and tied once all sutures are placed. An anterior colporrhaphy can be performed at this time and a cystoscopy must be performed to ensure ureteral patency. We do not perform abdominal (laparoscopic or open) paravaginal repair as other authors have found correcting apical defects are as effective in providing sufficient anatomical success [27]. Often, correcting the vaginal apex by either approach (abdominal or vaginal) obviates the need for paravaginal repair and the potential risk for ureteral and vascular injury inherent to it. For a description of abdominal approaches to abdominal paravaginal repair, one may refer to other resources which have summarized the procedures [25, 28].

Success rates for anterior prolapse repair have varied across the literature largely due to variability in study end points defining success [21]. Historical series have reported up to a 70% failure rate when measuring success by strict anatomic outcomes (stage 0 or stage 1) according to the POPQ system [29]. For example, Weber et al. performed a prospective, randomized study comparing anatomical outcomes of native tissue anterior colporrhaphy, polyglactin 910 mesh augmented anterior colporrhaphy, and ultralateral anterior colporrhaphy (paravaginal repair) [29]. After a median follow-up of 23.3 months, anatomic success was achieved in 30% of patients who underwent anterior colporrhaphy and 46% of patients in the paravaginal repair group. Despite the low anatomic success with anterior colporrhaphy, there was a high rate of symptomatic improvement measured by visual analog scales. In a multicenter randomized controlled trial comparing anterior colporrhaphy and polypropylene mesh augmented repair, Altman et al. found that 34.5% of patients undergoing native tissue repair achieved anatomic success at 1 year [30]. Chmielewski et al. reanalyzed the outcomes data from the Weber trial applying more clinically relevant definitions of success. They defined surgical success as the absence of prolapse beyond the hymen, absence of vaginal bulge symptoms, and no retreatment in the form of pessary or surgery. When the authors applied these criteria as the definition of surgical success, they found a success rate of 88% for anterior repair with no significant difference between the three approaches. Similarly, Sand et al. found an 89% success rate for native tissue anterior repair when defining surgical success as prolapse beyond the hymen [31]. Overall, surgical success rates are excellent for native tissue anterior repairs when utilizing clinically meaningful outcomes and obviate the need for augmented mesh repairs that may expose the patient to additional risk.

In order to improve upon surgical success rates of native tissue anterior repairs, several technical modifications and non-synthetic materials have been utilized. Bergman et al. performed a longitudinal cohort study comparing anterior colporrhaphy performed with rapidly absorbing suture (polyglactin 910, polysorb, or polycaprolate) or slowly absorbing suture (polydiaxanone or polyglyconate) [32]. They identified 1107 women who underwent primary anterior colporrhaphy using the Swedish National Quality Register for Gynecological Surgery and success was defined as the subjective absence of vaginal bulge symptoms. After 1-year follow-up, 22% of patients in the slowly absorbing suture group reported vaginal bulge symptoms versus 30% in the rapidly absorbing suture group; however, satisfaction rates remained high regardless of group (83% and 75%, respectively). Song et al. performed a retrospective review of 69 patients who underwent a modification of anterior colporrhaphy using a purse string technique with an additional plicating layer [33]. After a mean follow-up of 49 months, 98% of patients achieved surgical success as defined by < grade 1 on the Baden-Walker classification [34]. Lavelle et al. reported long-term follow-up results of a cohort of patients undergoing a modified anterior vaginal wall suspension for stage 2 anterior prolapse (based on POPQ) [35]. Although only 7% of patients had isolated anterior compartment recurrence, 10% of women underwent subsequent apical prolapse repair and 19% underwent surgical repair for multiple compartment prolapse recurrence. Given the relationship between apical compartment defects and symptomatic anterior compartment prolapse, success rates for anterior compartment repairs are greatly augmented by performing a concomitant apical suspension (sacrospinous ligament fixation or uterosacral ligament suspension) [36]. Eilber et al. identified 3244 women who underwent surgery for POP and compared women undergoing anterior repair alone versus concomitant apical repair [37]. At 10-year follow-up, reoperation rates in the patients undergoing anterior repair only were significantly higher than those undergoing concomitant apical repair (20.2% vs. 11.6%, $p < 0.01$). Therefore, in women with advanced, symptomatic anterior compartment prolapse, addressing the vaginal apex should often be considered to improve the durability and efficacy of the repair.

Paravaginal defects account for 60–80% of anterior compartment defects; thus, many authors suggest that failing to

address these defects during anterior colporrhaphy accounts for the high failure rate of native tissue anterior repairs [38]. Despite the high prevalence of these defects, the literature reporting outcomes is limited to studies with short follow-up and small cohorts. Furthermore, many studies include patients undergoing concomitant apical compartment procedures; therefore, it is unclear which procedure accounted for the durability and success of the anterior repair. Paravaginal repairs can be performed utilizing a transabdominal or vaginal approach. Most contemporary series report outcomes of laparoscopic approaches to paravaginal repair. Duraisamy et al. reported their results of a longitudinal prospective observational study of 44 patients who underwent laparoscopic or robotic paravaginal repair with a follow-up of 1 year [39]. They reported a 97% anatomic cure for anterior compartment prolapse; however, 90% of their cohort underwent a concomitant apical suspension (sacrocolpopexy or uterosacral colpopexy). There is also limited data delineating success of vaginal paravaginal repairs. Arenholt et al. evaluated a cohort of 46 patients diagnosed with paravaginal defects preoperatively. A paravaginal defect was diagnosed by reducing the prolapsed anterior vaginal wall with a curved sponge forceps suspending each lateral wall to the ATFP. Recurrence at 6 months was defined by stage 2 prolapse with subjective vaginal bulge symptoms or > stage 3 prolapse. The overall anterior vaginal wall prolapse recurrence rate was 39% including patients in the cohort who underwent a concomitant apical repair. Overall, the literature reporting paravaginal repair by any approach is limited, and it is further confounded by the utilization of concomitant apical compartment procedures.

In addition to suture-based anterior prolapse repairs, non-synthetic grafts have been investigated as a way to augment anterior compartment repair while minimizing risks inherent to synthetic mesh. Autologous grafts, xenografts (derived from processed animal tissue), and cadaveric allografts (derived from cadaveric donor tissue) have been utilized [40, 41]. A recent Cochrane review in 2016 reviewed 7 randomized controlled trials comparing native tissue repair and biologic graft repairs. Overall, the panel did not find a difference in subjective patient-reported outcomes between 1 and 3 years or in reoperation rates following POP surgery and therefore could not draw definitive conclusions based on available data (consisting of lower quality studies with small cohorts of patients) [42]. Glazener et al. provided higher quality evidence to compare graft-augmented repairs in their multicenter, randomized controlled trial comparing outcomes of primary transvaginal anterior or posterior repairs with synthetic mesh or with biologic grafts [43•]. After a 2-year follow-up, investigators showed no benefit to graft (both biologic and synthetic mesh) augmentation for primary anterior or posterior repairs over native tissue repair for both subjective and anatomic cure. Furthermore, there was no significant difference between complication and reoperation rates between biologic grafts and native tissue repair. Overall, data from available trials to date show no clear benefit in utilizing biologic grafts for anterior compartment prolapse.

Apical Compartment

Apical vaginal prolapse is characterized by a loss of support in the uterosacral-cardinal ligament complex and defined as descent of the vaginal cuff or cervix within a point 2 cm less than the total vaginal length [44]. Vaginal vault prolapse is often associated with anterior and posterior defects, and with an enterocele in the post-hysterectomy setting [45, 46]. Although abdominal sacrocolpopexy (ASC) offers superior anatomic outcomes for vaginal vault prolapse, a recent meta-analysis found no difference between ASC and native tissue transvaginal repairs when comparing reoperation rates [47]. Furthermore, ASC was associated with a higher risk of adverse events; thus, native tissue apical repairs should remain an important part of the pelvic surgeon's armamentarium. Native tissue repairs for apical compartment prolapse include uterosacral ligament suspension (USLS), sacrospinous ligament fixation (SSLF), McCall culdoplasty, iliococcygeus fixation (ICS), and autologous fascial sacrocolpopexy.

Uterosacral Ligament Suspension

Uterosacral ligament suspension (USLS) is a native tissue repair that reestablishes level I support to the vaginal apex most commonly following concomitant hysterectomy. The procedure is most commonly performed transvaginally and involves identification of the uterosacral ligaments posterior and medial to the ischial spines. In Shull and colleagues' original description of the procedure, 2 permanent sutures and 1 delayed absorbable suture were placed through the ligaments bilaterally [48]. However, many surgeons utilize 2-3 delayed absorbable sutures which have been shown to offer similar anatomic outcomes while mitigating utilization of permanent material [49]. Once sutures are placed, each end can be placed anteriorly through the pubocervical fascia and posteriorly through the rectovaginal fascia, or brought directly through the anterior and posterior leaflets of the colpotomy. Tying these sutures down simultaneously closes the vaginal cuff and elevates it towards the uterosacral ligaments. Cystoscopy is performed to ensure ureteral patency as the ureters typically lie in close proximity (ventral and ~2 cm lateral) to the uterosacral ligaments and can potentially become injured or kinked by suspension sutures in up to 4.5% of cases [50].

Transvaginal USLS outcomes studies have reported good anatomic and subjective outcomes with apical support restored in over 90% of patients and 13–15% recurrence rates in long-term follow-up [48, 51–53]. In a recent retrospective study, Unger et al. found that 14.4% of patients had POP

recurrence which developed at a mean of 17 months postoperatively [54]. Smith et al. performed a recent retrospective study comparing surgical outcomes for USLS and robotic ASC [55]. They concluded in long-term follow-up (3–7 years) that USLS was noninferior to robotic ASC with no significant difference in objective or subjective outcomes. Complication rates were low; however, mesh-related complications occurred in 6.6% of the robotic ASC group. Abdominal USLS is most commonly performed using minimally invasive techniques (laparoscopic/robotic) and provides a non-mesh alternative to ASC (Fig. 1). Additionally, laparoscopic USLS series have reported lower rates of ureteral injury in comparison with the transvaginal approach [56, 57]. Lavelle et al. recently published their results demonstrating similar recurrence rates for women with stage 2 prolapse undergoing transvaginal or laparoscopic USLS when compared with ASC [58].

Sacrospinous Ligament Fixation

The sacrospinous ligament runs from the ischial spine and medially towards the sacrum and provides a firm structure for vaginal apical suspension. The procedure is most commonly performed in the post-hysterectomy setting using an extraperitoneal approach; however, the ligament can be approached anteriorly as well [59]. Suture placement is directed approximately 2 cm medial to the ischial spine and 0.5 cm below the superior border of the ligament to avoid injury to the nearby sacral nerves and pudendal neurovascular bundle [60••]. Unilateral suture placement on the right sacrospinous ligament is often preferred as the rectum is often in close proximity of desired suture placement; however, this may shift the vaginal axis and predispose the patient to subsequent anterior vaginal wall prolapse. Bilateral SSLF has been described as a way to maintain the vaginal access and in a recent observational study. Mothes et al. reported 94.5% anatomic cure in 110 patients without associated rectal injuries [61]. Immediate complications of SSLF include hemorrhage, rectal injury, and buttock pain. Recent anatomic studies suggest that buttock pain is typically due to entrapment of S3 and S4 fibers supplying the gluteal muscles [62]. Buttock pain is common and typically short lived (4–6 weeks) [63]. Intraoperative administration of long-acting local anesthesia has not been effective in controlling postoperative buttock pain and management consists of nonsteroidal anti-inflammatories (NSAIDs) and supportive pillows [64]. Pain along the sciatic nerve distribution suggests sciatic nerve entrapment and warrants immediate removal of suspension sutures.

Historical series for SSLF report excellent anatomic outcomes and resolution of POP symptoms in 80–100% of patients [65]. In 2014, Svabik et al. reported on a single-center, randomized trial comparing anatomic outcomes for SSLF and synthetic transvaginal mesh repair in women with post-hysterectomy vaginal vault prolapse [66]. At 1-year follow-up, 65% of women in the SSLF group ($n = 34$) demonstrated recurrent prolapse on physical exam and translabial ultrasound. There was no statistically significant difference in subjective outcomes measured by a validated questionnaire (Pelvic Organ Prolapse Distress Inventory); however, 8% of patients in the mesh group experienced mesh erosion.

The OPTIMAL trial provided results of the largest prospective, randomized clinical trial comparing SSLF and USLS approaches for apical POP [67]. Barber and colleagues randomized 374 women with apical prolapse and stress urinary incontinence to transvaginal ULSLS or SSLF. Patients were followed for 2 years and the primary outcome was surgical success defined by anatomic criteria (no apical descent > 1/3 down the vaginal canal and no anterior or posterior compartment prolapse to the hymen), absence of bothersome vaginal bulge symptoms, and retreatment within the follow-up period. After 24 months, there was no significant difference in any of the primary outcomes and surgical success was attained in 64.5% of patients in the USLS arm and 63.1% of SSLF patients. Nearly 15% of patients in the trial had anterior or posterior prolapse (or both) beyond the hymen; however, vaginal bulge symptoms improved in 82% with only 5% electing retreatment with pessary or surgery. Adverse events remained low in both groups (5%). Adverse effects specific to each treatment arm included ureteral obstruction in 3.7% of USLS patients (3.2% noted intraoperatively and 0.5% diagnosed postoperatively) and buttock pain persisting beyond 6 weeks in 4% of SSLF. In a 5-year extension of the trial including 76% of the original cohort, surgical failures

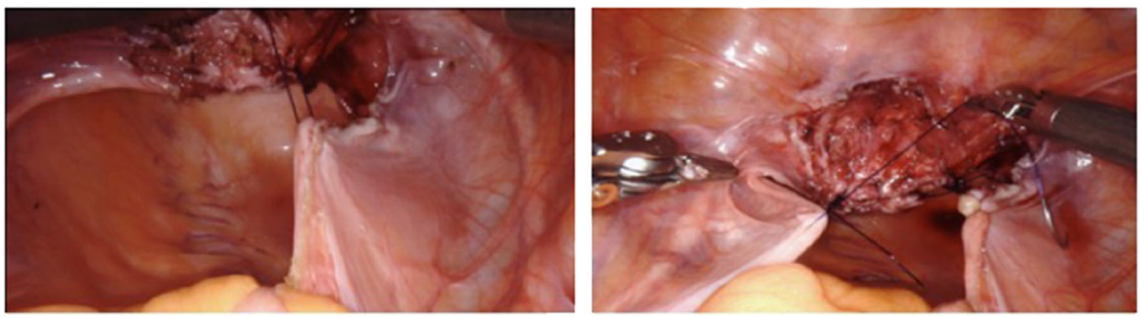

Fig. 1 Robotic uterosacral ligament suspension. This photo demonstrates a transabdominal view of a robotic uterosacral ligament suspension

occurred in 61.5% (USLS) and 70% (SSLF) with no statistically significant difference between the two procedures [68••]. Anatomic failures were noted in 47.5% (USLS) and 61.8% (SSLF) of patients, while bothersome bulge symptoms occurred in 37% (USLS) and 41.8% (SSLF) of patients. Despite the increase in failure rate over time, patients' prolapse symptom scores in the POPDI (Pelvic Organ Prolapse Distress Inventory) remained improved throughout the follow-up period.

Iliococcygeus Suspension

Iliococcygeus suspension is performed by suturing the vaginal apex to the iliococcygeal fascia below the level of the ischial spine. The technique was developed to prevent postoperative cystocele noted with SSLF; however, it can be particularly useful in women with shorter vaginal length or anatomy that is not conducive to performing SSLF safely [69]. Serati et al. reported subjective and objective cure rates of 88% and 84%, respectively, on a cohort of 44 patients who underwent iliococcygeus suspension with long-term follow-up [70]. Other contemporary series have reported comparable results to ASC as well as SSLF [71, 72].

Autologous Fascial Abdominal Sacrocolpopexy

Abdominal sacrocolpopexy utilizing synthetic graft material is associated with high anatomical success rates and the lowest recurrence rates in correcting apical prolapse [47, 73]. In addition to the procedure's morbidity inherent to a transabdominal approach (ileus, small bowel obstruction, etc.), synthetic mesh-specific complications like vaginal mesh erosion may occur in 10.5% of patients with long-term follow-up [74]. Despite a lower incidence of vaginal mesh erosion occurring in 0.7–4.2% of patients in contemporary series, there remains a concern over the utilization of synthetic mesh both by the medical community and by the public. As a result, several surgeons have begun performing ASC utilizing non-synthetic grafts such as autologous fascia (rectus abdominis fascia or fascia lata) and xenografts. Using non-synthetic graft material for ASC may be advantageous as the incidence of graft extrusion remains low and there have been no reported cases of spondylodiscitis [75]. Autologous rectus fascia grafts have been reported to have success in both primary and revision cases [76, 77]. Oliver et al. reported their experience with rectus fascia in a series of 19 patients with prior synthetic mesh ASC [78]. After a median follow-up of 9.9 months, only 2 patients required reoperation for anterior compartment prolapse. Autologous rectus fascia harvest can be performed utilizing the same incision for an open ASC; however, with the increased utilization of laparoscopic/robotic ASC, many contemporary series have focused on autologous fascia lata harvest to avoid an additional abdominal incision. Using autologous fascia lata, Scott et al. performed a robotic ASC in a cohort of 12 patients of which 1 patient had no history of pelvic reconstructive surgery [79]. After a median follow-up of 14.7 months, 3 patients reported symptoms of a vaginal bulge and had recurrent anterior compartment prolapse on examination.

In addition to autologous grafts, the use of porcine xenografts and cadaveric allografts has been utilized for ASC. Altman et al. compared outcomes of a small cohort of patients who underwent ASC with either synthetic mesh grafts or porcine xenografts. With a median follow-up of 2.5 years in the xenograft group and 4.3 years in the synthetic mesh group, they found no significant difference in surgical outcomes and no reoperations for prolapse [80]. In a more contemporary series with a mean follow-up of 21 months, Hijazi et al. reported an 8.3% failure rate when utilizing porcine xenografts for ASC [81]. Tate et al. reported long-term follow-up results of a randomized trial comparing synthetic mesh and cadaveric fascia lata [82]. ASC performed with synthetic mesh was superior in terms of anatomic outcomes; however, both procedures demonstrated over 90% clinical success.

Uterine-Sparing Techniques

Uterine prolapse may also be approached utilizing uterine-sparing techniques for those women who desire to preserve their uterus for various reasons or those that want to preserve fertility. Advocates of uterine-sparing prolapse repairs maintain that the uterus has no active role in prolapse and hysterectomy adds morbidity and operative time [83, 84]. In general, high-quality studies comparing uterine-preserving techniques to traditional prolapse repairs including concomitant hysterectomy have shown similar success rates. Non-synthetic options for uterine-sparing POP repairs include transvaginal sacrospinous or uterosacral hysteropexy. All such procedures can be performed without a concomitant hysterectomy utilizing a similar surgical approach to the traditional procedures done with concomitant hysterectomy [85–87]. Additionally, abdominal uterosacral hysteropexy can be performed laparoscopically or robotically [88]. Recently, Meriwether et al. performed a systematic review and meta-analysis of the literature available for uterine preservation versus hysterectomy for POP repairs [89••]. Additionally, the group added clinical practice guidelines based on their results which included trials utilizing synthetic mesh and native tissue repairs. With regard to non-synthetic prolapse repairs, their study recommendations are summarized in Table 1.

Colpocleisis

Colpocleisis is an obliterative (as opposed to reconstructive) uterine-sparing technique in the management of POP. When the uterus is present, a LeFort colpocleisis is performed by de-

Table 1 Clinical practice guidelines for non-synthetic uterine-sparing prolapse repairs versus non-synthetic prolapse repairs with concomitant hysterectomy (adapted from Meriwether et al.)*

Surgical comparison	Studies included	Grade	Recommendation
Lap hysteropexy vs. lap hysterectomy + lap native tissue repair (USLS)	2 non-randomized comparative trial	2C	Uterine preservation option -Increased risk of recurrence within 2–3 years -Lower operative time, blood loss, pain medication use
Lap USLS (hysteropexy) vs. TVH + USLS (transvaginal)	1 retrospective study	2C	TVH + USLS -Better anatomical success (apex) -Similar reoperation rate for prolapse -Lap USLS had longer postoperative vaginal length
Transvaginal hysteropexy vs. TVH and native tissue repair	4 randomized controlled trials 9 non-randomized comparative trials	2A	Transvaginal hysteropexy -Did not worsen outcomes -Shorter operative time -Less blood loss
Manchester procedure vs. TVH ± USLS or AP repair	1 randomized controlled trial 5 non-randomized comparative trials	2B	Manchester procedure if the surgeon offers this procedure in their practice

*These clinical practice guidelines are only applicable to those women who have no contraindications to uterine-sparing approaches and desire uterine preservation. Surgical plan must be individualized as with any prolapse repair being considered. *Lap* laparoscopic, *TVH* transvaginal hysterectomy, *USLS* uterosacral ligament suspension, *AP* anterior/posterior

epithelializing the anterior and posterior walls of the vagina and suturing them together to the level of the introitus, leaving lateral channels from the cervix to the introitus. As an obliterative procedure, it is only a suitable option for women who no longer desire vaginal intercourse and requires discrete patient selection and counselling. Despite this restriction, most patients report dissatisfaction/regret with postoperative lower urinary tract symptoms rather than regret due to loss of sexual function [90]. The procedure is very effective and anatomic success can be achieved in up to 98% of patients with minimal blood loss and short operative times, thus making it a great option for elderly women [91]. In more a recent multicenter study utilizing the University Health System consortium database, Mueller et al. reported outcomes of 4776 colpocleisis procedures [92]. Overall complication rates were low, with a 6.38% overall complication rate in patients above the age of 80. Colpocleisis is a safe and minimally invasive option with great anatomic outcomes when performed on its own; however, some authors do recommend performing concomitant perineorrhaphy which may contribute to short-term postoperative pain [93].

Posterior Compartment

Posterior compartment prolapse of the vagina may be the result of a rectocele, sigmoidocele, or enterocele. In addition to vaginal bulge symptoms, patients may experience defecatory symptoms including constipation, tenesmus, and incomplete rectal emptying, requiring manual splinting to defecate. Medical management utilizing fiber supplementation and stool softeners may help improve symptoms; however, surgical intervention is required to resolve bulge symptoms as vaginal pessaries are typically not successful. Non-synthetic posterior prolapse repairs are generally categorized into transvaginal rectocele repair and transrectal rectocele repair.

Transvaginal rectocele repair includes the site-specific repair as well as the posterior colporrhaphy (midline plication). For a posterior colporrhaphy, the vaginal epithelium is dissected off the rectovaginal fascia cephalad along the entire length of the vagina. Occasionally, a posterior enterocele can be encountered and repaired at this time by closing the posterior cul-de-sac defect between the cervix or vaginal apex and the rectovaginal fascia. We utilize interrupted 2-0 polyglycolic acid suture to reapproximate the edges of the rectovaginal fascia. The levator muscles can be reapproximated as well in the distal aspect of this compartment if the genital hiatus is widened and can serve as an additional layer of support over the rectovaginal fascial repair. Additionally, a perineorrhaphy can be performed by reapproximating the bulbocavernosus and the transverse perineii muscles to restore the perineal body. The distal-most aspect of the rectocele repair can additionally be sutured to the perineal body as this is a common site of detachment. De novo dyspareunia occurs in approximately 33% of patients undergoing rectocele repair thus is it imperative to avoid aggressive levator plication which can lead to narrowing of the introitus [94]. Native tissue posterior colporrhaphy is successful in eliminating bulge symptoms as well as defecatory symptoms [95, 96]. Schiavi et al. reported 88% objective cure rates after performing posterior colporrhaphy with perineorrhaphy in a cohort of 151 patients

with a median follow-up of 64 months [97]. Postoperatively, they reported complete resolution of vaginal digitation (15% of cohort) and significant improvements in defecatory dysfunction including constipation. Postoperative de novo dyspareunia was low and occurred in 3% of the cohort in long-term follow-up.

Site-specific rectocele repairs are described as one method to avoid postoperative dyspareunia by avoiding overtightening along the entire length of the posterior compartment. Typically, a gloved finger is used to perform a rectal exam and identify the area of defective support in the rectovaginal fascia. Studies for site-specific repair have reported conflicting results in surgical success as well as rates of de novo dyspareunia [98]. Paraiso et al. performed a randomized trial comparing posterior colporrhaphy, site-specific repair, and porcine xenograft site-specific repair [99]. After a 1-year follow-up, anatomic cure rates (defined by Bp point at least 1 cm proximal to hymen) were greatest in patients who underwent posterior colporrhaphy (86%) or site-specific repair (78%), compared with 54% of patients in the porcine xenograft group. There was no difference between the groups in terms of improvement in defecatory and sexual dysfunction; however, there was a higher rate of dyspareunia in the posterior colporrhaphy group compared with site-specific repair (20% vs. 14%).

The transrectal approach for rectocele repair is largely performed by colorectal surgeons and dissection is carried out through the anterior rectal mucosa as opposed to through the vaginal epithelium. By limiting the dissection to the anterior rectal wall, de novo dyspareunia can theoretically be avoided. Despite this important advantage, success rates are inferior to the transvaginal approach with 40–50% of patients experiencing recurrent rectoceles [100, 101].

Conclusion

Native tissue repairs are an increasingly important part of the pelvic surgeon's armamentarium in treating symptomatic pelvic organ prolapse. The negative connotations associated with vaginal mesh have had a significant impact on women and may influence their choice in surgical repair, steering them towards non-synthetic options. Both vaginal and abdominal native tissue repairs have demonstrated successful outcomes in medium-term follow-up studies. Patient selection for various types of prolapse repair should be studied to help determine the best options in women of various ages, lifestyles, and body habitus. Native tissue repairs aim to restore support and function by use of normal anatomic structures; thus, a comprehensive understanding of female pelvic anatomy is the basis for these types of surgical repairs. Uterine-sparing techniques should be considered in younger women and hysterectomy does not necessarily imply better anatomic or symptomatic outcomes according to current studies. Obliterative procedures offer a simpler yet highly effective method of prolapse correction in the appropriately selected woman. As pelvic surgeons treating conditions which affect women's quality of life, bladder and bowel function as well as sexual function, it is imperative that we remain able to offer a variety of surgical options, tailored to the individual woman's needs and lifestyle. Furthermore, we must consider each woman's specific desires and concerns regarding their choice of intervention. Native tissue repairs must remain a part of this discussion.

Compliance with Ethical Standards

Conflict of Interest Ricardo Palmerola and Nirit Rosenblum each declare no potential conflicts of interest.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

References

Papers of particular interest, published recently, have been highlighted as:
- • Of importance
- •• Of major importance

1. Haylen BT, de Ridder D, Freeman RM, Swift SE, Berghmans B, Lee J, et al. An International Urogynecological Association (IUGA)/International Continence Society (ICS) joint report on the terminology for female pelvic floor dysfunction. Neurourol Urodyn. 2010;29(1):4–20.
2. Barber MD, Maher C. Epidemiology and outcome assessment of pelvic organ prolapse. Int Urogynecol J. 2013;24(11):1783–90.
3. Hendrix SL, Clark A, Nygaard I, Aragaki A, Barnabei V, McTiernan A. Pelvic organ prolapse in the Women's Health Initiative: gravity and gravidity. Am J Obstet Gynecol. 2002;186(6):1160–6.
4. Olsen AL, Smith VJ, Bergstrom JO, Colling JC, Clark AL. Epidemiology of surgically managed pelvic organ prolapse and urinary incontinence. Obstet Gynecol. 1997;89(4):501–6.
5. Walker GJ, Gunasekera P. Pelvic organ prolapse and incontinence in developing countries: review of prevalence and risk factors. Int Urogynecol J. 2011;22(2):127–35.
6. Rortveit G, Brown JS, Thom DH, Van Den Eeden SK, Creasman JM, Subak LL. Symptomatic pelvic organ prolapse: prevalence and risk factors in a population-based, racially diverse cohort. Obstet Gynecol. 2007;109(6):1396–403.
7. Tegerstedt G, Maehle-Schmidt M, Nyren O, Hammarstrom M. Prevalence of symptomatic pelvic organ prolapse in a Swedish population. Int Urogynecol J Pelvic Floor Dysfunct. 2005;16(6):497–503.
8. Blomquist JL, Munoz A, Carroll M, Handa VL. Association of delivery mode with pelvic floor disorders after childbirth. JAMA. 2018;320(23):2438–47.

9. Mothes AR, Radosa MP, Altendorf-Hofmann A, Runnebaum IB. Risk index for pelvic organ prolapse based on established individual risk factors. Arch Gynecol Obstet. 2016;293(3):617–24.
10. Vergeldt TF, Weemhoff M, IntHout J, Kluivers KB. Risk factors for pelvic organ prolapse and its recurrence: a systematic review. Int Urogynecol J. 2015;26(11):1559–73.
11. Kapoor DS, Thakar R, Sultan AH, Oliver R. Conservative versus surgical management of prolapse: what dictates patient choice? Int Urogynecol J Pelvic Floor Dysfunct. 2009;20(10):1157–61.
12. Wiegersma M, Panman CM, Kollen BJ, Berger MY, Lisman-Van Leeuwen Y, Dekker JH. Effect of pelvic floor muscle training compared with watchful waiting in older women with symptomatic mild pelvic organ prolapse: randomised controlled trial in primary care. BMJ. 2014;349:g7378.
13. Cheung RY, Lee JH, Lee LL, Chung TK, Chan SS. Vaginal pessary in women with symptomatic pelvic organ prolapse: a randomized controlled trial. Obstet Gynecol. 2016;128(1):73–80.
14. Hagen S, Stark D, Glazener C, Dickson S, Barry S, Elders A, et al. Individualised pelvic floor muscle training in women with pelvic organ prolapse (POPPY): a multicentre randomised controlled trial. Lancet. 2014;383(9919):796–806.
15. Wu JM, Matthews CA, Conover MM, Pate V, Jonsson FM. Lifetime risk of stress urinary incontinence or pelvic organ prolapse surgery. Obstet Gynecol. 2014;123(6):1201–6.
16. Weber AM, Richter HE. Pelvic organ prolapse. Obstet Gynecol. 2005;106(3):615–34.
17. Denman MA, Gregory WT, Boyles SH, Smith V, Edwards SR, Clark AL. Reoperation 10 years after surgically managed pelvic organ prolapse and urinary incontinence. Am J Obstet Gynecol. 2008;198(5):555 e1–5.
18. https://www.fda.gov/medical-devices/implants-and-prosthetics/urogynecologic-surgical-mesh-implants.
19. Clemons JL, Weinstein M, Guess MK, Alperin M, Moalli P, Gregory WT, et al. Impact of the 2011 FDA transvaginal mesh safety update on AUGS members' use of synthetic mesh and biologic grafts in pelvic reconstructive surgery. Female Pelvic Med Reconstr Surg. 2013;19(4):191–8.
20. Siff LN, Barber MD. Native tissue prolapse repairs: comparative effectiveness trials. Obstet Gynecol Clin N Am. 2016;43(1):69–81.
21. Barber MD, Brubaker L, Nygaard I, Wheeler TL 2nd, Schaffer J, Chen Z, et al. Defining success after surgery for pelvic organ prolapse. Obstet Gynecol. 2009;114(3):600–9.
22. Richardson AC, Lyon JB, Williams NL. A new look at pelvic relaxation. Am J Obstet Gynecol. 1976;126(5):568–73.
23. Kelly H. Incontinence of urine in women. Urol Cutan Rev. 1913;17:291–3.
24. Weber AM, Walters MD. Anterior vaginal prolapse: review of anatomy and techniques of surgical repair. Obstet Gynecol. 1997;89(2):311–8.
25. Wein AJ, Kavoussi LR, Partin AW, Peters C, Campbell MF, Walsh PC, et al. Campbell-Walsh urology [text]. Available from: ClinicalKey. http://libproxy.tulane.edu:2048/login?url=https://www.clinicalkey.com/dura/browse/bookChapter/3-s2.0-C20121035874. Accessed 2 June 2019
26. Shippey S, Gutman RE, Quiroz LH, Handa VL. Contemporary approaches to cystocele repair: a survey of AUGS members. J Reprod Med. 2008;53(11):832–6.
27. Shippey SH, Quiroz LH, Sanses TV, Knoepp LR, Cundiff GW, Handa VL. Anatomic outcomes of abdominal sacrocolpopexy with or without paravaginal repair. Int Urogynecol J. 2010;21(3):279–83.
28. Chinthakanan O, Miklos JR, Moore RD. Laparoscopic paravaginal defect repair: surgical technique and a literature review. Surg Technol Int. 2015;27:173–83.
29. Weber AM, Walters MD, Piedmonte MR, Ballard LA. Anterior colporrhaphy: a randomized trial of three surgical techniques. Am J Obstet Gynecol. 2001;185(6):1299–304 discussion 304-6.
30. Altman D, Vayrynen T, Engh ME, Axelsen S, Falconer C. Nordic Transvaginal Mesh G. Anterior colporrhaphy versus transvaginal mesh for pelvic-organ prolapse. N Engl J Med. 2011;364(19):1826–36.
31. Sand PK, Koduri S, Lobel RW, Winkler HA, Tomezsko J, Culligan PJ, et al. Prospective randomized trial of polyglactin 910 mesh to prevent recurrence of cystoceles and rectoceles. Am J Obstet Gynecol. 2001;184(7):1357–62 discussion 62-4.
32. Bergman I, Soderberg MW, Kjaeldgaard A, Ek M. Does the choice of suture material matter in anterior and posterior colporrhaphy? Int Urogynecol J. 2016;27(9):1357–65.
33. Song HS, Choo GY, Jin LH, Yoon SM, Lee T. Transvaginal cystocele repair by purse-string technique reinforced with three simple sutures: surgical technique and results. Int Neurourol J. 2012;16(3):144–8.
34. Baden WF, Walker TA. Genesis of the vaginal profile: a correlated classification of vaginal relaxation. Clin Obstet Gynecol. 1972;15(4):1048–54.
35. Vigil HR, Mallick R, Nitti VW, Lavallee LT, Breau RH, Hickling DR. Risk factors for urinary tract infection following mid urethral sling surgery. J Urol. 2017;197(5):1268–73.
36. Lowder JL, Park AJ, Ellison R, Ghetti C, Moalli P, Zyczynski H, et al. The role of apical vaginal support in the appearance of anterior and posterior vaginal prolapse. Obstet Gynecol. 2008;111(1):152–7.
37. Eilber KS, Alperin M, Khan A, Wu N, Pashos CL, Clemens JQ, et al. Outcomes of vaginal prolapse surgery among female Medicare beneficiaries: the role of apical support. Obstet Gynecol. 2013;122(5):981–7.
38. Hosni MM, El-Feky AE, Agur WI, Khater EM. Evaluation of three different surgical approaches in repairing paravaginal support defects: a comparative trial. Arch Gynecol Obstet. 2013;288(6):1341–8.
39. Duraisamy KY, Balasubramaniam D, Kakollu A, Chinnusamy P, Periyasamy K. A prospective study of minimally invasive paravaginal repair of cystocele and associated pelvic floor defects: our experience. J Obstet Gynaecol India. 2019;69(1):82–8.
40. JC Winters AS, R Krlin. Vaginal and abdominal reconstructive surgery for pelvic organ prolapse. In: AJ Wein LK, A Partin, C Peters, editors. Campbell-Walsh Urology. 11th edn. Philadelphia: Elsevier; 2016. p. 1939–86.e6.
41. Cormio L, Mancini V, Liuzzi G, Lucarelli G, Carrieri G. Cystocele repair by autologous rectus fascia graft: the pubovaginal cystocele sling. J Urol. 2015;194(3):721–7.
42. Maher C, Feiner B, Baessler K, Christmann-Schmid C, Haya N, Marjoribanks J. Transvaginal mesh or grafts compared with native tissue repair for vaginal prolapse. Cochrane Database Syst Rev. 2016;2:CD012079.
43.• Glazener CM, Breeman S, Elders A, Hemming C, Cooper KG, Freeman RM, et al. Mesh, graft, or standard repair for women having primary transvaginal anterior or posterior compartment prolapse surgery: two parallel-group, multicentre, randomised, controlled trials (PROSPECT). Lancet. 2017;389(10067):381–92. **Provided further high-quality evidence demonstrating no added benefit to utilization of transvaginal mesh.**
44. Abrams P, Cardozo L, Fall M, Griffiths D, Rosier P, Ulmsten U, et al. The standardisation of terminology of lower urinary tract function: report from the standardisation sub-committee of the International Continence Society. Neurourol Urodyn. 2002;21(2):167–78.
45. Uzoma A, Farag KA. Vaginal vault prolapse. Obstet Gynecol Int. 2009;2009:275621.

46. Summers A, Winkel LA, Hussain HK, DeLancey JO. The relationship between anterior and apical compartment support. Am J Obstet Gynecol. 2006;194(5):1438–43.
47. Siddiqui NY, Grimes CL, Casiano ER, Abed HT, Jeppson PC, Olivera CK, et al. Mesh sacrocolpopexy compared with native tissue vaginal repair: a systematic review and meta-analysis. Obstet Gynecol. 2015;125(1):44–55.
48. Shull BL, Bachofen C, Coates KW, Kuehl TJ. A transvaginal approach to repair of apical and other associated sites of pelvic organ prolapse with uterosacral ligaments. Am J Obstet Gynecol. 2000;183(6):1365–73 discussion 73-4.
49. Bradley MS, Bickhaus JA, Amundsen CL, Newcomb LK, Truong T, Weidner AC, et al. Vaginal uterosacral ligament suspension: a retrospective cohort of absorbable and permanent suture groups. Female Pelvic Med Reconstr Surg. 2018;24(3):207–12.
50. Unger CA, Walters MD, Ridgeway B, Jelovsek JE, Barber MD, Paraiso MF. Incidence of adverse events after uterosacral colpopexy for uterovaginal and posthysterectomy vault prolapse. Am J Obstet Gynecol. 2015;212(5):603 e1–7.
51. Silva WA, Pauls RN, Segal JL, Rooney CM, Kleeman SD, Karram MM. Uterosacral ligament vault suspension: five-year outcomes. Obstet Gynecol. 2006;108(2):255–63.
52. Milani R, Frigerio M, Cola A, Beretta C, Spelzini F, Manodoro S. Outcomes of transvaginal high uterosacral ligaments suspension: over 500-patient single-center study. Female Pelvic Med Reconstr Surg. 2018;24(1):39–42.
53. Cardozo L, Hessdorfer E, Milani R, Arano P, Dewilde L, Slack M, et al. Solifenacin in the treatment of urgency and other symptoms of overactive bladder: results from a randomized, double-blind, placebo-controlled, rising-dose trial. BJU Int. 2008;102(9):1120–7.
54. Unger CA, Barber MD, Walters MD, Paraiso MFR, Ridgeway B, Jelovsek JE. Long-term effectiveness of uterosacral colpopexy and minimally invasive sacral colpopexy for treatment of pelvic organ prolapse. Female Pelvic Med Reconstr Surg. 2017;23(3):188–94.
55. Smith BC, Crisp CC, Kleeman SD, Yook E, Pauls RN. Uterosacral ligament suspension versus robotic sacrocolpopexy for treatment of apical pelvic organ prolapse. Female Pelvic Med Reconstr Surg. 2019;25(2):93–8.
56. Turner LC, Lavelle ES, Shepherd JP. Comparison of complications and prolapse recurrence between laparoscopic and vaginal uterosacral ligament suspension for the treatment of vaginal prolapse. Int Urogynecol J. 2016;27(5):797–803.
57. Barbier HM, Smith MZ, Eto CU, Welgoss JA, Von Pechmann W, Horbach N, et al. Ureteral compromise in laparoscopic versus vaginal uterosacral ligament suspension: a retrospective cohort. Female Pelvic Med Reconstr Surg. 2015;21(6):363–8.
58. Lavelle ES, Giugale LE, Winger DG, Wang L, Carter-Brooks CM, Shepherd JP. Prolapse recurrence following sacrocolpopexy vs uterosacral ligament suspension: a comparison stratified by Pelvic Organ Prolapse Quantification stage. Am J Obstet Gynecol. 2018;218(1):116 e1–5.
59. Cespedes RD. Anterior approach bilateral sacrospinous ligament fixation for vaginal vault prolapse. Urology. 2000;56(6 Suppl 1):70–5.
60.•• Katrikh AZ, Ettarh R, Kahn MA. Cadaveric nerve and artery proximity to sacrospinous ligament fixation sutures placed by a suture-capturing device. Obstet Gynecol. 2017;130(5):1033–8. **Provided a detailed description of sacrospinous ligament anatomy and surrounding structures important to surgical anatomy.**
61. Mothes AR, Wanzke L, Radosa MP, Runnebaum IB. Bilateral minimal tension sacrospinous fixation in pelvic organ prolapse: an observational study. Eur J Obstet Gynecol Reprod Biol. 2015;188:1–5.
62. Florian-Rodriguez ME, Hare A, Chin K, Phelan JN, Ripperda CM, Corton MM. Inferior gluteal and other nerves associated with sacrospinous ligament: a cadaver study. Am J Obstet Gynecol. 2016;215(5):646 e1–6.
63. Unger CA, Walters MD. Gluteal and posterior thigh pain in the postoperative period and the need for intervention after sacrospinous ligament colpopexy. Female Pelvic Med Reconstr Surg. 2014;20(4):208–11.
64. Propst K, O'Sullivan DM, Steinberg AC. Randomized double-blind trial of short- versus long-acting analgesia at the sacrospinous ligament. Int Urogynecol J. 2019;30(1):123–30.
65. Morgan DM, Larson K. Uterosacral and sacrospinous ligament suspension for restoration of apical vaginal support. Clin Obstet Gynecol. 2010;53(1):72–85.
66. Svabik K, Martan A, Masata J, El-Haddad R, Hubka P. Comparison of vaginal mesh repair with sacrospinous vaginal colpopexy in the management of vaginal vault prolapse after hysterectomy in patients with levator ani avulsion: a randomized controlled trial. Ultrasound Obstet Gynecol. 2014;43(4):365–71.
67. Barber MD, Brubaker L, Burgio KL, Richter HE, Nygaard I, Weidner AC, et al. Comparison of 2 transvaginal surgical approaches and perioperative behavioral therapy for apical vaginal prolapse: the OPTIMAL randomized trial. JAMA. 2014;311(10):1023–34.
68.•• Jelovsek JE, Barber MD, Brubaker L, Norton P, Gantz M, Richter HE, et al. Effect of uterosacral ligament suspension vs sacrospinous ligament fixation with or without perioperative behavioral therapy for pelvic organ vaginal prolapse on surgical outcomes and prolapse symptoms at 5 years in the OPTIMAL randomized clinical trial. JAMA. 2018;319(15):1554–65. **Provided long-term results on OPTIMAL trial demonstrating no difference in efficacy between USLS and SSLF.**
69. Shull BL. Pelvic organ prolapse: anterior, superior, and posterior vaginal segment defects. Am J Obstet Gynecol. 1999;181(1):6–11.
70. Serati M, Braga A, Bogani G, Leone Roberti Maggiore U, Sorice P, Ghezzi F, et al. Iliococcygeus fixation for the treatment of apical vaginal prolapse: efficacy and safety at 5 years of follow-up. Int Urogynecol J. 2015;26(7):1007–12.
71. Biler A, Ertas IE, Tosun G, Hortu I, Demir A, Taner CE, et al. Perioperative complications and short-term outcomes of abdominal sacrocolpopexy, laparoscopic sacrocolpopexy, sacrospinous ligament fixation, and iliococcygeus fixation procedures. Turk J Med Sci. 2018;48(3):602–10.
72. Milani R, Cesana MC, Spelzini F, Sicuri M, Manodoro S, Fruscio R. Iliococcygeus fixation or abdominal sacral colpopexy for the treatment of vaginal vault prolapse: a retrospective cohort study. Int Urogynecol J. 2014;25(2):279–84.
73. Maher C, Feiner B, Baessler K, Schmid C. Surgical management of pelvic organ prolapse in women. Cochrane Database Syst Rev. 2013;4:CD004014.
74. Nygaard I, Brubaker L, Zyczynski HM, Cundiff G, Richter H, Gantz M, et al. Long-term outcomes following abdominal sacrocolpopexy for pelvic organ prolapse. JAMA. 2013;309(19):2016–24.
75. Abraham N, Quirouet A, Goldman HB. Transabdominal sacrocolpopexy with autologous rectus fascia graft. Int Urogynecol J. 2016;27(8):1273–5.
76. Quiroz LH, Gutman RE, Shippey S, Cundiff GW, Sanses T, Blomquist JL, et al. Abdominal sacrocolpopexy: anatomic outcomes and complications with Pelvicol, autologous and synthetic graft materials. Am J Obstet Gynecol. 2008;198(5):557 e1–5.
77. Mahendru R. Rectus fascia colpopexy for post-hysterectomy vault prolapse: a valid option. J Turk Ger Gynecol Assoc. 2010;11(2):69–72.

78. Oliver JL, Chaudhry ZQ, Medendorp AR, Wood LN, Baxter ZC, Kim JH, et al. Complete excision of sacrocolpopexy mesh with autologous fascia sacrocolpopexy. Urology. 2017;106:65–9.
79. Scott VCS, Oliver JL, Raz S, Kim JH. Robot-assisted laparoscopic sacrocolpopexy with autologous fascia lata: technique and initial outcomes. Int Urogynecol J. 2019. https://doi.org/10.1007/s00192-019-03884-2.
80. Altman D, Anzen B, Brismar S, Lopez A, Zetterstrom J. Long-term outcome of abdominal sacrocolpopexy using xenograft compared with synthetic mesh. Urology. 2006;67(4):719–24.
81. Hijazi S, Echtle D, Aboumarzouk OM, Heinrich E. Abdominal sacrocolpopexy with Pelvicol xenograft and concomitant Burch colposuspension. Int J Women's Health. 2017;9:625–30.
82. Tate SB, Blackwell L, Lorenz DJ, Steptoe MM, Culligan PJ. Randomized trial of fascia lata and polypropylene mesh for abdominal sacrocolpopexy: 5-year follow-up. Int Urogynecol J. 2011;22(2):137–43.
83. Ridgeway BM. Does prolapse equal hysterectomy? The role of uterine conservation in women with uterovaginal prolapse. Am J Obstet Gynecol. 2015;213(6):802–9.
84. Farthmann J, Watermann D, Erbes T, Roth K, Nanovska P, Gitsch G, et al. Functional outcome after pelvic floor reconstructive surgery with or without concomitant hysterectomy. Arch Gynecol Obstet. 2015;291(3):573–7.
85. Romanzi LJ, Tyagi R. Hysteropexy compared to hysterectomy for uterine prolapse surgery: does durability differ? Int Urogynecol J. 2012;23(5):625–31.
86. Hefni MA, El-Toukhy TA. Long-term outcome of vaginal sacrospinous colpopexy for marked uterovaginal and vault prolapse. Eur J Obstet Gynecol Reprod Biol. 2006;127(2):257–63.
87. Carey MP, Slack MC. Transvaginal sacrospinous colpopexy for vault and marked uterovaginal prolapse. Br J Obstet Gynaecol. 1994;101(6):536–40.
88. Haj-Yahya R, Chill HH, Levin G, Reuveni-Salzman A, Shveiky D. Laparoscopic uterosacral ligament hysteropexy vs total vaginal hysterectomy with uterosacral ligament suspension for anterior and apical prolapse: surgical outcome and patient satisfaction. J Minim Invasive Gyne col. 2019. https://doi.org/10.1016/j.jmig.2019.02.012.
89.•• Meriwether KV, Antosh DD, Olivera CK, Kim-Fine S, Balk EM, Murphy M, et al. Uterine preservation vs hysterectomy in pelvic organ prolapse surgery: a systematic review with meta-analysis and clinical practice guidelines. Am J Obstet Gynecol. 2018;219(2):129–46 e2. **Provided clinical practice guidelines for uterine-sparing pelvic organ prolapse repairs based on review of clinical trials performed.**
90. Crisp CC, Book NM, Cunkelman JA, Tieu AL, Pauls RN, Society of Gynecologic Surgeons' Fellows' Pelvic Research N. Body image, regret, and satisfaction 24 weeks after colpocleisis: a multicenter study. Female Pelvic Med Reconstr Surg. 2016;22(3):132–5.
91. Zebede S, Smith AL, Plowright LN, Hegde A, Aguilar VC, Davila GW. Obliterative LeFort colpocleisis in a large group of elderly women. Obstet Gynecol. 2013;121(2 Pt 1):279–84.
92. Mueller MG, Ellimootil C, Abernethy MG, Mueller ER, Hohmann S, Kenton K. Colpocleisis: a safe, minimally invasive option for pelvic organ prolapse. Female Pelvic Med Reconstr Surg. 2015;21(1):30–3.
93. Krissi H, Aviram A, Eitan R, From A, Wiznitzer A, Peled Y. Risk factors for recurrence after Le Fort colpocleisis for severe pelvic organ prolapse in elderly women. Int J Surg. 2015;20:75–9.
94. Madsen LD, Nussler E, Kesmodel US, Greisen S, Bek KM, Glavind-Kristensen M. Native-tissue repair of isolated primary rectocele compared with nonabsorbable mesh: patient-reported outcomes. Int Urogynecol J. 2017;28(1):49–57.
95. Mellgren A, Anzen B, Nilsson BY, Johansson C, Dolk A, Gillgren P, et al. Results of rectocele repair. A prospective study. Dis Colon Rectum. 1995;38(1):7–13.
96. Grimes CL, Tan-Kim J, Whitcomb EL, Lukacz ES, Menefee SA. Long-term outcomes after native tissue vs. biological graft-augmented repair in the posterior compartment. Int Urogynecol J. 2012;23(5):597–604.
97. Schiavi MC, D'Oria O, Faiano P, Prata G, Di Pinto A, Sciuga V, et al. Vaginal native tissue repair for posterior compartment prolapse: long-term analysis of sexual function and quality of life in 151 patients. Female Pelvic Med Reconstr Surg. 2018;24(6):419–23.
98. Abramov Y, Gandhi S, Goldberg RP, Botros SM, Kwon C, Sand PK. Site-specific rectocele repair compared with standard posterior colporrhaphy. Obstet Gynecol. 2005;105(2):314–8.
99. Paraiso MF, Barber MD, Muir TW, Walters MD. Rectocele repair: a randomized trial of three surgical techniques including graft augmentation. Am J Obstet Gynecol. 2006;195(6):1762–71.
100. Roman H, Michot F. Long-term outcomes of transanal rectocele repair. Dis Colon Rectum. 2005;48(3):510–7.
101. Nieminen K, Hiltunen KM, Laitinen J, Oksala J, Heinonen PK. Transanal or vaginal approach to rectocele repair: a prospective, randomized pilot study. Dis Colon Rectum. 2004;47(10):1636–42.