Review Article

Surgical management of recurrent urinary tract infections: a review

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Abstract: There are many causes of recurrent urinary tract infections (rUTI) which are amenable to surgical management. This usually follows a lengthy trial of conservative management. Aetiological classification of rUTI requiring surgical management may be divided into congenital or acquired. Predisposing factors are classified into two groups; those providing a source for organisms, or by maintaining favourable conditions for the proliferation of organisms. Sources of infections include calculi, fistulae or abscesses. Conditions which predispose to bacterial proliferation include malignancies, foreign bodies, high post void residuals, and neuropathic bladders. Removal of identified sources, treating the obstruction, and improving urinary drainage, are all goals of surgical management. Surgical options for rUTI management can range from minimally invasive procedures such as endoscopic or percutaneous, through to more invasive requiring laparoscopic or an open approach. Surgery remains a very important and viable solution.

Keywords: Urinary tract infections; surgical management; urinary stasis; bladder outlet obstruction

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Introduction

There are many causes of recurrent urinary tract infections (rUTI) which are amenable to surgical management, often following a period of failed conservative management. Classification of the causes of rUTI requiring surgical management may be divided into congenital or acquired (*Table 1*). Predisposing factors are described into two groups, those providing a source for organisms, or by maintaining favourable conditions for the proliferation of organisms (1). Sources of infections include calculi, fistulae or abscesses. Favourable conditions for bacterial proliferation can occur in the form of malignancies, foreign bodies or high post void residuals.

Many cases are multifactorial and a multidisciplinary approach is essential in the assessment of patients both before and after surgical intervention. Physician (renal and infectious disease), Microbiology, Gynaecology and Surgical (Colo-Rectal) are all consulted for input on occasion. Local and regional microbial resistance patterns must be understood when deciding upon appropriate peri-operative management of infections and antimicrobials. Similarly, there are many uncommon infections, such as Tuberculosis or Schistosomiasis, which when diagnosed, must be referred to Infectious Diseases colleagues. These types of infections are becoming more prevalent in our community with increased migration and overseas travel.

Assessment of rUTI commences with a thorough history and examination. Causes which may be easily treated are identified. Investigations may include urinalysis, urine microscopy, culture and specificity, and urine cytology. Imaging techniques utilised include ultrasound, computed tomography or magnetic resonance. Urodynamics (cystometrograms) and cystoscopy may also provide information on causative factors.

Table 1 Surgically correctable causes of recurrent UTIs

Congenital
Vesico-ureteric reflux
Pelvi-ureteric junction obstruction
Urethral valves (posterior or anterior)
Megaureter
Neurogenic bladder (e.g., spina bifida)
Phimosis
Acquired
Calculi
Fistulae
Foreign Bodies (stents, catheters)
Sexually acquired
Neuropathic bladder dysfunction
Detrusor dysfunction (acontractile or hypo-contractile bladders)
Dysfunctional voiding
Bladder outflow obstruction (bladder neck dyssynergia, prostate disease, urethral stenosis, high tone non-relaxing sphincters)
Chronic renal disease (infected cysts, papillary necrosis)
Malignancies
Immune deficiency—diabetes mellitus, immune suppressant medications, acquired immune deficiency syndrome

Lower urinary tract infections

Recurrent infections of the lower urinary tract are common in females. The incidence of the various causes is often age related and there are two peaks of UTI incidence. The first is females in their twenties, most commonly following onset of sexual activity with frequency of intercourse being the strongest risk factor for the development of UTI (2,3). The incidence in one cohort of university women was 0.5 to 0.7 UTIs per person per year (4). The second is post-menopausal, secondary to vaginal mucosal atrophy.

For men, it is uncommon to have a UTI at any age and this should always be investigated. The highest incidence is in male uncircumcised infants less than 12 months old and the elderly (5). The incidence is five to eight UTIs per year per 10,000 middle aged men (6,7). The proposed reasons for this gender imbalance include longer urethral length, less moisture than within the female peri-urethral environment, and lastly, anti-microbial substances within prostatic fluid such as zinc (8,9). Despite the relative low incidence in men, risk factors involve either instrumentation or bladder outlet obstruction due to prostatic hypertrophy (10).

There are several methods to classify causes of rUTI and their surgical options. As mentioned one approach divides the topic into congenital and acquired, with congenital malformations generally being alleviated with reconstructive options, and acquired causes, amenable to excision or repair of the offending issue. The principles of surgical management involve the identification of an aetiology, and to determine the most appropriate surgical option. The most common initial procedure is endoscopic assessment and potential management, followed by minimally invasive options, and if required laparoscopic or open repair.

Urinary stasis

Recurrent or relapsing infections often result from urinary stasis. The most common mechanism is obstruction. A hypo-contractile or acontractile bladder may co-exist with an obstructive element in the urethra. Pathogenic organisms generally arise in the bowel where they displace the normal flora of the vagina or perineum and then

progress into the urinary system. From here several factors determine whether the infection progresses from the lower urinary tract . If untreated or associated with structural or functional abnormalities, infection may ascend and present as pyelonephritis or urosepsis.

Frequent voiding driven by an increased fluid intake and urine output, has been shown to reduce the incidence of UTI (11,12). Emptying the bladder, including any residual volume every 4 to 6 hours has been associated with the fewest complications (13). Concomitant medical conditions such as chronic use of analgesics that interfere with bladder contractility, diabetes mellitus and neuropathic conditions such as spinal cord injury predispose to rUTI.

Investigating urinary stasis involves a careful history and examination followed by focused pathology and imaging investigations. Flow rates, post void residuals, ultrasonography, and cystometrograms with urethral pressure profiles are often required for a diagnosis. It has been shown that as little as 20 mL of persistent urine is significant in the formation of recurrent symptomatic infections (14,15). Other findings such as high pressure bladders, refluxing or dilated ureters can point to a specific and surgically correctable diagnosis.

Diagnosis and exclusion of non-infective cystitis

It is worth noting that the simple act of cystoscopy with urine sample taken directly from the cystoscope has a higher yield than a mid-stream urine. In our institution, bladder washouts are performed routinely for such patients and many have bacteria isolated despite negative microscopy for red and white cells. This allows us to target a specific organism and to reassure the patient, who despite several "normal" mid-stream urine tests, have ongoing symptoms. The finding of high red cell count and white cell count alone does not always equate to a UTI. Our practice is to perform bladder biopsies on these patients. This is to provide a diagnosis, and help differentiate between infective and inflammatory causes of rUTI type symptoms. Our technique for a bladder washout is to first inspect the bladder and drain it. With a 60-mL catheter tip (Toomey) syringe, flush the bladder gently with 100 mL of normal saline, then aspirate and send for microscopy, culture and sensitivity .

Foreign bodies

Ureteric stents or erosive mesh or sutures can also act as a nidus for infection and re-infection after initial treatment. These can be removed endoscopically, reserving open or laparoscopic approaches to more complex cases.

When laparoscopic or open procedures are required, interposition of tissue is recommended to reduce the potential risk of fistulae formation. Informed consent should also include consideration of the functional effects of removing the foreign body e.g., erosive mesh may be associated with recurrent stress incontinence.

Urothelial malignancy

Generally urothelial malignancy is treated by transurethral resection of the bladder tumour in the first instance. The tumour, like a foreign body may harbour bacteria and be recalcitrant to antibiotics. Typically, endoscopic resection will resolve the infective risk as the tumour is removed. Depending on patient and tumour factors, treatment may also involve post-operative intra-vesical immuno- or chemo-therapy.

Fistulae

These can occur throughout the entire genitourinary system; however, they are much more prevalent in the lower urinary tract. Fistulae occur following the disruption of normal tissue. Examples include direct invasion due to malignancy, post-surgical complications including prolapse and stress urinary incontinence procedures, and inflammatory conditions such as from radiation therapy or diverticular disease. In the developing world, obstetric trauma is the most common cause of fistulae. Urinary infection is one of the sequelae that may manifest in a spectrum of devastating complications.

Common communications include vesico-vaginal (VVF), urethro-vaginal, or a colo-vesical fistula. Less common communications are uretero-vaginal and prostatorectal fistula. In most cases, biopsies are required to exclude malignancy, but in enteric fistulae this may be associated with colonic perforation and hence, care must be taken. Laparoscopic or open surgery is required to correct the abnormality, often in conjunction with the colorectal or gynaecological surgeon, depending on the site of the fistula.

VVF may be managed either in the trans-vaginal or trans-abdominal approach. The fistula is usually circumscribed and excised. It is preferable that interposition of natural tissue be used. With a trans-vaginal approach, a Martius fat graft may be harvested, or in the trans-

abdominal approach, the omentum is mobilised. Other options for interposition of tissue trans-abdominally include nearby peritoneum or xenogenous graft material. More complex cases may need interposition with a muscle flap (e.g., gracilis flap, rectus abdominis flap) and often will need the expertise of our Plastic Surgery colleagues. Major determinants of success include fistula size (<3 cm) and availability of tissue for interposition. For VVF treated with a trans-abdominal approach, success rates were 0/3 for no tissue interposition, 3/5 for peritoneal interposition, and 15/16 for omental interposition (16). The ureters may need to be catheterised or stented, and if the ureteric orifice is involved or close to the repair site, then a ureteric re-implantation may be required.

Colovesical fistulae are typically the province of Colorectal surgery after characterisation with radiological imaging and colonoscopically. The basis of the fistula may be malignant or benign, typically diverticular disease. A segment of bowel is usually resected, with a covering colostomy if required. A small cuff of bladder may be excised with the bowel specimen requiring a simple repair of the bladder wall in one or two layers of absorbable suture. When the bladder is more extensively involved with malignant invasion from carcinoma of the rectum or sigmoid, a more extensive resection or even cystectomy may be required.

Bladder outlet obstruction

Bladder outlet obstruction is a potent risk factor for urinary infection. Many conditions may lead to bladder outlet obstruction. In women, causes include pelvic organ prolapse and iatrogenic causes e.g., tight sling for treatment of stress urinary incontinence. In men, benign prostatic hyperplasia is the most common cause. Less common causes include urethral strictures, malignancies, and urethral valves which occur in 1 in 5,000 to 8,000 male newborns (17).

Bladder outlet obstruction in women

Pelvic organ prolapse

Determination of surgical therapy depends on prolapse grading, presence of symptoms (discomfort and bleeding), and urinary or faecal trapping and its sequelae. Scoring systems for vaginal wall prolapse include the POP-Q (pelvic organ prolapse questionnaire) system and the Baden-Walker Scoring System (18,19). Surgical management options comprise of either a trans-vaginal or trans-abdominal approach, or in combination.

Trans-vaginal anterior or posterior colporrhaphy may be performed with either direct plication, or reinforcement with either mesh or xenogenous graft material. A systematic review of 66 studies found that synthetic mesh augmentation of anterior wall prolapse repair improved anatomic outcomes compared to native tissue repair (autologous, allogenic, xenograft) (20-23). The improvement in outcomes came at the expense of higher synthetic mesh erosion rates. These ranged from 1.4–19% with an anterior colporrhaphy, and 3–36% when placed in multiple compartments. The lowest erosion rates were reported with polypropylene mesh (0.5%) (20). Operative mesh revision rates ranged from 3–8% (23).

Sacrocolpopexy performed more commonly trans-abdominally, involves fixing the apex of the vagina to the periosteum of the sacrum using mesh as the connecting "tissue" bridge. This is often utilised for vaginal vault or cervical prolapse or multi- wall prolapse repairs. A Cochrane review from 2008 looked at 22 randomised controlled trials and found that the abdominal approach was associated with lower rates of recurrent vaginal wall prolapse (RR 0.23, 95% CI 0.07–0.77) and dyspareunia (RR 0.39 95% CI 0.19–1.11) than the vaginal approach. There was however, an increased morbidity—with longer operating times, longer duration to return to work, and an increased financial cost (24). It is recommended that sub-specialised surgeons perform prolapse repairs. Patients with significant vault prolapse should be counselled about the use of a pessary to hold the prolapse in place versus a surgical repair. Sacrocolpopexy, transvaginal sacrospinous ligament fixation and other options need to be discussed.

Generally, each of the vaginal compartments (anterior vaginal wall, vaginal vault and cervix, posterior vaginal wall including elements of rectum and small bowel) need to be evaluated carefully. The anatomic presence of a low grade prolapse may not require surgery or indeed intervention. The relative merit of intervention needs to be considered for each compartment. Recurrent or persistent urinary infection may tip the balance in favour of surgical correction of prolapse particularly if otherwise symptomatic and moderate to high stage.

Fowler's syndrome

The characteristic features of this condition include young women, more commonly in their 20's or 30's, with obstructive urinary symptoms, high residual volumes, difficulty in self-catheterisation due to urethral discomfort,

and a propensity for rUTI. There is an association of Polycystic Ovarian Syndrome. Cystometrograms and urethral pressure profiles reveal a high tone, non-relaxing sphincter.

Management options include alpha blockers with a high failure rate (25), intermittent self-catheterisation or sacral neuromodulation with a long-term success rate of approximately 60–70%, with low residual volumes, and reduced straining being characteristic of treatment success (26,27). Sacral neuromodulation comprises of a two-stage approach, spanning between two to four weeks of testing. Typically performed as a day procedure, under sedation or a general anaesthetic, the first stage is performed without a muscle relaxant. Stage one involves the insertion of a tined lead under fluoroscopic imaging into the S3 foramen. It is connected to a second wire which is brought out through the skin, and connected to an external battery source. The aim of the initial procedure is to produce a reflex of the S3 nerve (anal bellows and plantar flexion) with the lowest possible voltage. Over the ensuing weeks, testing of the electrode and external generator are trialled with varying programs. If there is greater than 50% improvement in symptoms (subjective) and reduction of residual volumes (objective), then a permanent pulse generator is placed sub-cutaneously, and attached to the internal tined lead. Stage two is a day procedure, preferably performed under sedation.

Stress urinary incontinence surgery

The incidence of urethral obstruction secondary to a complication of sub-urethral sling surgery is not known (28). The intervention rate is between 1% and 2% (28). It is treated with urethrolysis and sling division. This is typically associated with improved bladder emptying and relief of rUTI. Patients with rUTI may not be aware that they have had a sling as part of their prolapse repair. If through urodynamics, their voiding studies show high voiding pressures, poor opening of the urethra, or an elevated bladder neck, further clarification of their surgical history is in order.

Bladder outlet obstruction in men

Bladder outlet obstruction in men is commonly associated with rUTI. When BPH is found to be the causative factor, there are several therapeutic options. Firstly, conservative therapy with alpha blockers, 5-alpha reductase inhibitors, or in combination, should be offered. Long term catheterisation or clean intermittent self-catheterisation is other options, usually reserved for when surgery is contraindicated. Surgical options include bladder neck incision, endoluminal implants, laser enucleation or vaporisation, and transurethral resection of prostate (TURP). The latter remains the gold standard though review of the relative efficacy of these is beyond the scope of this paper. When considering these options, the urologist must consider both patient and anatomical factors.

Urethral strictures

Urethral strictures are a relatively common cause of obstruction which can affect both genders. There are various surgical approaches to their management, depending on the cause and location. Urethral strictures are classified as anterior or posterior depending upon their position relative to the membranous urethra. Urethral narrowing can be managed with urethral dilatation, either with local anaesthetic or under a general anaesthetic. It involves the gentle passage of calibrated instruments, either metallic (male "sounds") or plastic dilators (29). It is generally accepted that urethrotomy and dilation are equally effective and will cure approximately 50% of short bulbar urethral strictures (30). Long term results of repeated procedures are poor and rarely curative. A decision is therefore made between urethroplasty or palliation of the stricture, depending on the time to recurrence and potential morbidity (29,31). Urethral strictures in women are also managed with dilatation or urethroplasty. The appropriate maximal size dilator (Hegar) is unknown, however, sizes between 10 (30 Fr) and 11 (33 Fr) are commonly used. Duration of dilatation is also unknown, however holding the dilator in the female urethra for up to two minutes is a common practice.

Urethroplasty can be either anastomotic, where the stricture is excised and the urethra is spatulated and anastomosed, or substitution urethroplasty, which involves either stricturotomy or patch (preferred) or circumferential repair (29). Anastomotic urethroplasty is possible where the stricture is less than 1 cm long, commonly resulting from trauma or congenital causes. If possible it is the preferred option as it gives the most sustained results in terms of re-stricture rate and low complication rate (29). Techniques in straightening the curve of the bulbar urethra may provide additional urethral length when required. Separating the crura at the base of the penis or performing a wedge pubectomy of the pubic arch are two such examples. Substitution urethroplasty can utilise a variety of grafts. Free grafts are preferred to flaps (32) and can be sourced

from penile shaft, foreskin, post auricular or buccal mucosa. Buccal mucosa is generally preferred due to its low donor site morbidity (33). For long and extensive strictures, a flat plate is often formed, then tubularized as a two-stage procedure. It is considered durable with improved long term results (34). For females, the benefit of grafts over flaps is less pronounced. With short distal strictures, they may be divided and a vaginal mucosal flap inserted (35).

Consequences of obstruction which predispose to rUTI

Bladder diverticula

Bladder diverticula are classified as congenital or acquired (secondary to high pressure bladder outlet obstruction). They range in size, up to several hundred millilitres. They are a cause of rUTIs through the inability to empty, and result in urinary stasis. Of importance is the consideration that the diverticulum does not have a detrusor muscle lining, and thus, cannot contract with the remainder of the bladder. Investigations include excluding malignancy and the presence of calculi, defining their size and ability to empty. Imaging of choice includes ultrasonography, CT, and fluoroscopic cystometrogram or urodynamics. The majority are small (<5 mL) and are managed conservatively. There are no prospective comparisons between management options. They include endoscopic incision of the diverticulum neck to enhance drainage, with or without electro-cauterisation of the bladder diverticulum mucosa (36,37). More invasive options include laparoscopic assisted (trans-abdominal) or open (extra-peritoneal) excision of the entire diverticulum with multi-layer bladder wall closure (38,39). Ureteric catheterisation or stenting is often necessary when the diverticulum is close to the ureteric orifice or overlies the ureter. In complex cases, ureteric re-implantation may be required.

Bladder calculi

Calculi are a nidus for infection and are typically associated with urinary stasis. The main causes include bladder outlet obstruction from benign prostatic hyperplasia, bladder diverticula, and the presence of long term urinary catheters. The majority are small (<2 cm) and managed endoscopically. Endoscopic techniques include crushing (lithotrite), finer fragmentation with Holmium: YAG laser or a pneumatic lithotripter. An open extra-peritoneal approach through a small Pfannenstiel incision may be used for larger stones (>3 cm diameter). Of fundamental importance when treating bladder stones, is to treat the cause of obstruction, to reduce the risk of recurrent stone formation (40).

Neuropathic bladders

High resting detrusor pressures, such as those in patients with neuropathic bladders can lead to rUTI through tissue hypoperfusion and decreased delivery of antibiotics to inflammatory cells (41). Male spinal cord injury patients with detrusor sphincter dyssynergia who fail medical management and who are unable to intermittently self catheterise, may obtain improved emptying with the insertion of a suprapubic catheter (performed surgically or radiologically), or rarely a trans -sphincter incision (sphincterotomy) with condom drainage, or the injection of botulinum neurotoxin directly into the sphincter (off label use) (42). To reduce resting detrusor pressures, medications, injections of intra-vesical botulinum neurotoxin, or as a last resort, bladder augmentation cystoplasty, may be utilised. It is recommended to perform a cystometrogram approximately 6 weeks after injection of intra-vesical botulinum neurotoxin, to ensure the resting pressure has reduced. The aim is a pressure below 9 cmH_2O (42).

Non-obstruction

Hypo- or acontractile bladders

Large capacious bladders (>800 mL) that do not empty is a difficult and controversial topic for which there was previously no role for surgery. Conservative management in the form of clean intermittent self catheterisation or long term catheters (urethral or suprapubic) were the only options. A 5-year prospective multi-centre trial researching patients with voiding dysfunction has shown that 71% of those with urinary retention had a greater than 50% benefit in ability to void with low residual volumes, following the insertion of a sacral neuromodulator (43).

Cysto-reduction surgery has been tried with limited success. A small study looked at ten patients who had reductive cystoplasty treated with either fundus invagination or detrusor duplication (44). It found that detrusor efficiency did not improve. Despite this, residual volumes and rUTIs were reduced.

Urethral diverticulum

Outpouching of urethral mucosa, devoid of muscular fibres may arise in the urethra particular in the posterior wall of the female urethra. Presenting symptoms include the classic triad of dribbling of purulent matter, dyspareunia, and dysuria, however, the symptoms are often non-specific.

The incidence is unknown but an autopsy study showing 1–5%, and a population-based study showing 0.02% (45,46). There is a higher incidence in women than men (47). rUTIs may occur from urinary stasis or from diverticulum calculi. Investigations include vaginal examination, trans-vaginal ultrasonography, pelvic MRI, and cysto-urethroscopy. There are no controlled studies to inform best practice. Minimally invasive options include urethroscopic incision of a tight diverticulum neck with a Collin's knife. It has been suggested this should be reserved for distal and small diverticula (48). For large and complex diverticula, or where other forms of management have failed, a trans-vaginal urethral diverticulectomy is performed. The aim is to remove the diverticulum in its entirety. Potential complications include post-operative stress urinary incontinence with reported rates of 1–16%, fistula or stricture formation, and ureteric injury (49). If the ureters are involved, the combination with a trans-abdominal approach may be required. It is preferable to utilise a Martius fat graft to reduce the risk of an urethro-vaginal fistulae (16). Fascial slings have also been used to prevent sphincteric dysfunction, reduce the risk of diverticulum recurrence and prevent fistulae (50).

Upper urinary tract infections

Any lower urinary tract pathology can be conveyed to the upper urinary tract. Treatment of recurrent pyelonephritis is therefore often directed at resolution of the lower urinary problem. There are instances however where the bladder and urethra are normal and infections are due to true upper urinary tract pathology. Infections of the upper tract can be divided anatomically into issues relating to the kidney, pelvi-ureteric junction (PUJ), ureter, and the vesico-ureteric junction (VUJ).

Kidney

The most common pathology requiring urological intervention for infection in the upper urinary tracts is calculus disease. The clear majority, however, do not cause rUTIs. Struvite stones, otherwise known as infection stones, consist of magnesium ammonium phosphate. They are strongly associated with urinary tract infections from urea splitting organisms and can grow rapidly over weeks to months to fill the entire renal pelvis. This can lead to renal failure and/or sepsis (51,52). One study found a mortality risk of 27% and renal failure risk of 28% over an 8-year period for untreated struvite calculi (53).

The aim of therapy is to remove all calculi and their fragments. Residual fragments can act as a nidus for further stone formation. Depending on the size and stone components, surgical management options include Extracorporeal Shock Wave Lithotripsy (ESWL), Ureteroscopy with Laser lithotripsy, Per-Cutaneous Nephro-Lithotomy (PCNL) or Open surgery. Calyceal diverticulum may harbour stones. When accompanied by a long narrow neck, it is difficult to treat endoscopically. Options include direct PCNL, which may be difficult, laparoscopic or open approach, to lay open the diverticulum, or excise in total, and oversew the infundibulum.

Chronic infections such as recurrent abscesses, xantho-granulomatous pyelonephritis, tuberculosis, or hydatid disease are difficult to treat with empiric medication. They generally require surgical excision, with either partial or total nephrectomy, and either lap-assisted or open surgery.

PUJ

There are several options in the treatment of a PUJ obstruction. A minimally invasive approach includes endoscopic ureteric stenting. This however, requires multiple future stent changes with its associated risks. Laser (Holmium) endo-pyelotomy has up to an 80% success rate for patients with strictures <2 cm, a normal sized renal pelvis, split function >20% and a high ureteric insertion (54). The gold standard remains laparoscopic or open pyeloplasty of which two types exist: dismembered (Anderson-Hynes) and non-dismembered (Y-V). No statistical difference was found in outcomes between the two surgical techniques (55,56). Other options for definitive treatment include further reconstructive procedures in the form of a calico-ureterostomy, or if there is a poorly functioning renal unit (<10%), a nephrectomy.

Ureter

Unrelieved complete ureteric obstruction can lead to irreversible renal damage within hours, particularly in the context of infection (57). Stenosis of a ureter can occur at any position and may involve any length of ureter. Ureteric obstruction may be classified as intraluminal, luminal or extra-luminal. Intraluminal causes include stones, benign and malignant tumours. Luminal causes include strictures or congenital abnormalities such as megaureters. Extra luminal causes include malignant or benign masses or retroperitoneal fibrosis which in turn may be benign or malignant.

Management involves identification and treatment of the underlying cause. Prior to definitive treatment there may be a temporising phase to stabilise the patient via drainage of the obstructed ± infected renal unit with a ureteric stent or nephrostomy tube. Ureteric stent insertion may be short or long-term stenting with polymeric stents or longer term metallic stents. Though balloon dilation has a reported success rate of 40–64% at 6 months, it may still be an option for ureteric stricture treatment given its relatively low morbidity and short post procedure length of stay in hospital (58,59). More invasive procedures include ureterolysis, either unilateral or bilateral, with the goal to dissect the affected ureter from the inflamed tissue and encircle it with omentum or adjacent peritoneum. Other major surgical options include uretero-ureterostomy, Psoas Hitch or Boari-Flap with ureteric re-implantation, trans uretero-ureterostomy, or lastly, an ileal interposition. Detail about each of these options is beyond the scope of this review.

VUJ

Recurrent pyelonephritis may be secondary to vesico-ureteric reflux (VUR). VUR may occur in an otherwise normal bladder owing to a congenitally deficient tunnel through which the ureter naturally implants into the bladder. VUR may also result from elevated storage pressures. This can allow easy and rapid transmission of infected urine from the bladder.

Surgical management options range from bulking agents, such as polydimethylsiloxane, to laparoscopic or open ureteric non-refluxing re-implantation technique in the instance of normal bladder storage pressures and urethral relaxation. Associated congenital abnormalities such as ureteroceles may need to be surgically treated in the management of the VUR. An ureterocele is a congenital dilation of the distal ureter and forms a sac-like pouch into the bladder. Its incidence is 1 in 4,000 live births (60). A narrow punctum leads to urinary stasis and potential calculus formation. Ureteroceles may also cause rUTI via bladder outlet obstruction if they protrude into the urethra. Surgical options include endoscopic puncture with Bugbee diathermy electrode or transverse incision at the inferomedial edge of the ureterocele (61). This simple approach may facilitate drainage of an obstructive ureterocele. Alternatively, partial or total resection of the ureterocele with a Holmium Laser can be performed. Once excised, there is a tendency to VUR, particularly to the lower pole moiety in the instance of a duplex system and ectopic ureterocele. More invasive options include excision of the sac via an open trans-vesical approach, with or without a ureteric re-implantation. That each of these surgical options requires a thorough informed consent process is self evident. By their very nature the conditions are infrequent and surgical intervention is only required for refractory rUTI and other specific indications.

Conclusions

Patients afflicted with recurrent UTIs, having more than 2 in 6 months, or 3 in 1 year, should be referred to a Specialist and investigated for a reversible cause (62). A thorough history, physical examination, and selected investigations should be performed. Non-surgical or surgical management options may then be offered, based on the corresponding findings. Surgical options may be both diagnostic and therapeutic in the work-up for rUTIs. Therapeutic surgical options may be considered in two broad categories—to remove the source of infection, and secondly, to remove any predisposing conditions.

For complex cases, a urinary tract infection is often associated with a condition, such as an anatomical or functional abnormality of the genitourinary tract, or the presence of an underlying disease. This increases the risk of a more serious outcome over patients without an identifiable cause (63). Disease processes are often multifactorial and can cross multiple specialties. Hence, a multidisciplinary team approach should be utilised. It may be necessary to have present surgeons of differing specialties at complex procedures, and to consider referring to a surgeon who has a sub-specialty interest.

There are many surgical options for the management of rUTI. These range from minimally invasive procedures such as endoscopic or percutaneous, through to more invasive ones requiring laparoscopic or an open approach. With an ever-expanding knowledge on infection causation and new technique development, surgery for rUTI is important to prevent a lifetime of antibiotics and their sequelae where targeted surgery may be curative.

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Footnote

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