Management of the Exposed or Perforated Midurethral Sling

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INTRODUCTION

Stress urinary incontinence (SUI) is a common condition that affects close to one-third of all adult women in the United States and when untreated is associated with depression, anxiety, social isolation, and decreased quality of life. The cause of SUI has been attributed to intrinsic sphincter deficiency and/or hypermobility of the urethra, with contributing factors such as parity, body mass index, tobacco use, and collagen disorders. Patients with symptomatic SUI have several choices regarding treatment options, ranging from noninvasive to surgical interventions. For those considering surgical intervention, level A evidence supports treatments such as synthetic midurethral sling (MUS), autologous fascia pubovaginal sling, Burch colposuspension, and urethral bulking agents. Historically, autologous fascial pubovaginal slings and Burch colposuspension were the surgeries of choice for SUI. The synthetic MUS was introduced in 1995, and as a minimally invasive technique, it eventually became the most popular option for treatment of SUI, stress predominant urinary incontinence, and occult SUI associated with pelvic organ prolapse. The principles of all synthetic MUSs are similar, which involves transvaginal placement of a small piece of mesh at the midurethral position in a tension-free fashion. The MUS can be placed retropubically, either top-down or bottom-up, or via an inside-out or outside-in transobturator (TO) approach. Techniques and choice of manufacturer are typically

KEYWORDS
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KEY POINTS
• Evolution of mesh midurethral slings as the gold standard for treatment of stress urinary incontinence has led to an increased incidence of mesh-related complications, including an approximate 2% risk of mesh exposure.
• Risk factors for mesh exposure or perforation include comorbidities and behaviors associated with poor wound healing, including diabetes, smoking, nutritional deficiency, and advanced age, as well as intraoperative factors, such as bleeding/hematoma formation and trocar perforation.
• Diagnosis of mesh exposure or perforation requires focused history taking, pelvic examination with half speculum and careful palpation, and in certain situations, cystourethroscopy, vaginoscopy, and/or translabial/vaginal ultrasound.
• For small mesh exposures with minimal symptoms, less-invasive management options may be offered.
• For symptomatic or large mesh exposure, treatment options are typically more invasive.
based on surgeon preference or training, although recent 5-year longitudinal data from the TOMUS trial comparing retropubic (RP) to TO MUSs show increased success rates in patients who underwent an RP MUS. Although the utilization of synthetic mesh has offered a reliable, efficacious long-term treatment option for SUI, its use has also introduced novel mesh-related complications. Two of the most common complications include pain and “mesh erosion,” a catch-all description that is defined in later discussion.

Recent focus has therefore been drawn to the use of synthetic mesh materials, particularly in its transvaginal use for MUSs and its associated complications. In response to this, the Food and Drug Administration conducted a systematic review in 2011 of all published literature from 1996 to 2011 and concluded that the rate of mesh erosion through the vagina is 2% at 1 year following surgery and that the safety and effectiveness at 1 year after MUS is well established. Based on this report, the Society of Urodynamics, Female Pelvic Medicine and Urogenital Reconstruction (SUFU) and the American Urogynecologic Society (AUGS) published a joint position statement stating that “polypropylene mesh midurethral slings are a standard of care for the surgical treatment of SUI,” which is also repeated and supported by the European Commission enquiry.

Despite its level A evidence and recommendations for use by the major American and European Gynecologic and Urologic associations, the use of transvaginal synthetic mesh for SUI is not without risk. To better classify the various mesh complications, the International Urogynecological Association and the International Continence Society published a joint classification to standardize the terminology and complications related to mesh-related surgery. This language has largely been used in the literature since its publication. They emphasize the avoidance of the term mesh “erosion” due to the implication that the mesh inherently wears away through adjacent tissue. Instead, a mesh “exposure” is described as the ability to identify vaginal mesh, either visibly or by palpation at the surgical incision site. Alternatively, an “extrusion” is the passage directly out of a body structure or tissue and represents a delayed process whereby mesh gradually passes through the vaginal wall. A “perforation” represents a delayed event of mesh entering a viscus organ, such as the urethra, bladder, or bowel. For simplicity and standardization within this article, the term mesh exposure describes visible or palpable mesh at the incision site or vaginal wall. Perforation will continue to be used as defined above, but may also describe an intraoperative event, such as trocar injury through the vaginal mucosa or lower urinary tract.

As the synthetic MUS will likely remain the gold-standard treatment of SUI with continued risk of mesh complications, this article focuses on the preoperative, perioperative, and postoperative factors that may influence mesh exposure or perforation due to MUS placement. Typical patient presentation, recommended evaluation for diagnosis, as well as treatment options for mesh complications are also discussed.

PREVALENCE OF MESH EXPOSURE AND PERFORATION

It has been estimated that more than 3 million synthetic MUSs have been placed for treatment of SUI since they were introduced. Synthetic grafts are produced with some degree of variance by different manufacturers, but all synthetic slings currently in use are composed of large-pore monofilament polypropylene mesh, also known as a type 1 mesh. Because this mesh is commonly used in general surgery and in hernia repairs, much of the research on the safety and efficacy of the human use of synthetic mesh comes from literature published in this area. The ideal mesh material is porous enough to allow for adequate tissue ingrowth. It should be permanent, nonabsorbable, inert, and resistant to infection and have the ability to completely incorporate into the host tissue.

Despite this ideal material, the rate of mesh sling exposure, as discussed above, occurs in approximately 2% of sling placements, with a range in the literature from 0% to 8.1%. A 2017 Cochrane Review of MUS operations in women for SUI reported the overall rate of erosion/exposure/ extrusion to be 24/1000 with a TO approach versus 21/1000 for a RP approach. Older slings, which were not as porous as type 1 mesh and did not allow for adequate tissue ingrowth, such as the Obtape and Uratape, have been known to have a higher rate of exposure and are no longer in use.

PREOPERATIVE CONSIDERATIONS AND PATIENT FACTORS CONTRIBUTING TO MESH EXPOSURE AND PERFORATION

While evaluating whether a patient is a good candidate for synthetic MUS placement, there are many preoperative factors to consider that may influence surgical outcomes. Various retrospective reviews have been performed in women who have had vaginal mesh exposures in an effort to determine preoperative risk factors that may increase a patient’s likelihood of such an event occurring. In general, risk factors for mesh exposure or perforation
include comorbidities and behaviors associated with poor wound healing, including diabetes, smoking, nutritional deficiency, and advanced age as well as intraoperative factors, such as bleeding/hematoma formation and trocar perforation.

Linder and colleagues performed a case-control study of 2123 women who underwent MUS sling placement and then identified predictive clinical risk factors of the 1.3% necessitating surgical repair for mesh exposure. They found that previous bariatric surgery and preoperative hemoglobin (<13 g/dL), premenopausal status, and age less than 50 were all significant risk factors for postoperative mesh exposure. The association with bariatric surgery and anemia may be suggestive of poor nutritional state. Complications from a younger, premenopausal cohort may be secondary to increased periurethral vascularity and risk of bleeding/hematoma formation intraoperatively, being sexually active with increased likelihood of mesh exposure becoming symptomatic, as well as likelihood to have more invasive surgery than an older cohort.

Another case control study by Kolkani and colleagues demonstrated in a multivariate analysis of their study population that older age, diabetes mellitus, current smoking, length of vaginal incision greater than 2 cm, recurrent vaginal incision for postoperative complications, and previous pelvic organ prolapse or incontinence surgery were independent risk factors for mesh exposure. Unlike the previous study, older age was found to be a contributing risk factor, likely due to increased comorbidities in this population, including vaginal atrophy.

Vaginal atrophy is typically seen in the postmenopausal state and advanced age. Atrophy is manifested by thin, poorly perfused tissue that in theory may increase the likelihood of postoperative mesh exposure. Topical vaginal estrogen is known to accelerate reepithelialization and stimulate angiogenesis and wound contraction. Therefore, some surgeons anecdotally pretreat patients with vaginal atrophy before performing surgery for incontinence, although there are few studies that evaluate vaginal estrogen on perioperative outcome. A report by the Society of Gynecologic Surgeons Systematic Review Group assessed the literature on vaginal estrogen and the management of pelvic floor disorders in postmenopausal women and determined no studies were powered to determine the effect of postoperative vaginal estrogen on surgical complications.

In another retrospective review, Osborn and colleagues noted an increased association of mesh perforation in patients with a trocar injury, bleeding complications, and diabetes and a decreased risk of mesh perforation of the bladder or urethra in those with an increased body mass index. It is postulated that increased perivesical fat deposition separates the bladder from the pubic symphysis, allowing space for passage of trocars without injury.

Appropriate preoperative counseling of increased risk of mesh complication would therefore be appropriate for patients with diabetes, active smokers, and patients with deficient nutritional status. The 2017 AUA/SUFU Guidelines on Surgical Treatment of SUI also emphasize proper healing of vaginal epithelium to prevent mesh exposures. Patients at risk for poor healing include those with scar tissue from previous pelvic surgery, history of pelvic radiation therapy, severe atrophy, as well as chronic states such as immunosuppression, collagen, and autoimmune disorders. If patients with these risk factors or comorbidities are seeking surgical intervention, care must be taken to discuss chance of complications and alternatives to synthetic mesh.

PERIOPERATIVE CONSIDERATIONS AND TECHNICAL FACTORS CONTRIBUTING TO MESH EXPOSURE AND PERFORATION

Most intraoperative complications are due to injury of adjacent structures either during the dissection to place the trocar or during trocar passage. Bleeding and/or hematoma formation secondary to vascular injury is common. Although not uncommon due to the nature of the procedure, and typically only a complication if unrecognized, vaginal skin, bladder, and urethral perforation not addressed during time of surgery may also lead to postoperative complications. Patient positioning, hydrodissection, and vigilant inspection for mesh exposure or perforation at time of surgery are key technical factors to minimizing immediate as well as delayed mesh complications.

Patient positioning is an often underestimated factor in minimizing surgical complications. The patient is typically placed in the dorsal lithotomy position with the table in the Trendelenburg position to help bowel fall out of the way of trocar trajectory, with legs padded carefully to prevent neuropraxia.

Hydrodissection may also be used throughout the case to minimize injury to adjacent tissue. RP hydrodissection is a technique used in placement of top-down or bottom-up MUS to minimize chance of bladder perforation. A spinal needle is used to inject dilute local anesthesia posterior to the pubic symphysis and lateral to the bladder, and in doing so, displaces the bladder away from the pelvic sidewall allowing a wider space for unobstructed trocar passage. Vaginal wall hydrodissection with local anesthesia plus epinephrine into the submucosa at the level of the midurethra is also used to...
find the optimal plane for dissection between the vaginal wall and periurethral fascia.\textsuperscript{18} Blanching of vaginal mucosa with injection suggests a superficial plane, whereas no evidence of distension suggests injection might be too deep. Extending hydrodissection toward bilateral vaginal sulci also allows the vaginal skin to be elevated off the pelvic bone.

Bladder perforation with trocar placement is more common with RP sling placement, and there are various techniques to minimize the chance of perforation depending on the surgical technique. To decrease trocar perforation when placing a tension-free vaginal tape using bottom-up RP approach, it is recommended to use a catheter with stylet or cystoscope sheath to deviate the bladder neck to the opposite side of trocar placement.\textsuperscript{19} In a top-down RP approach, many surgeons have found that taking care to place the trocar in close proximity to the pubic symphysis while maintaining fingertip control of the trocar during its entry into the periurethral space can minimize the incidence of bladder perforation with the trocar.

Vigilant inspection for mesh complications begins with careful vaginal palpation and cystoscopy after trocar passage. Inspection of the anterior vaginal wall is crucial to rule out a buttonhole injury. If the trocar passes through the vaginal skin, remove the trocar, form a new, slightly deeper passage, repass the trocar, and close the vaginal defect with a 3-0 absorbable suture. Missing a vaginal skin injury will lead to mesh exposure, which may not be noted until follow-up.

Cystoscopy should be performed with a 70° lens to rule out trocar perforation. Recognition of trocar perforation intraoperatively is imperative. The bladder should be fully distended because folds in the mucosa of an underfilled bladder may impair visualization of an injury. Drainage of cystoscopic irrigation emanating from the suprapubic trocar sites is also a sign of bladder perforation. If a perforation is noted, the trocar should be removed and placed again. A Foley catheter may be placed at the surgeon’s discretion. Perforation into the urethra calls for delay of synthetic sling placement at a future time and management of the urethra, with either Foley placement or urethral repair depending on the degree of laceration.

Placement of a TO versus RP MUS sling may also influence the eventual location of delayed mesh exposure due to the differences in trocar trajectory. The TO approach is often noted to have a higher chance of exposure at the fornix because the vaginal skin is thinner at that location, predisposing the chance of buttonhole injury or a delayed extrusion. The TOMUS trial reported iatrogenic vaginal wall injury with trocar passage noted at time of surgery to occur 4.4% of the time with TO slings compared with 2.3% with RP slings. Rate of mesh exposure upon postoperative follow-up was more likely with TO slings (1.3%) compared with RP slings (0.7%).\textsuperscript{20}

As noted above, vascular injury and subsequent bleeding and hematoma are not uncommon in sling placement. Vascularity is increased closer to the periurethral fascia, and deep dissection while creating vaginal tunnels may lead to bleeding and subsequent hematoma formation. Trocar passage through the endopelvic fascia may also disrupt vasculature and cause significant bleeding at the vaginal tunnels. Most bleeding is self-limited and will stop once the incision is closed. Vascular packing may also be placed after closure of the incision. Closure should be performed with an interlocking suture to increase hemostasis along the incision. Recognition and response to bleeding are important because formation of a hematoma behind the vaginal mucosal closure may create pressure along the suture line and may contribute to dehiscence, tissue breakdown, and eventual mesh exposure.

**POSTOPERATIVE CONSIDERATIONS FOR SYNTHETIC MESH MIDURETHRAL SLING SURGERY**

The AUA guidelines for surgical treatment of female SUI recommend patients be seen and examined within 6 months of their surgery and that a physical examination, with attention to incisional sites and evaluation for healing, tenderness, mesh exposure, and other abnormalities, should be performed.\textsuperscript{17} Although surgeon preference dictates follow-up further than 6 months after surgery, the authors believe the patient should be counseled and knowledgeable of common presentations for mesh complications so that they can return to the office for complete evaluation should any of these signs or symptoms occur.

**PATIENT PRESENTATION WITH MESH EXPOSURE AND PERFORATION**

Although there are many symptoms associated with vaginal mesh erosion, it is not uncommon that patients may be asymptomatic with a diagnosis made only upon physical examination. Regardless, a focused history should be obtained from the patient detailing the most common presenting symptoms of exposed mesh, including vaginal discharge or bleeding, dyspareunia, pelvic/groin pain, palpated mesh on self-examination, voiding dysfunction, and urinary tract infections as well as the timing/onset of any of these symptoms.
A retrospective review of patients who underwent surgical removal of a sling due to mesh-related complications revealed that vaginal pain was the most common reason for sling removal. Patients who underwent TO sling placement were more likely to complain of groin pain, whereas those who underwent RP sling reported suprapubic pain. Partner pain during intercourse, also termed “hispareunia,” may be present and may be an initial indication of sling exposure when the patient is otherwise asymptomatic.

Wang and colleagues also suggest that presenting symptoms of mesh complications evolve over time. Within their cohort of 278 patients, the mean number of presenting symptoms per patient was 3.8 ± 1.4 and increased significantly in relation to time since MUS placement. There was a higher rate of pain complaints in those presenting within 2 years of surgery and a higher rate of recurrent urinary tract infections and urinary incontinence in the later groups.

In addition to the symptoms noted above for vaginal mesh exposure, symptoms associated with mesh perforation into the bladder, urethra, or bowel/rectum vary and may include hematuria, recurrent urinary tract infections, dysuria, weak stream, urinary retention, irritative voiding, constant urinary or fecal drainage secondary to fistula, suprapubic pain, urethral pain, rectal pain, and fecal urgency or incontinence. Therefore, it is imperative to always suspect and evaluate for a possible mesh exposure or complication when a patient presents with new symptoms, even if it is remote from their initial MUS procedure.

EVALUATION AND DIAGNOSIS OF MESH EXPOSURE AND PERFORATION

Previous operative reports should be requested before consultation or planned surgical intervention. Pelvic examination is performed with a half speculum and appropriate lighting. Inspection might reveal findings ranging from small areas of granular tissue to visible mesh through the vaginal skin (Fig. 1). Careful palpation should be used to try to identify the entire course of the sling. Vaginoscopy with a cystoscope should be considered if a patient cannot tolerate a thorough examination with a speculum due to pain, or in select cases if the sling cannot be visualized but is palpable. Based on patient presentation and history, a cystouretroscopy may also be performed, especially when a bladder or urethral perforation is suspected (Figs. 2 and 3).

Although sling exposure into the vagina is often easily assessed during physical examination, and sling perforation is typically visualized on cystourethroscopy, there are instances whereby the degree of mesh complication is more subtle. A synthetic MUS appears as an easily visualized echogenic structure on ultrasound, which can be imaged by transvaginal, translabial, or introital approaches. Recent literature suggests 2-dimensional and 3-dimensional imaging may be used to allow dynamic assessment of the sling and can help in diagnosis of sling failure, obstruction, sling exposure/perforation, or mesh-related pain. Perforated slings may become calcified, making them easily visible on ultrasound and configuration of sling arms, especially when multiple slings have been placed, can be identified to help with preoperative planning during sling removal.

Staack and colleagues reviewed a series of women who underwent repeat surgery after sling placement and had clinical and intraoperative translabial ultrasound performed. The group was consistently able to identify whether a sling was TO or RP; however, identification of mesh exposure was less reliable given the variable thickness of vaginal tissue.

The physician should have a high degree of suspicion for a mesh exposure or perforation...
based on the patient’s history before the physical examination. An accurate diagnosis based on physical examination findings will aid the physician in further conservative or surgical management.

**MANAGEMENT OF MIDURETHRAL SLING MESH EXPOSURE**

Once a mesh exposure has been identified, management depends on several factors. In terms of the patient’s history, it is necessary to consider if the patient is symptomatic, is sexually active, and/or has pain. Based on the physical examination, the size and location of the exposure should be noted as well as the quality of vaginal tissue. Return to the operating room to excise exposed vaginal mesh is typically the most definitive treatment option, although it is not without risk of bleeding and possible injury to the urethra and lower urinary tract. For these reasons, less-invasive treatment options are often offered as initial management to patients who are asymptomatic, who are not sexually active, or who have a limited amount of exposed mesh.

Conservative management of mesh exposure includes observation, topical estrogen cream application, or local excision of the exposed mesh in the office setting. Expectant management is not unreasonable in an asymptomatic patient with exposure of type 1 mesh. A retrospective review of women presenting to a tertiary care center with a mesh complication demonstrated that 51% of women were initially treated with conservative management, but of this 51%, 59.3% went on to a surgical intervention, including in office, operating room, and combination of both.

Although there are minimal prospective data on the use of topical estrogen, the American College of Obstetricians and Gynecologists and AUGS Committee Opinion offers that there is little risk in offering a trial of hormonal cream for 6 to 12 weeks to improve or resolve the mesh exposure. It is recommended to reserve this management for exposures less than 0.5 cm. Efficacious outcomes were noted by Kobashi and Govier when they described 4 patients with MUS exposure, approximately 0.5 to 1.0 cm in length, all noted on physical examination at 6-week follow-up. With time alone, all exposures reepithelialized spontaneously without further complication. The authors have not had the same degree of success.

Local excision in the office is appropriate if the area of exposed mesh is small, easily visible, and accessible without significant retraction. Exposure of this sort is commonly at the incision site and/or is just an edge of distorted mesh. The surgeon should infiltrate the surrounding vaginal mucosa using lidocaine with epinephrine and excise the visible portion of the mesh with surgical scissors. Closure of the defect should be performed, if possible. Patients should be counseled that the in-office success rate of mesh trimming is not high. Abbott and colleagues showed that 73.3% of women who underwent an in-office trimming of their exposed vaginal mesh went to the operating room for definitive treatment. To a large degree, the success rate depends on the size of the exposure.

For more extensive mesh exposure, treatment options include covering the exposed mesh with vaginal flaps or partial versus total sling excision. Covering the exposed mesh with vaginal skin flaps is a treatment option when the exposure is limited and a goal is to preserve urinary continence. Giri and colleagues reviewed their series of 5 patients with vaginal mesh exposure who underwent primary reclosure of the vaginal skin over the mesh as a first-line treatment option. The margin of the vaginal skin and granulation tissue was trimmed; vaginal flaps were mobilized and closed with absorbable suture over the mesh with interrupted vertical mattress sutures in a single layer. Patients remained symptom free, without additional exposure or SUI recurrence at 12-month follow-up. In a slightly larger series, Kim and colleagues described 8 mesh exposures treated by covering with vaginal flaps, of which 2 patients (25%) had recurrent exposure. Alternately, a series by Lee and colleagues attempted to preserve mesh with vaginal flap coverage, but all 3 patients who underwent conservative management failed.

![Mesh perforation into the urethra as visualized on cystourethroscopy.](image)
Although this approach may be successful in some patients, they must understand that the exposure can recur, necessitating further surgery.

If conservative measures fail, or more definitive treatment is sought for larger, symptomatic mesh exposures, partial or total mesh excision may be considered. During partial excision, dissection is begun at the tissue underlying the exposed mesh. Dissection is carried out at least 0.5 cm in either direction of the exposed portion. Hemostats or surgical clamps are placed at the part of mesh to be removed, and surgical scissors are used to cut out the exposed mesh. Vaginal mucosa is closed with absorbable suture.

In select circumstances, such as mesh-related pain or infection, total mesh excision may be performed. As noted previously, non–type 1 mesh is less porous and may not allow for adequate tissue ingrowth. The mesh may become encapsulated instead of scarred into place allowing mobility of the mesh. The mesh may become encapsulated instead of scarred into place allowing mobility of the mesh and for the sling to be removed more easily at the time of excision (Fig. 4). Although total mesh excision may help alleviate chronic pain from nerve or muscle compression or irritation, this is not always the case. Patients who present with pain should be carefully examined, and the surgeon should identify if the pain is overlying the area near the mesh exposure, or if the pain follows the trajectory of the sling arms to help determine if a partial versus total excision is necessary. The more mesh that is excised, the higher the likelihood of recurrent SUI. A retrospective review of 94 patients with no preoperative stress incontinence who underwent surgery for excision of MUS mesh exposure demonstrated that there was greater postoperative stress incontinence with complete versus partial removal of sling at short-term (42% vs 14%, \( P = .03 \)) and long-term (59% vs 7%, \( P = .003 \)) follow-up. Patients must be counseled about the risks and benefits of total sling excision, including that their pain may not be improved or resolved with total excision, and that the chance of SUI with need for repeat SUI procedure is significant.

**MANAGEMENT OF MIDURETHRAL SLING MESH PERFORATION INTO THE URETHRA OR BLADDER**

Sling perforation into the urinary tract, specifically the urethra, is uncommon with a <1% overall incidence. Risk factors for mesh perforation into the urethra include decreased vascularity due to excessive vaginal dissection or vaginal atrophy, excessive sling tensioning, or missed intraoperative perforation. As previously noted, careful intraoperative cystourethroscopy is essential to recognize injury at time of surgery. Once injury is acknowledged, synthetic sling placement is aborted. If the perforation is small, placing a urethral catheter to allow for healing may be sufficient, but if there is a significant laceration, primary repair of the urethra should be performed. Many patients who end up with a urethral perforation likely had the sling placed with excessive tension, and over time the sling eroded into the urethra. The authors have seen many patients with a history of postsling retention, prolonged catheterization, continued difficulty voiding, and ultimately, symptoms related to urethral perforation.

Treatment options include endoscopic management as well as transvaginal removal. The authors generally perform a transvaginal removal of the perforating mesh as well a few centimeters laterally in each direction.

Trocar perforation into the bladder is more common with incidence rates ranging from 0% to 24% in RP MUS series. Bladder perforation incidence with a TO approach is low, but higher with an outside-in than inside-out technique. Management options of perforated mesh into the lower urinary tract includes endoscopic intervention via Holmium laser ablation or resection with electrocautery, or excision via a transvaginal or abdominal (either open or laparoscopic) approach.

Endoscopic management is viewed as a less-invasive treatment option to avoid significant reconstruction of the urethra or bladder. Laser ablation of mesh perforating the urethra or...
bladder is meant to obliterate the exposed portion the synthetic sling, allow reepithelialization of the vaporized tissue, and potentially avoid more invasive reconstructive efforts. However, attempts at transurethral removal of mesh are often incomplete (Fig. 5). Residual mesh within the urethra might cause stone formation, recurrent urinary tract infections, or irritable voiding symptoms. A case series of 6 patients who underwent holmium transurethral removal of eroded mesh demonstrated that although intraoperatively they were able to achieve complete endoscopic removal and excision of the exposed mesh, 4 of the 6 patients represented with exposed fibers at repeat cystoscopy. Transurethral endoscopic excision is another method proposed as a minimally invasive way to remove exposed mesh in the bladder. In a small case series of 14 patients, 13 had complete resolution at 18-month follow-up. If one chooses one of these minimally invasive techniques, it is critical to resect/excise the mesh deep to the mucosal layer so that adequate healing without continued mesh exposure results.

Definitive management of eroded mesh into the bladder can be achieved via a transvaginal or suprapubic cystotomy. With the advent of minimally invasive techniques, many surgeons are comfortable performing the cystotomy either laparoscopically or robotically. Misrai and colleagues describe their extraperitoneal laparoscopic approach to the removal of RP mesh and demonstrated no major complications in their 30 patients at a mean follow-up of 38.4 months. Similarly, Macedo and colleagues describe their robotic approach to the removal of mesh eroded into the bladder and demonstrate that this technique is efficacious and may provide an alternative to an open cystotomy in the experienced surgeon’s hands.

**SUMMARY**

Mesh complications, including vaginal wall exposure and lower urinary tract perforation, after MUS surgery are not uncommon. Thorough preoperative evaluation and counseling should be provided to minimize risk and manage patient expectations of complications. Physicians should also have a high index of suspicion for mesh complications when a patient presents with bleeding, discharge, dyspareunia/algpareunia, recurrent urinary tract infections, pelvic/groin pain, or voiding dysfunction. Careful history taking and physical examination will lead to most diagnoses; however, additional diagnostics, such as cystourethroscopy, vaginoscopy, examination under anesthesia, or ultrasound, may be used. Treatment options for mesh exposure are patient and symptom dependent and include less-invasive management, such as observation, trial of topical estrogen cream, and local excision of mesh in the office setting, to more definitive procedures, such as covering mesh with vaginal flaps, and partial or total sling excision. Mesh perforation into the lower urinary tract requires more complex interventions. Minimally invasive techniques with transurethral resection or laser ablation can be attempted. More definitive treatments include transvaginal or abdominal (open or laparoscopic) surgery, or a combination of the 2.

**REFERENCES**

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