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Teaching module for three midurethral sling complications

Knowledge of urethral closure/opening mechanisms and pathogenesis of SUI informs management of "difficult" cases

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ABSTRACT

We begin this teaching module with a short summary of the mechanism of urethral closure as originally presented in the 1990 "Integral Theory of Female Urinary Incontinence", the relative roles of muscles and ligaments, how they coordinate to effect urethral closure and evacuation and then relate how these mechanisms impact on surgical technique. Following this, we present three different clinical problems. We have invited comments from surgeons from the International Society of Pelviperineology who are experienced experts in the midurethral sling as to how they would manage these problems.

Keywords: Midurethral sling; complications; management

INTRODUCTION

The midurethral sling (MUS) is now the gold standard operation for cure of stress urinary incontinence. Between 1996 and 2019, it is estimated that 10,000,000 MUS operations have been performed.[1] It is our view that knowledge of urethral closure/opening mechanisms and pathogenesis of stress urinary incontinence (SUI) informs management of "difficult" cases. The pathogenesis of MUS surgery failure comes down to two questions; 1. How does a MUS restore continence? Why does continence fail when the sling is excised? The answers can be found in the initial experimental studies on which all MUS operations are based,[2] and which we summarize below.

Normal closure

In Figure 1, A forward vector "pubococcygeus muscle (PCM)" (large arrow) contracts against the pubourethral ligament (PUL) to close distal urethra; two backward forces (posterior arrows) rotate the bladder around PUL and close the urethra at bladder neck,[2] Figure 1. https://www.youtube.com/watch?v=3vJx2OvUYe0

Pathogenesis

In Figure 1, A weak PUL lengthens on effort, "L", cannot support the posterior urethral wall and vagina; both are pulled down to open the urethra from "C" closed, to "O" open. Because PUL is lax, the muscles which contract against it weaken;[3] they cannot close urethra on effort and urine is lost, SUI. Supporting a weak PUL with a hemostat, white arrow, lower ultrasound diagram, Figure 1, prevents PUL stretching ("L") "https://youtu.be/0UZuJtajCQU" exactly as happens with a MUS. The vector closure forces (large arrows) now restored, contract optimally: funnelling disappears and urethra is closed distally and at bladder neck (Figure 1, right lower figure).

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Urethral opening (micturition)

With reference to Figure 1, the forward vector PCM relaxes (large broken arrow); the posterior vectors levator plate (LP)/ longitudinal muscle of the anus (LMA) pull open the trigone and anterior vaginal wall (broken blue lines). The urethra is opened out. This exponentially reduces the resistance to urine flow inversely proportional to the 4th power of the radius (Poiseuille's Law). https://www.youtube.com/watch?v=eiF4G1mk6EA&feature=youtu.be

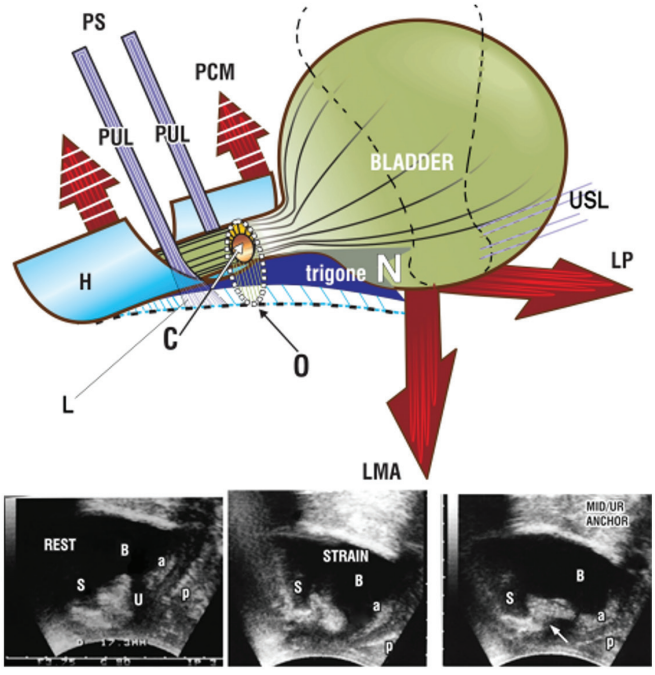

Figure 1. Pathogenesis of stress urinary incontinence Upper figure on effort, a weak PUL is stretched down by LP/LMA muscle forces to lengthen, "L". PUL+L cannot support the posterior trigone and posterior vaginal wall (broken lines) which are pulled down. Urethral cavity is forcibly opened out from C (closed) to O (open). Both closure mechanisms fail. Urine is lost - SUI.
Lower figure transperineal ultrasound reflects upper figure. At rest urethra is closed. On strain, note how the anterior "a" and posterior "p" vaginal walls are stretched back and down; urethra U is forcibly opened out (funnels) at bladder neck and distally. On placement of hemostat at midurethra, (white arrow) bladder neck and distal urethral closure are immediately restored.
B: Bladder; S: Symphysis; LP: Levator plate; LMA: Longitudinal muscle of the anus; SUI: Stress urinary incontinence; PUL: Pubourethral ligament

How these mechanisms inform management of this case

Excision of tape weakens PUL which elongates, "L", Figure 1. Option 1: make a midline incision, excise intervening tissue, suture the two ends of tape together. Do under spinal. Insert 300 ml saline. Test by asking patient to cough; tighten further if required. Option 2: put in a 2nd tape. These options are preferable to a bladder neck sling which is traumatic, prevents the funnelling required to assist micturition. The patient (predictably) will get urinary retention. All bulking does is obstruct urethra. The mechanism of closure is closure by three directional forces acting against a competent PUL. https://youtu.be/0UZuJtajCQU.

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DEALING WITH COMPLICATIONS FROM MIDURETHRAL SLING SURGERY

In this section, we present the three complications. We have invited experienced surgeons from International Society of Pelviperineology to provide comments and discuss how they would manage each case.

1st clinical problem

The 1st clinical problem was originally presented in the journal Int Urogynecol J, 2020;31:1747-1754. It was reviewed by four International Urogynecological Association experts. Treatment by fascial sling was commonly considered and the literature review outlined the pros and cons of autologous fascia versus donor fascia for this specific case.

A 34-year old para 4 woman had a retropubic tension-free vaginal tape performed as an outpatient procedure and reported complete cure of her SUI. Three years later, she returned with the complaint of new vaginal pain during intercourse. A 1×1 cm mesh exposure was found midline in the vagina. Treatment with topical vaginal estrogen was initiated but unsuccessful. She subsequently underwent excision of the exposed mesh in the operating room. 3 cm of mesh from the midline to the right vaginal sulci was removed. At her post-operative visit, there was no evidence of mesh erosion, but the patient complained that her SUI had returned to baseline.

Suggested managements

I think that the Hammock-suture is a good method to prevent tape exposure after suburethral tape placement. I know that

almost nobody performs that. But above the functional aspects of this part of the procedure it prevents surgeons to end up with the tape in the wrong layer.

In my experience topical estrogen does not help in mesh exposures of that size, so I would suggest to excise the exposed tape as far as possible to both sides right away. A second tape will help to restore continence in this patient, careful dissection is advised.

Prim. Dr. BURGHARD ABENDSTEIN
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I guess that – once again – the laxity of PUL, probably hammock and with high possibility even of the back structures (LP, SUL and CL) have returned to baseline after tape excision. This is the most likely explanation for the recurrence of SUI. To solve this problem firstly the situation should be checked by simulated operations and secondly, if necessary, by repair of hammock and with PIVS.

The second possibility is as follows:

If simulated operations show symptoms of tethered vagina syndrome the remaining tape and scar tissue has to be removed and the laxity of the bladder neck area has to be restored by a muscle skin flap. In about 80% of these cases a concomitant PIVS is necessary. Furthermore about 80% of these patients need a new tension-free vaginal tape (TVT) or **transobturator tape** (TOT) 6 months later. In both cases the success rate is in a range of 80%.

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In spite of the wide spectrum of options available for treatments of SUI, treatment fails in 10-15% of patients.[1] With removal of part of the tape, SUI recurs in about 20% of the cases.

How to best manage recurrent SUI after a failed MUS procedure is still a controversial issue. There are different treatment options such as pelvic floor muscle exercises, use of periurethral bulking injections, pubovaginal slings, a new MUS (retropubic or transobturator), an adjustable suburethral sling, salvage spiral slings or even an artificial urinary sphincter.

In a meta-analysis entitled "The surgical management of recurrent stress urinary incontinence: a systematic review", Nikolopoulos KI, Betschart C and Doumouchtsis SK, from United Kingdom and Switzerland[1] showed that in general, all recurrent procedures have a lower success rate compared with those reported following primary procedures. Colposuspension have a pooled objective cure rate of 76% (95% CI±5.04), MUS procedures – 68.5% (95% CI±3.11), urethral bulking injections – 38% (95% CI±10.7).

We have recently reviewed our data on 40 women with recurrent SUI treated by retro-pubic MUS after failure of primary MUS, and followed 38 for up to one year.[2] Thirty-five were cured of SUI (92.1%), and three remained with SUI after a year. Obviously, success rates may differ between centers, but, based on our data and considering the strengths and limitations of the various management approaches that we mentioned above, we recommend that retro-pubic MUS may be considered as the treatment of choice for recurrent SUI after failure of primary MUS.

Another issue that arises from this case is that the patient undergoing primary MUS for SUI should be informed about the possible recurrence rate of MUS, in particular when removal of a tape section may become necessary.

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2nd clinical problem

Fifty-two years old patient who had a TOT 8 years ago. Referred to us for a vesical fistula to the right TOT insertion without SUI. Cystoscopy: transurethral passage of the sling. No vaginal erosion. We have fixed the problem with the total removal of the TOT including the part behind the ischiopubic ramus along the fistula, and reconstruction of the urethra with sutures and I performed a Martius flap to cover. Excellent anatomical result but recurrence of SUI. Physiotherapy failed. In this case, it seems difficult to try a second MUS as we would recommend in the other case. So, what now? Bulking agents or colposuspension?

Dr. PETER VON THEOBOLD
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Your clinical case is very interesting. With my resident, we are at the end of a published work about 37 patients with Martius flap after treatment of complication of tape.

In 9 patients I did Retropubic tape after Martius (tape between Martius flap and the vaginal wall). with no other complication and 70% excellent outcome. 3 patients need a second-time surgery by plication of the tape to get continence. Among the failure of the second tape, 2 patients got artificial sphincter.

Prof. Dr. EMANUEL DELORME
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I think the Martius flap would be protective. We had a similar case some years ago. We used a Martius graft and placed the tape

around the graft. It worked well, and the patient was continent a year later.

Prof. Dr. PETER PETROS
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Thank you, but the technique of Martius flap with or without fat is well-known by all of us. It means me the real question is: what is the advantage of Martius to treat the complications of tapes? Is the Martius the good indication to treat a complication of tape after removing of the tape and uretholysis?

The only answer would be a prospective randomized study between surgery of tape's complications with and without Martius flap... and we have not in the literature. Similarly, we can't answer the question with the surgery of visceral pelvic fistulas: no answer in the literature.

The only answer our study brings: it is easier and secure to do dissection to introduce a tape if there is a Martius flap after first-time surgery of tape' complication. But it is more difficult to adjust the tape.

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I agree with Emmanuel. I use Marius Flap in case of urethrovaginal or rectovaginal fistula (only fat) or to reconstruct the vagina After too tight colporraphy or the perineum after repairs (mainly skin). It isn't efficient for SUI and makes adjusting of the tape difficult.

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As Peter von Theobald knows, bulking agents and colposuspension are no promising maneuvers for cure of SUI. In cases where the urethra is endangered to get injured by a re-operation we had good experiences by using an cystoscope in the urethra whilst dissection. The light shows us the border of the urethral wall and the structures in the surrounding.

I would recommend to start with a midline elliptical incision under cystoscopy to create a bridge (like Max Haverfield´s description below). Then visualisation of the bladder neck and base on both sides with the cystoscope light and insertion of a transobturator tape out/in. Doing all the steps under visual light control reduces the danger of urethra or bladder perforation tremendously.

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3rd clinical problem

This case was published in Pelviperineology in 2012.

Following a TVT MUS 4 years earlier, (initially deemed 85% successful), a 53-year woman presented with gradual deterioration of her incontinence. By mid 2009, the patient was leaking 800-1000 ml/24 hours. There was no urine leak at rest or at night, but she leaked on the slightest effort during the day. On ultrasound examination, the whole posterior urethral wall was opened out during straining, with observed urine loss. The maximal urethral closure pressure was 60 cm H2O, with no urodynamically detected detrusor overactivity.

At operation, the urethra was paper thin, 1,5 cm wide, fragile and attached to a wide loose TVT tape partly embedded in the urethral wall. Two small holes were made during tape removal and repaired. A "bridge/flap" of full thickness vaginal mucosa (3x1cm) Figure 2, was brought up to protect the thin urethral wall. A Tissue Fixation System (TFS) adjustable MUS was then inserted over the vaginal flap, then covered by approximation of the lateral vaginal edges to form a double layer, Figure 3. The patient was entirely cured at 12 months review, with no vaginal retention cysts evident. Though midurethral tapes generally enhance the urethral closure mechanisms, a loosely applied tape may fibrose in such a way as to "hold open" the urethra and prevent closure.

Dr. MAX HAVERFIELD
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To insert the Tape over the bridge is an excellent idea and a simple and safe procedure.

His last comment "Though midurethral tapes generally enhance the urethral closure mechanisms, a loosely applied tape may

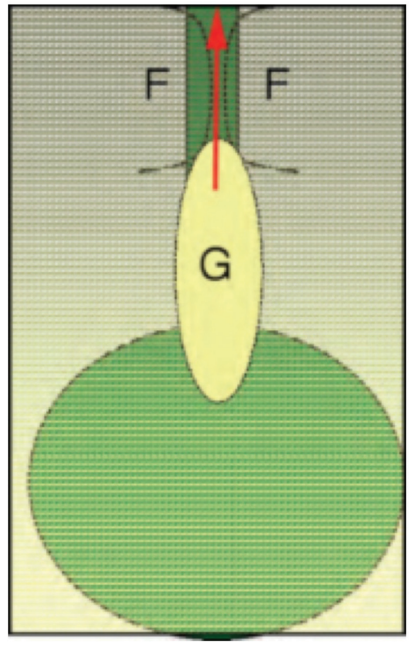

Figure 2. Creation of vaginal skin graft "G" ("bridge") to cover urethra. The sling sits over the graft. F=2 cm flaps created to cover the midurethral sling. Arrow indicates how the graft is pulled upwards.
F: Fascia, G: Graft

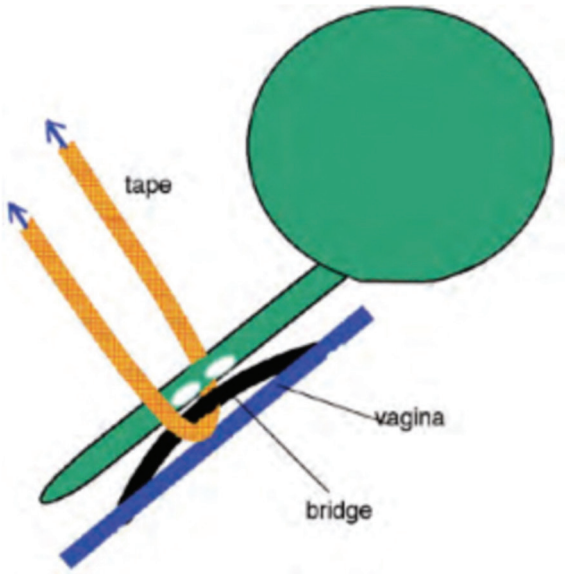

Figure 3. Tape and graft-sagittal view. The white ovals indicate the position of the holes. The vaginal graft ("bridge") covers the urethra protecting it from the applied tape. Both are overlaid by the vaginal flaps "vagina".

fibrose in such a way as to "hold open" the urethra and prevent closure" is in my opinion tremendous important for the success of MUS operations. If the tape is to "tension free" = loose, as mentioned by Max Haverfield, it can slip and create fibrosis with the consequences described above. If the tape is too fast, it compresses the urethra with the consequence of urine obstruction, urge and residual urine. Therefore, in order to find the right "tension free" position of the tape after insertion, we always perform the following procedure:

If a combined repair of the pelvic floor is necessary (due to cystocele, entero/rectozele, with or without hysterectomy) the MUS operation is always the last step.

At the end of the MUS operation, that means after suturing all incisions (midline, paraurethral, possibly hammock an/or external urethral ligament incisions, additional incisions for cystocele, entero/rectocele) we fill the bladder with 300 ml saline, insert an Hegar 8 into the urethra, move softly the Hegar just a bit downwards and adjust the tape carefully to the urethra. After removing the Hegar we retropubically tap on the bladder from above. If no leaking is observed, the tape is in the right position. We cut the external tape ends and finalise the operation.

If tapping causes leaking, we insert the Hegar into the urethra again and repeat the procedure until leaking stops.

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Ethics

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