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ORIGINAL ARTICLE

Techniques for total excision of retropubic and transobturator midurethral mesh slings

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ABSTRACT

For management of mesh complications relating to full-length midurethral slings, a number of techniques for total excision of mesh have been reported. Surgical excision is invasive due to scarring and anatomical location, requiring effective techniques to avoid complications, such as neurovascular injuries or incomplete excision of mesh when total mesh excision is planned.

Detailed surgical technique descriptions of total excision of retropubic midurethral mesh slings and transobturator midurethral mesh slings are presented, including surgical points. In addition, illustrations provide an accurate view of the path of midurethral mesh slings in relation to anatomic considerations.

The described techniques have been utilised for the total excision of over 150 midurethral mesh slings, with the authors avoiding any unplanned incomplete mesh excisions.

For total excision of retropubic midurethral mesh slings, an open retropubic technique combined with vaginal dissection, allows for effective access to the vaginal, retropubic and subcutaneous potions of the sling, without the addition of risks related to intraperitoneal access with pneumoperitoneum and Trendelenburg positioning. Transobturator midurethral mesh slings can be located and completely excised through vaginal and inner thigh/groin incisions, with good cosmesis.

Keywords excision, mesh, midurethral sling, retropubic, transobturator

INTRODUCTION

The utilisation of midurethral mesh slings in the management of stress urinary incontinence in women, has resulted in the emergence of some mesh-related complications necessitating comprehensive techniques for their complete excision. This article provides an in-depth description of an effective surgical method for the total removal of both the full-length retropubic and transobturator midurethral mesh slings. The potential advantages and justifications supporting these techniques are also discussed in detail.

Over the past 25 years, the management of stress urinary incontinence by utilising synthetic mesh as midurethral slings have had commendable success rates. Nonetheless, mesh-related complications have emerged as a significant global concern and legal issue over the last decade. Although certain complications can be managed conservatively, some of the issues, such as infected mesh and symptomatic mesh erosion into the bladder, urethra and vagina, necessitates surgical interventions. However, these interventions are not without any considerable risks and complications.

The spectrum of complications associated with total mesh sling removal includes the universal hazards of anaesthesia, bleeding, infection, and thrombotic events. Additionally, specific complications are associated with the anatomical and functional intricacies within the surgical areas, including urinary tract injury, formation of hematomas, and nerve damage resulting in chronic pain. The removal of the mesh sling is also anticipated

Hannah G Krause*
Greenslopes Private Hospital, Brisbane, Australia
Queensland Pelvic Mesh Service, Gold Coast University Hospital, Gold Coast, Australia
University of Queensland, Brisbane, Australia
Email hannahkrause@hotmail.com

Kurinji Kannan
Townsville General Hospital, Townsville, Australia
Mater Townsville Private Hospital, Townsville, Australia

Judith TW Goh
Greenslopes Private Hospital, Brisbane, Australia
Queensland Pelvic Mesh Service, Gold Coast University Hospital, Gold Coast, Australia
Griffith University, Gold Coast, Australia

*Corresponding author

to lead to the recurrence or worsening of stress urinary incontinence. Therefore, the management strategies for mesh complications related to the complete removal of mesh slings requires careful consideration and thorough discussion with patients. All patients require extensive counselling and multidisciplinary team assessments prior to proceeding with mesh removal. All management options including non-surgical, or surgical, with either partial removal or complete removal, need to be presented to allow for informed consent.

The literature reports various techniques for partial and total removal of mesh slings, including vaginal, open laparotomy, and endoscopic removal via cystoscopy, laparoscopy, and robotic approaches.[1–16] While the procedures for inserting retropubic or transobturator mesh slings are classified as minimally invasive, the comprehensive removal of these slings can prove substantially more intricate, necessitating more extensive dissections.

The objective of this paper is to describe effective surgical techniques for the complete removal of both retropubic and transobturator full-length midurethral mesh slings. These techniques take into consideration variations in sling type and placement.

PROCEDURE

Excision of retropubic mesh sling

The excision of a full-length retropubic mesh sling is a surgical procedure aimed at addressing complications associated with mesh implants. This technique is particularly valuable when complete removal of the mesh, including vaginal, retropubic, and subcutaneous components, is desired. This section provides a detailed description of the excision process, highlighting its key steps and potential advantages, and includes an illustration of the path of a retropubic midurethral mesh sling (see Figure 1).

Surgical preparation and positioning: The patient is positioned in lithotomy, and both the abdomen and vagina are prepped and draped. A vaginal retractor with hooks is employed to ensure optimal vaginal exposure. In cases where total mesh removal is pursued, the vaginal, retropubic, and subcutaneous segments must be removed.

Vaginal dissection: Commencing with a transverse mid-urethral incision, the underlying mesh sling is identified. Diluted local anaesthetic with adrenaline is infiltrated to facilitate dissection and assist with haemostasis. The sling is dissected free of surrounding tissue across the midline and the dissection is continued laterally in both directions. The mesh sling may be divided midline (with a suture placed at each cut end to assist with identification) to improve traction, or left intact. As the mesh extends into the retropubic space, the perineal membrane is punctured at this point with scissors, granting access to the retropubic region. The vaginal portion of the mesh sling is thus free of the vagina and no longer adherent to the perineal membrane.

Abdominal dissection: Through a low transverse suprapubic skin incision and a transverse incision through the rectus sheath, the rectus muscles are separated and the retropubic space accessed. Retractors can be used to facilitate exposure. The gloved hand is often employed to access the retropubic space, and sharp dissection may be necessary in cases of adhesions. Retropubic mesh arms adherent to the posterior pubic bone are identified. The retropubic mesh can then be grasped with an artery forceps and traced/dissected up to its penetration through the rectus fascia. This may assist with identification of the supra-fascial subcutaneous portions of the mesh sling arms. Alternatively, the supra-fascial subcutaneous mesh sling arms can be directly sought by accessing the mons pubis fatty tissue below the rectus fascial incision, where the mesh would be expected to penetrate the fascia. This area can be palpated directly, or the subcutaneous tissue can be partially dissected off the underlying fascia to enhance palpation and identification of the mesh. The mesh sling's "square end" (the original cut end of the mesh sling), located within the mons pubis fatty tissue, is grasped with artery forceps. It is then dissected towards the rectus sheath, perforating it to pull the mesh end through into the retropubic space. The mesh sling is carefully dissected off the surrounding tissues and posterior pubic bone. Mesh on the bladder side may require sharp dissection or diathermy, while mesh on the pubic bone side often necessitates blunt dissection only. The mesh should then be fully mobilised and can be removed vaginally. Haemostatic matrix agents with thrombin are placed into the retropubic dissection.

Closure of incisions: The rectus sheath defects resulting from sling arm penetrations are closed at the mons pubis level. The rectus muscles are approximated using absorbable interrupted sutures, and the rectus sheath incision is repaired. The abdominal wall is closed in layers. Haemostatic agents can also be placed within

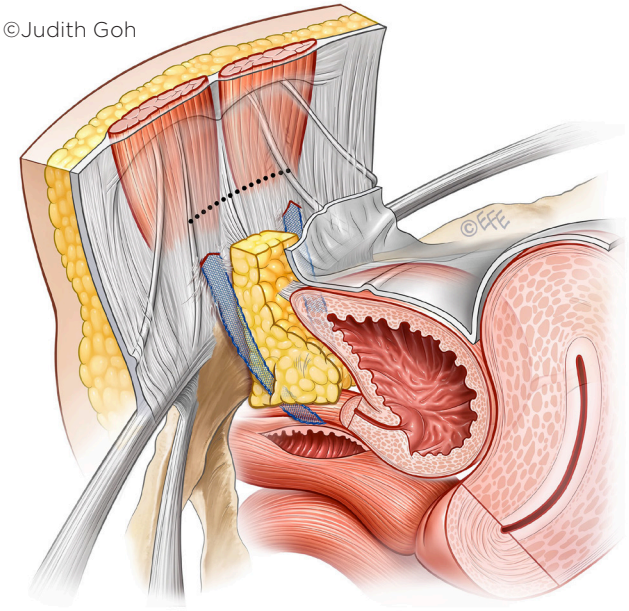

Figure 1. Path of retropubic midurethral mesh sling

the vaginal tunnels if needed, and vaginal epithelium closure is performed.

Cystoscopy and postoperative care: A cystoscopy and urethroscopy is conducted to rule out bladder and urethral injury and assess ureteric jets. A vaginal pack and catheter remain in place for 24–48 hours. Prophylactic antibiotics and antithrombotics are administered to minimise risk of postoperative complications.

Surgical considerations: Several important points deserve attention during the procedure.

- Typically, a "pseudocapsule" exists around the mesh sling, which when entered, allows for a close dissection of the surrounding tissue off the mesh. Aim to remove the mesh only, sparing as much of the native tissue as possible.
- Retropubic mesh arms are typically quite easily detachable from the posterior pubic bone surface, while careful sharp dissection is required for mesh detachment from the bladder, with potential risk of bladder injury. If bladder injury occurs, repair the bladder in 2 layers, full thickness and tension-free. A dye test should then be performed to confirm the closure is watertight. More prolonged post-operative catheterisation will be required.
- The identification of "square ends" in the mons pubis fatty tissue may be challenging as the mesh path is often variable, in particular where they are adherent to the fascial sheath at its insertion into the pubic bone. Care must be taken to avoid obturator neurovascular injury in cases of more lateral traversal of mesh arms.
- There is an increased risk of bleeding in the retropubic space when adhesions are present, with an associated increased risk of post-operative haematoma and need for blood transfusion.
- Long surgical instruments for the retropubic dissection are utilised.
- With experience and consideration of patient habitus and previous surgical incisions/scarring, the size of the supra-pubic incision can be minimised.

Advantages of the technique: A notable advantage of this excision technique lies in its extraperitoneal approach, mitigating risks associated with intraperitoneal methods. The complete abdominal segment of the mesh sling can be accessed via the retropubic incision, including portions traversing the mons pubis fatty tissue or adherent to the fascial sheath. Despite the necessary abdominal skin incision, patients typically experience a swift recovery due to the extraperitoneal approach's inherent benefits.

Excision of transobturator mesh sling

The procedure for the excision of a full-length transobturator midurethral mesh sling involves a meticulous approach to address mesh-related complications. This section provides a comprehensive description of the surgical steps involved in the excision process, highlighting key aspects and techniques. Two illustrations detail the path of a transobturator midurethral mesh sling (see Figures 2 and 3).

Patient positioning and preparation: The patient is placed in the lithotomy position, with the thighs not too acutely flexed. Thorough preparation and draping of the vaginal area and thighs are carried out. Utilisation of a vaginal retractor with hooks facilitates optimal exposure during the procedure.

Vaginal dissection: An anterior transverse vaginal incision is performed, usually situated in the midurethral region or over the palpable location of the sling if positioned abnormally. Following incision, the mesh sling is located and grasped using artery forceps. Local anaesthetic with adrenaline is then infiltrated around and under the mesh to facilitate hydro-dissection and haemostasis. Sharp dissection is employed to mobilise the vaginal epithelium off the underlying mesh. The dissection is conducted by inserting scissor tips between the mesh and epithelium, using slightly open scissors to gently push the tissue away. Artery forceps are used to provide traction on the mesh during dissection. The caudal and cephalad edges of the mesh

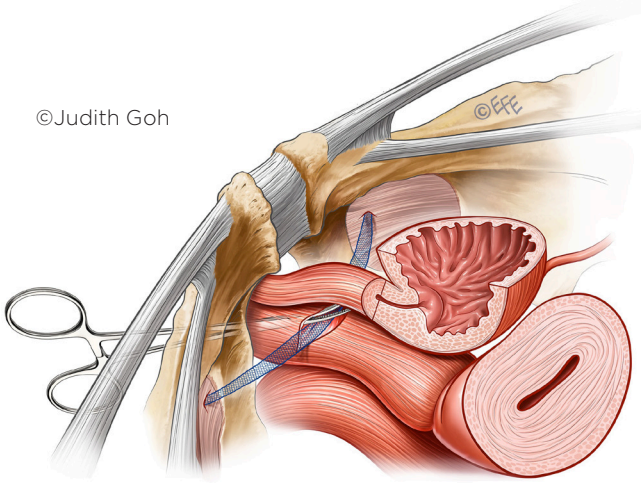

Figure 2. Path of transobturator midurethral mesh sling

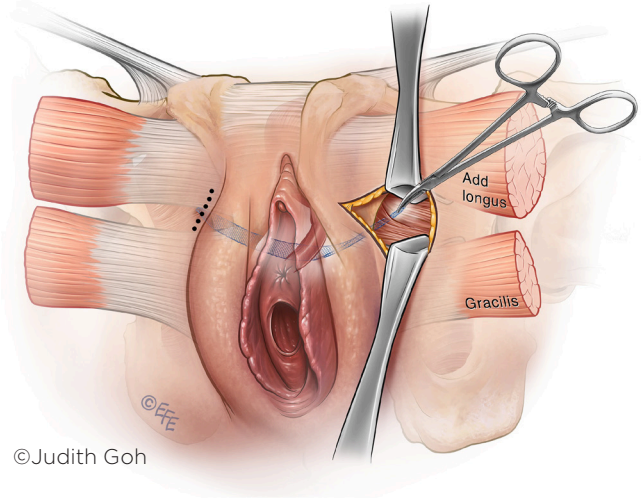

Figure 3. Transobturator midurethral sling inner thigh dissection

are exposed, and vertical passage of scissors behind the mesh in the midline frees the mesh and allows for a good grasp of the sling to assist with traction, which assists with lateral dissection on each side. There is the option to divide the mesh in the midline, utilising sutures on each end to identify the division points, for enhanced traction. Care is taken to prevent fraying or fragmentation of the mesh during these manoeuvres.

Right and left lateral vaginal dissection: The lateral dissection of the mesh sling is carried out by carefully "sliding" the scissors along the mesh, maintaining precision and control throughout the process. Additional local anaesthetic with adrenaline is infiltrated to enhance the dissection and manage haemostasis. The artery forceps, grasping the mesh, is directed outward and lateral, facilitating sharp dissection to separate the bladder and urethra from the mesh. Utiliation of a retractor laterally and superiorly further assists with exposure of the mesh, providing the necessary visualisation for careful dissection. The sharp dissection of the surrounding tissue off the mesh is extended laterally toward the obturator foramen membrane. The tip of the suction device often aids in creating exposure, assisting with better visualisation of the operative site. With the scissor tip positioned on the lateral side of the mesh as it penetrates the obturator membrane, the scissors are inserted and opened to establish an opening in the membrane. This process is then repeated on the medial side of the mesh, effectively creating openings in the obturator membrane on both sides.

Inner thigh dissection: The incision for accessing the transobturator mesh sling arms is initiated approximately 2cm below the upper edge of the adductor longus muscle. It spans 2.5-4cm, starting at around the level of the clitoris. The edges of the inner thigh incision are grasped with Allis forceps and elevated, facilitating visualisation. Diathermy is used to dissect through the fatty layer until the fascia over the muscle is reached. The fascia of the adductor longus muscle is subsequently exposed, and the gloved finger is utilised to assess whether the mesh is palpable superficial to the fascia.

Retraction with hooks contributes to exposure of the operative site. Diathermy is employed to create a 1.5cm transverse incision over the fascia, revealing the underlying muscle. The gloved finger is then employed to bluntly dissect medially and laterally, aiming to locate the space between the bellies of the adductor longus and gracilis muscles. Retractors positioned above and below the space aid in exposure, while additional blunt dissection with an artery forceps tip aids with access between the muscle bellies, improving visibility. Notably, the proximity of the gracilis neurovascular bundle should be considered, as it is located immediately lateral to the dissection site.

The gloved finger is used for palpation, allowing the identification of mesh by detecting any abnormalities between and beneath the muscle bellies. The mesh is characterised by a slightly rough, scarred, or "tendinous" texture. Inspection tools like a nasal speculum and long, narrow retractor are valuable in scrutinising the likely mesh area. Once the mesh is located, it is grasped with long forceps, and its path is traced both laterally and medially. If the mesh traverses the adductor muscle, the muscle is split to trace up to the "square end." A suture is placed through the mesh end for identification and traction.

During lateral tracking of the mesh, the tissue is dissected off the mesh both superiorly and inferiorly. Rotation of the artery forceps holding the mesh puts the mesh on tension, facilitating its exposure. This technique, referred to as "rotating the mesh out of the muscle", allows the lateral portion of the mesh sling to be dissected as it tracks superficially towards the skin. The dissection continues until the "square end" is located. Mesh dissection medially ensues, using scissors and blunt gloved finger dissection, toward the lateral side of the obturator foramen. Placement of scissors between the mesh and bone, with the tip facing medially, is used in conjunction with the previously created opening in the obturator membrane. The mesh is often adherent to the bone, requiring the use of the Semb periosteal elevator for detachment. Once liberated, the mesh sling arm is removed, followed by the immediate placement of a haemostatic matrix agent with thrombin into the transobturator tunnel for haemostasis.

The same procedure is repeated on the opposite side.

Groin incision closure: Closure of the groin incisions involves interrupted dissolvable sutures transversely to the fascia, followed by vertical closure of the fatty layer and skin closure using subcutaneous sutures. Skin glue is applied for wound sealing. Careful reconstruction of the dissected area is vital to prevent tissue retraction and ensure satisfactory cosmesis.

Vaginal closure and cystoscopy: The vaginal epithelium is closed with absorbable sutures. A cystoscopy is performed to verify bladder and urethral integrity and assess ureteric jets.

Our standard post-operative care includes leaving an indwelling catheter and vaginal pack for 24–48 hours and using prophylactic antibiotics and antithrombotics. Early mobilisation is encouraged, along with a normal diet as tolerated.

Surgical considerations and key points: Successful execution of the transobturator midurethral mesh sling excision relies on attention to various surgical nuances. This section outlines essential surgical considerations and key points that contribute to the safe and effective completion of the procedure.

1. **Timing of local anaesthetic infiltration:** It is recommended to infiltrate local anaesthetic with adrenaline only after identifying the mesh. Premature infiltration can hinder mesh identification.
2. **Mesh identification challenges:** In situations where locating the groin mesh proves challenging, a technique involving palpation by both gloved fingers—one in the vaginal dissection and the other

in the groin—can help estimate the mesh sling's trajectory.

3. **Alternative identification approaches:** If locating the groin mesh becomes particularly difficult, progressing with dissection until the mesh exits the obturator membrane can provide a point of identification. Subsequent tracing of the sling laterally or superiorly can then be based on its determined trajectory.
4. **Cautious mesh dissection behind pubic arch:** When navigating the mesh behind the pubic arch, exercise care to avoid tearing it, as adherence at this point is common. Utilise alternating techniques involving scissors and the Semb elevator to gradually dissect the mesh from the bone. Employ the gloved finger for lateral support, while the scissors work to create separation between the mesh and bone.
5. **Safe use of Semb elevator:** During Semb periosteal elevator usage, maintain control and a firm grip on the instrument. Holding the Semb elevator with the index finger straight prevents the instrument from advancing too deeply should sudden movement occur due to mesh or tissue yielding.
6. **Refinement of bilateral groin incisions:** As experience and expertise grow, the size of bilateral groin incisions can be minimised, contributing to improved surgical outcomes.

These surgical considerations and key points are instrumental in ensuring the proficient and safe removal of transobturator midurethral mesh slings, ultimately enhancing patient care and procedural outcomes. Post-operative recovery following this transobturator excision technique is typically quite comfortable.

Variations in slings

An appreciation of the various sling characteristics and their potential variations is crucial in ensuring accurate and successful excision procedures. This section outlines key variations in sling attributes that surgeons should be mindful of when performing mesh sling excision.

- **Colour of slings:** Mesh slings can present in either clear or blue colours, depending on the specific manufacturer and date of production.
- **Transobturator sling insertion direction:** Transobturator slings can be inserted in two different directions: "out-to-in" or "in-to-out." This choice influences the potential path that the sling takes through the transobturator region. The "out-to-in" slings tend to hug the pubic bone more closely than the "in-to-out" slings.
- **Sling configuration and position:** The sling's physical configuration can vary, with options including flat or crumpled/folded and narrow variations. Additionally, the sling's position within the vaginal space can range from superficial to deep.
- **Sling location relative to urethra:** The positioning of the sling in relation to the urethra can vary. Slings may be midurethral or situated proximally or distally along the urethra.
- **Path through obturator foramen:** The path that the sling takes through the obturator foramen can exhibit variability. Surgeons should be prepared for diverse trajectories through this anatomical region.
- **Retropubic space path:** The path that the sling follows as it traverses the retropubic space can vary significantly. The sling's path may range from a medial trajectory to a potentially dangerous lateral orientation.

Understanding these variations in sling characteristics and potential paths is essential for surgeons performing mesh sling excision procedures. This awareness ensures adaptability and precision during excisions, contributing to favourable patient outcomes.

OUTCOMES

To date, the authors have been successful in achieving total excision of full-length retropubic and transobturator mesh slings in all cases where total excision was planned (over 150 cases), using the described techniques. This underscores its reliability and proficiency in achieving complete mesh sling removal. Further detail and follow-up of these patients is planned for a further publication.

DISCUSSION

We have found the utilisation of open and vaginal approaches for the total excision of retropubic and transobturator mesh slings to be effective. The success of these techniques hinges on meticulous dissection to identify and ensure complete removal of mesh, coupled with careful attention to haemostasis, both of which are vital in minimising potential complications.

Retropubic mesh arms can exhibit considerable variability in their path. These arms may be identified anteriorly (caudally or inferiorly) to the pubic bone, traverse the obturator foramen before becoming anterior to the pubic bone, or even extend several centimetres within the rectus muscle in a cephalad direction. Mesh arms in such atypical placements are presumed to carry a higher risk of unintended complications, including chronic pain. Consequently, these variations may be overrepresented in patients seeking mesh sling removal.

The open retropubic technique circumvents entry into the peritoneal cavity and obviates the need for procedures involving pneumoperitoneum or Trendelenburg positioning. This is particularly advantageous for patients with intra-abdominal adhesions or anaesthesia-related concerns. By avoiding these additional complexities, the open approach streamlines surgical and anaesthetic considerations. With experience, the size of the retropubic incision can be minimised.

Other surgical mesh excision options for retropubic slings include a laparoscopic or robotic approach, both of which are valid options, in addition to the vaginal

incision. Heathcote et al[7] document a combined laparoscopic and vaginal procedure for the removal of the retropubic mesh sling, however they describe the option of intentional incomplete mesh excision of the supra-fascial portions due to their concerns regarding potential injury to subcutaneous tissues or hernia formation with that technique. These approaches are intraperitoneal, with access into the mons pubis fatty tissue limited, and inherently risk incomplete mesh excision. Therefore, further suprapubic incisions over the supra-fascial portion of the mesh sling arms are required, as there are often several centimetres of mesh which may be inaccessible despite laparoscopic or robotic intraperitoneal dissection through the fascia, or when the mesh is adherent to the rectus sheath insertion to the pubic bone. All rectus fascial incisions should be closed to reduce risks of hernia formation.

With the surgical technique for total removal of transobturator midurethral mesh sling described here, incision and dissection of the inner thigh/groin to identify the mesh arms does not involve any division of muscles. Murphy et al[11] describe a technique which includes detaching the gracilis and adductor brevis muscles from the inferior pubic ramus. Such extensive dissections have not been required for mesh identification in our cases.

Laparoscopic and robotic approaches for excision of transobturator mesh slings have been developed,[4] however vaginal and groin incisions are still required for most. The cost and availability of robotic surgery options limit its widespread usage.

The abdominal laparoscopic and robotic approaches include additional intraperitoneal risks and extensive pelvic floor dissection for access to transobturator mesh slings. Some of the techniques for transobturator mesh sling removal, recommend involving plastic or orthopaedic surgeons, due to gynaecologists' unfamiliarity with the anatomy of thigh/groin areas. The surgical technique described in this paper does not require the involvement of other specialties. With this technique, even abnormally placed transobturator mesh sling arms, where mesh arms are anterior to the bone (trans-labial instead of transobturator) and hence very superficial, or mesh which is piercing and attached to the periosteum, can be removed. Once experienced in the non-abdominal technique described here, groin skin incision size can be reduced, and once healed, scarring is usually minimal.

In conclusion, the open retropubic and vaginal approach has proven its effectiveness in total retropubic mesh sling excision, and inner thigh/groin incisions coupled with a vaginal approach is effective for total excision of transobturator mesh slings. The techniques' adaptability to diverse mesh arm paths, avoidance of additional risks associated with intraperitoneal procedures, and consistently high success in achieving complete removal, underscore its value in addressing mesh-related complications and patient care.

The management of stress urinary incontinence has evolved significantly with the introduction of synthetic midurethral mesh slings. However, mesh complications have become a focal point of concern, prompting the need for effective removal techniques. This paper comprehensively documents surgical techniques for the total excision of full-length retropubic and transobturator midurethral mesh slings, focusing on open non-endoscopic approaches and providing valuable insights into surgical considerations. By emphasising meticulous dissection, advice on ways to identify mesh location, careful attention to haemostasis, and avoidance of intraperitoneal complexities, these techniques offer robust solutions for patients seeking total midurethral mesh sling removal.

FUTURE DIRECTIONS

It would be expected over time, that there will be less need for transobturator mesh sling removals, in view of changes in clinical practices and the recommendations from the Australian Commission on Safety and Quality in Health Care[17] regarding the type of midurethral slings utilised for stress urinary incontinence. Increasing access and advancement in robotic surgery and techniques for mesh sling removals, will provide additional options for mesh excision. With the establishment of dedicated mesh removal services, women will have better access to a multidisciplinary team approach for the management of pelvic mesh complications.

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Nil

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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