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Urology: The Home of Endoscopy

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1. Introduction

1.1 Place of endoscopy in urology

Urology is truly the home of endoscopy. Starting with the introduction of first cystoscope, Urology has been at the forefront of endoscopic use in clinical practice. Endoscopy is used in both diagnosis and therapeutic settings (Table 1). Currently, endoscopy is used for diagnosis of bladder pathology and this is primarily with the use of flexible instruments under local anaesthesia. It is the gold standard for the identification of urethral stricture disease and diagnostic standard for the identification of intravesical *Transitional Cell Carcinoma (TCC)* and the primary follow-up tool for non-muscle invasive TCC. Transurethral Resection of Bladder Tumour (TURBT) is the mainstay for pathological diagnosis of Transitional Cell Carcinoma (TCC). Its efficacy has been improved by modern technical developments such as blue-light cystoscopy. This staging provides information on whether more radical therapies are necessary or whether continued endoscopic surveillance can be continued.

Relief of ureteric obstruction often involves stenting of the relevant ureter. Above the bladder, rigid endoscopy is used to diagnose ureteric stone disease. Treatment of identified stones is usually endoscopic, using either Holmium laser or lithoclast technology. In recent times this practice seemed to have shifted toward a greater role for Shock wave lithotripsy.

In the sphere of organ ablative surgery, since the introduction of laparoscopy to Urology it has been possible to apply endourological techniques to ablative procedures. Thus laparoscopic nephrectomy is now the standard for radiological T1-T2 lesions where partial ablation is inappropriate. This chapter proposes to track the use of endoscopy in Urology and to show why Endoscopy and Endoscopic techniques have become central to Urological diagnosis and treatment.

1.2 History of endoscopy in urology

This section is not meant to be the didactic history of Urological Endoscopy. For that we would suggest Mr J Shah's review (Shah 2002) or Dr Herr's review in the Journal of Endourology (Herr 2006). Rather it is an attempt to provide an insight into developments and timelines in the evolution of Urological endoscopy.

Organ	Endoscopy used for Diagnosis D/ Therapy T/ Both B	Open or Endoscopic Techniques as the prime Surgical modality	Conditions (examples)
Urethra	B	E >> O	Stricture, HUA, Pain, Foreign bodies, Malignancy
Prostate / Bladder neck	B	E >>> O	Obstruction, Malignancy,
Benign Malignancy	T	O = E	
Bladder	B but D >>T	E >>> O	Storage symptoms, HUA, Malignancy,
Benign Malignancy	B	E > O	Foreign bodies
Ureter including renal collecting system	B	E >>> O	Urolithiasis, HUA, Malignancy, Stricture,
Benign Malignant	B but T >> D	O = E	Functional obstruction eg Pelvi-ureteric-junction
Kidney	Little place	E = O	Glomerulonephritis
Benign Malignant	T		Renal Cell malignancy

Table 1. The place of Endoscopic Urological procedures in the treatment of Urological disease

The first to attempt to visualise the urogenital tract was by Bozzini in 1806. His "Lichtleiter" consisted of a funnel, candle and a reflector. Its problem was of poor illumination so much so that from the practical viewpoint it was unusable. Further improvements made by Ségales and Fischer led to the development by Desormeaux of a cystoscope where illumination was provided by an alcohol and turpentine lamp. This was the first instrument to be used for a therapeutic manoeuvre. Desormeaux, has been called "the Father of Cystoscopy", in part because he was one of the first to introduce a Lichtleiter into a patient. Cruise, Newman and especially Nitze were responsible for modifications which improved illumination including the use of intra-corporeal bulbs. In 1887 Nitze introduced a cystoscope which did not require a cooling apparatus and through which biopsies could be taken.

In 1889 Boisseau du Rocher introduced a twin sheath modification which allowed simultaneous visualisation and instrumentation/ irrigation. Albarran in 1896 introduced a catheter deflector. Further developments in both the USA and Europe in illumination allowed the use of prisms as lenses. These developments led to the resectoscope which was first introduced in 1926 by Stern and modified by McCarthy in 1931 to produce the Stern-McCarthy resectoscope. This was the first instrument recognisable as a modern resectoscope. Trans-Urethral Resection of the Prostate / Bladder lesions was made possible

through the work of Hertz and DeForest who described the use of high frequency current for and vacuum tube that made tissue resection possible. Their work was further progressed by Wappler and Wyeth (cutting current) and W.T. Bovie and G.H. Leibel (coagulating current). The true modern resection instrument was then developed by Frederick Wappler in 1931 and resection of the prostate (TURP) was first described in a published account by Nesbitt in 1943.

Flexible instruments were initially developed by Mikulicz in 1881 who attached a 30 degree deflection mechanism to a cystoscope and performed an oesohagoscopy. The first semi-flexible cystoscopy was performed using a Wolf and Schindler instrument in 1936. Ureteroscopy was first performed in the early 1900`s using a Brandford Lewis instrument.

As alluded to above, the earliest instruments used external combustible light sources. Their main disadvantage was of poor illumination and a certain danger of burns to their operator and the patient. Candles gave way to alcohol burners which produced more light but the heat they produced required the addition of a cooling device. The field of view was still limited to the diameter of the instrument although the light intensity was increased.

The major improvement came from Edison`s invention of the bulb in 1880. The development of the "Mignon" lamp allowed better illumination of the bladder from its position at the distal end of the cystoscope. Distal illumination remained the main stay until fibre-optics was applied to endoscope design in the 1950`s. Fibre-optics use the phenomenon of Multiple Total Internal Reflection. Professor Harold Hopkins and Narinder Kampany published in Nature in January 1954 on image transmission through unclad fibres. In the same edition Van Heel reports on image transmission through clad light fibres. Hence light could be transmitted through fibre-optic bundles and the target image viewed through the same telescope. To see a true image the fibres had to be coherently arranged *i.e.* the fibres had to occupy the same relative position at either end. Hopkins also worked on rigid systems and the application of glass fibre innovations led to the rod-lens system currently used in most rigid endoscopes. The advantage of this system is the increased light intensity delivered to the target and the better image due to a reduction in light loss within the lens casing.

The development which will further revolutionise endoscopy is the development of distal sensors. These are based on either CCD (charge coupled device) or CMOS (complementary metal-oxide semi-conductor) technology. Both technologies register an image as an electrical charge proportional to the light intensity of the image. These charges / impulses are then processed and reformatted as a colour image. CCD cameras and telescopes are further along in development. Three chip (one for each of the prime colours) systems have resulted in increased visualisation and resolution. Its introduction has led to NBI (Narrow Band Imaging) technology which is discussed later. In a head to head comparison between fibre-optic and distal sensor endoscopes, Okhunov et al showed that distal sensor technology was superior in the 1000 procedures tested (Okhunov 2009).

2. Endoscopy of lower urinary tract

2.1 Flexible cystoscopy (figure 1)

Flexible cystoscopy permits direct visual inspection of the urethra and bladder following instillation of lubricant local anaesthetic gel. The instruments used currently predominantly use fibre-optic technology for light and image transmission. Hence they need a separate light source and usually a camera system. The indications are principally diagnostic (investigation of haematuria, the storage lower tract symptoms of frequency and urgency)

where intravesical pathology is suspected and in the surveillance of patients with previously diagnosed and treated bladder cancer. The gradual introduction of newer technology such as distal sensor all digital endoscopes and narrow band imaging will improve resolution and thus detection of recurrent bladder TCC (Transitional Cell Carcinoma).



Fig. 1. Modern fibre-optic flexible cystoscope

In terms of therapeutic indications flexible cystoscopy can be used for biopsy and destruction of small tumours using diathermy fulguration or holmium laser vaporisation. Polymer based stents (eg JJ stents) inserted to relieve ureteric obstruction are usually removed at flexible cystoscopy and in some cases can even be inserted (Reynard et al., 2009). However the majority of such procedures are performed at rigid cystoscopy. Intravesical Botulinum-A toxin sub-mucosal injection performed through the flexible cystoscope is now a standard treatment for intractable storage symptoms resistant to oral anti-muscarinic agents. Complications of flexible cystoscopy include mild burning or bleeding on passing urine for a short period (common) and urinary tract infection requiring antibiotics (<5-10%-this rate can be reduced by prophylactic antibiotics).

2.2 Rigid Cystoscopy and Trans Urethral Resection of Bladder Tumour; TURBT (Figure 2 shows instruments in common use)

Rigid cystoscopy as a diagnostic tool has been virtually replaced by flexible cystoscopy. However it is the main vehicle through which reasonable bladder biopsies are taken and a pre-requisite to many endoscopic procedures. Instruments are available for paediatric and adults and the adult instruments usually are 18-22 Ch in diameter.

TURBT is the most important diagnostic procedure for bladder tumours as the histological evaluation of the resected tissue allows a clinician to distinguish between non-muscle invasive ("superficial") and muscle invasive bladder cancer. The most common histological sub-type of bladder cancer is Transitional Cell Carcinoma (TCC). 75-85% of newly diagnosed bladder TCC are non-muscle invasive ("superficial") and for these TURBT is also the definitive treatment. The remaining 15-25% are muscle invasive, requiring radical treatment (either surgical- radical cystectomy, or radical radiotherapy).

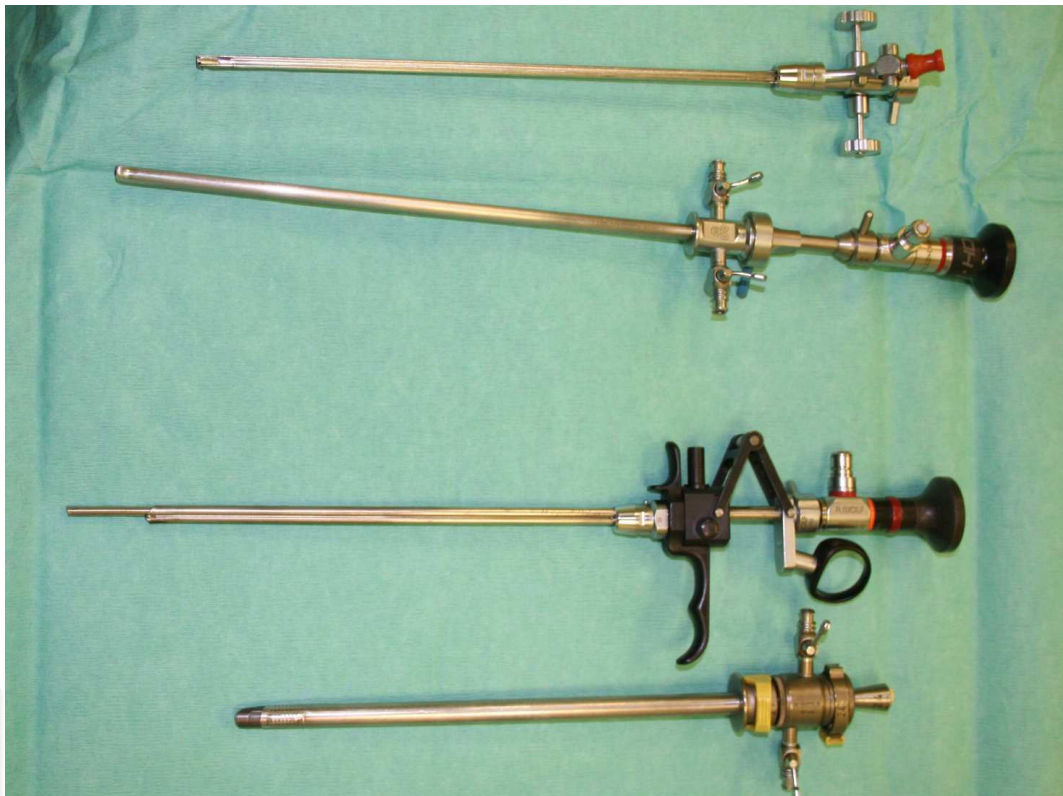


Fig. 2. Instruments used in Lower tract endoscopy

From top to bottom; Modern Albarran catheterizing bridge, Rigid cystoscope in its 22f sheath, Resectoscope working element with its lens and resectoscope sheath and obturator.

TURBT starts with bimanual palpation to assess whether a tumour mass is palpable and to ascertain whether its mobile. A fixed mass implies a more locally advanced disease process. Following this, a rigid cystoscopy is performed to visualise the bladder tumour and assess the size (in cm), appearance (?papillary, ?solid, ?flat/red area) , position (base, lateral wall, posterior wall, dome) and their relationship to the ureteric orifici.

A resectoscope is then placed per-urethrally with an external diameter 18Ch and 28 Ch. Identified lesions are then resected using a loop electrode and sent for histology. Bladder muscle (muscularis propria) should be present in resected tissue as the presence of TCC in

muscle is the hallmark of muscle invasive disease. The resected tissue is then removed using an Ellik evacuator and diathermy to bleeding points performed with a rollerball electrode. At the end of the procedure, repeat bimanual palpation is performed as a means of ensuring complete resection of the lesion. A 3-way irrigation catheter is inserted and removed within 24-48 hours unless an extra-peritoneal perforation has occurred. For tumours which appear superficial, Intravesical Mitomycin C within 24 hours of resection has been shown to reduce number of recurrences by 39% (Sylvester et al., 2004). Currently the only place for open procedures in TCC diagnosis and management is in radical cystectomy and a urinary diversion procedure. However, the technique of laparoscopic cystectomy has been developed (Parra 1992) and is gaining acceptance.

2.3 Trans-Urethral Resection of Prostate (TURP)

While the majority of men are managed medically, TURP is the gold standard surgical treatment for lower urinary tract symptoms (LUTS) due to benign prostatic hyperplasia (BPH) causing bladder outlet obstruction (BOO). TURP involves resection of prostatic adenomatous tissue to the level of the prostatic capsule. Prostatic chippings are flushed into the bladder during resection by irrigation fluid (usually 1.5% glycine) and at the end of the procedure washed out from the bladder (using Ellik bladder evacuator) and sent for histological examination. The most important landmarks are the ureteric orificii proximally and the Veru montanum distally. The Veru is the marker of the proximal limit of the external sphincter, damage to which results in stress urinary incontinence.

TURP is performed for men with voiding symptoms which fail to respond to medical treatment (alpha-blockers, 5-alpha reductase inhibitors), for men with urinary retention (failed trial of catheter removal on medical treatment) and for those who develop complications of bladder outlet obstruction especially renal impairment. Complications are as follows severe bleeding requiring blood transfusion (1-2%), sepsis (3%), TUR syndrome (<1%), urinary incontinence (<1%), bladder neck stenosis/ urethral stricture (3-5%), retrograde ejaculation (80-100%) and erectile dysfunction (approximately 10%). Alternative surgical treatments include "Greenlight" laser ablation or Holmium laser enucleation, both of which are performed under cystoscopic guidance. Smaller prostates are also managed endoscopically using a Bladder Neck Incision (BNI). Open surgery for benign prostatic disease is now extremely rare and performed only when the prostate is > 100 gr or if there is a concurrent bladder stone (McAllister 2010).

2.4 Technological advances in the endoscopic diagnosis of bladder cancer

The development of distal sensor technologies has led to development of techniques which aim to increase the diagnostic capability of white-light cystoscopy (WLC) in the detection of TCC. Probably the two landmark developments are Photodynamic diagnosis (PDD), also referred to as "fluorescence cystoscopy" and Narrow-Band Imaging (NBI).

2.4.1 Photodynamic diagnosis (PDD)

PDD requires the intravesical instillation of a fluorescent agent (e.g. 5-aminolaevulinic acid (5-ALA), or its ester hexaminolevulinate) before performing blue-light cystoscopy. The principle of PDD is based on the difference in uptake of fluorescence molecules in normal and pathologic tissue. Absorption of light of an appropriate wavelength causes excitation of the fluorophore molecule which on returning to its ground state emits a photon equivalent

to the energy difference between these states. Endoscopes with specially developed light sources and filters are used, and with the aid of a foot pedal or push-button on the camera one can easily switch from WLC to PDD. By illuminating the bladder wall with blue light, the malignant tissue appears intensely pink or red on a blue background (Cauberg et al., 2009). Clinical trials have shown that the detection of TCC with PDD is superior to WLC with reported sensitivities of 82-97% for PDD versus 62-84% for WLC. With regard to the detection of CIS lesions, PDD performs significantly better than WLC with detection rates of 92-97% versus 56-68%, respectively. PDD use may also have an impact on recurrence rate. This has been studied by cystoscopic re-evaluation six weeks following initial resection using WLC or Blue light cystoscopy. Results of published studies seem to show a statistically significant reduction in residual tumour if resection was performed with PDD (25-53% for white-light resection vs 4- 32% for PDD-assisted resection). However, PDD has a relatively low specificity, ranging from 41 to 98% and false-positive fluorescence can be induced by inflammation, scarring after TUR, prior intravesical therapy and tangential illumination of mucosa (Cauberg et al., 2009). It is hoped that the initial cost of the technology will be recouped by an increased recurrence-free survival or progression-free survival. This remains to be proven in larger randomised clinical trials.

2.4.2 Narrow-band imaging (NBI)

NBI is an optical image enhancement technique designed to enhance the contrast between mucosal surfaces and microvascular structures without the use of dyes. It is based on the phenomenon that the depth of light penetration into the mucosa increases with increasing wavelength. The tissue surface is illuminated with light of a narrow bandwidth, with centre wavelengths in the blue (415 nm) and green (540 nm) spectrum of light. Since these specific wavelengths are strongly absorbed by haemoglobin, the vascular structures appear dark brown or green against a pink or white mucosal background. Systems that have integrated NBI and WLC are commercially available. With the push of a button, the NBI mode is activated by mechanical insertion of the narrow-band filter in front of the white-light source. NBI has not been as extensively investigated as PDD and therefore it is hard to know the effect of inflammation, previous intra-vesical instillations or scarring on its sensitivity (Cauberg et al., 2009). The inherent advantage of NBI over PDD is that it avoids the physical discomfort and extra cost associated with requirement for instillation of the intra-vesical agent pre-operatively. The small number of studies performed comparing NBI to WLC suggested a non-significant improvement in the detection of bladder cancer, but more studies are needed to assess the benefit of NBI further.

2.5 Optical urethrotomy (figure 3)

Modern Urethral stricture diagnosis is primarily by flexible endoscopy. The initial endoscopy can identify the number of, diameter of and the rigidity of any identified strictures. Previously diagnosis was primarily by radiological means prompted by clinical suspicion. It is possible to definitively treat a stricture by endoscopic means by performing a Direct Visual Internal Urethrotomy, using an optical urethrotome.

An Optical urethrotome has a straight (0 degree) lens, cold knife and a channel for the introduction of a guide-wire into the bladder. This guidewire allows a urethral catheter to be passed if bleeding obscures visualisation of the lumen. A cold-knife incision is made at the 12 o'clock position until the lumen of the strictured segment is approximately the same

as of the remaining urethra. A 16-18 Fr catheter is inserted post-operatively and removed after 2-5 days. Optical urethrotomy is most suitable for strictures less than 1 cm in length, of the Bulbar urethra (71% success rate) and for strictures with a calibre of greater than 15F (69% vs 36%). Recurrences, if they occur, will do so within 12 (56%) or 24 months (26%) months (Pansadoro 1996). For all other strictures the definitive treatment should still be open reconstructive surgery.



Fig. 3. Anterior Urethral stricture at Direct Visual Optical Urethrotomy (optical urethrotomy with a cold knife seen at 12 o'clock)

Endoscopy of upper urinary tract

2.6 Ureteroscopy (figure 4)

Ureteroscopy can be performed using semi-rigid or flexible instruments to allow visual inspection of ureter and renal pelvis (semi-rigid ureteroscope) and major and minor renal calyces (flexible ureteroscope). Semi-rigid ureteroscopes have high-density fibre-optic bundles for light (non-coherently arranged) and image transmission (coherently arranged to maintain image quality). The instrument can be bent by several degrees without the image being distorted, hence the description semi-rigid. The working tip of most current models is 7-8 Ch with the proximal end being 11-12 Ch. There is usually at least one working channel of at least 3 or 4 Ch (Reynard et al., 2009). In a flexible instrument, the operator can control the degree of deflection of the distal end (active deflection). Behind the actively deflecting tip is a segment of greater flexibility than the rest of the shaft. This section is able to undergo passive deflection (when the tip is fully actively deflected, by advancing the scope further, this flexible segment allows even more deflection). The fibre-optic bundles in flexible instruments are identical to those in semi-rigid scopes, only of smaller diameter. The price of the extra mobility is reduced image quality and light transmission (Reynard et al., 2009). The working tip of most current models is 7-8 Ch, with the proximal end of the scope 9-10 Ch. There is usually at least one working channel of at least 3.6 Ch. Flexible instruments are more expensive and less durable than semi-rigid scopes.

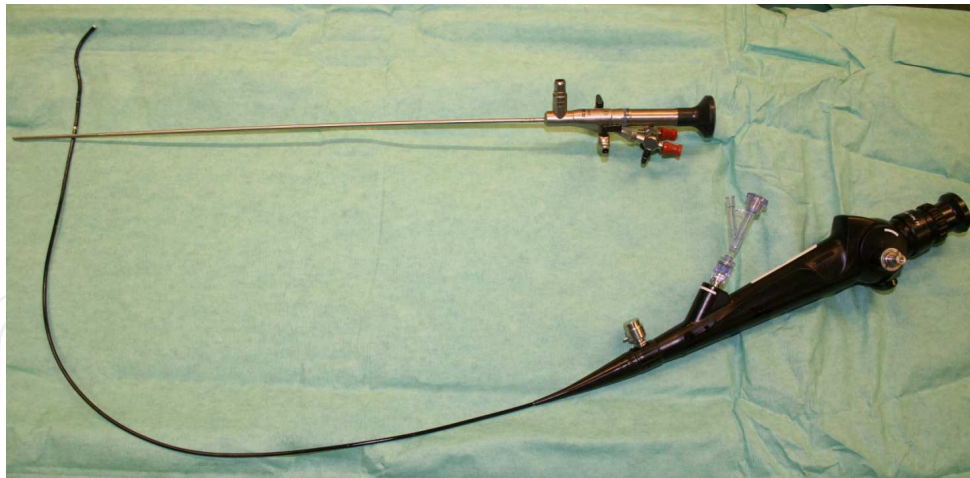


Fig. 4. Examples of Modern Upper Tract instruments in routine Urological use. Top: Semi-Rigid Ureteroscope. Bottom: Flexible Ureteroscope (fibre-optic technology)

The indications for ureteroscopy are either diagnostic (e.g. patient with haematuria and filling defect in upper urinary tract on contrast study) or therapeutic. The primary therapeutic use of Ureteroscopy is in upper tract stone disease (figure 5) where stone destruction can be achieved with laser, ultrasonic or EHL (electrohydrolic) technology. Fragments can be removed using a variety of baskets introduced through the working channel. Potential complications include stone migration (4%), ureteric injury (3.5%), sepsis (1%) and failure to reach stone (3.7%) (Geavlete 2006).

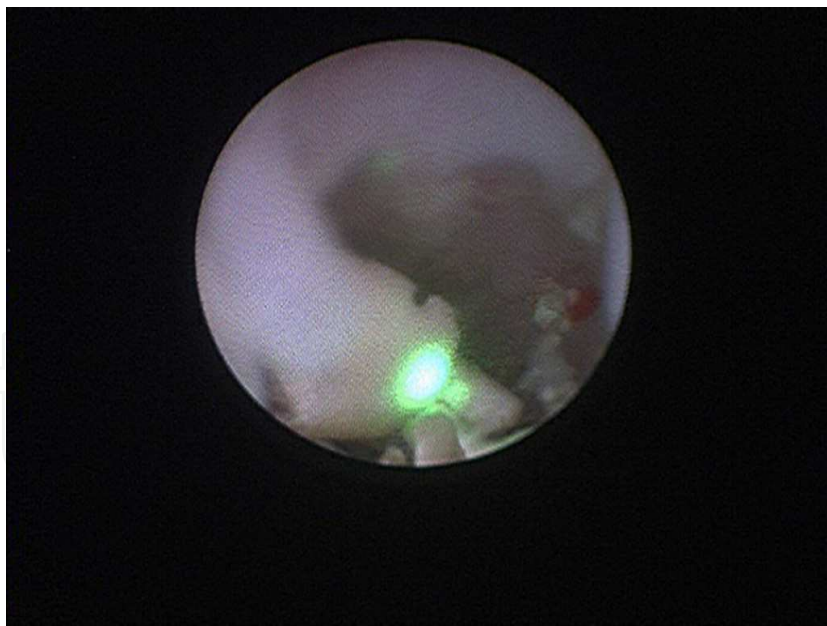


Fig. 5. Ureteroscopic holmium laser lithotripsy. Laser fibre at 6 o'clock with green aiming beam shining on the stone.

to the extent that, for stones requiring surgical treatment, open stone surgery is now the exception rather than the normal. The other main therapeutic indication is in selected cases of upper urinary tract transitional cell carcinoma (TCC).

2.7 Per-Cutaneous NephroLithotomy (PCNL)

The first PCNL was performed in 1976. Since then open nephrolithotomy has reduced in frequency to the current rate of < 1% of all stone procedures. The current treatment options are PCNL, Shock-wave lithotripsy and flexible ureteroscopy. PCNL is the 1st line treatment option for staghorn and other large renal stones (>2 cm in maximum diameter). A Staghorn stone is defined as a stone filling the entire renal pelvis and at least one (partial staghorn) or all of the calyces (complete staghorn). PCNL is also indicated for smaller stones in specific circumstances such as abnormal anatomy (e.g. horseshoe kidney, calyceal diverticulum), failure of other treatment options (ureteroscopy, ESWL) or patient preference. PCNL is more invasive (higher morbidity) than ureteroscopy or ESWL but has a higher efficacy in single treatment stone clearance (especially for larger stones). Treatment of lower pole calyceal stones measuring 1-2 cm in maximum diameter remains a controversial issue. As stated above, the available options are flexible ureteroscopy, ESWL or PCNL. Access to the lower pole calyx by flexible ureteroscopy can be difficult and the stone-free rates after ESWL are lower than for stones in other parts of the kidney. This has led some to favour PCNL as the first line option for 1-2 cm stones in lower pole calyx. Two prospective, randomised studies tried to resolve this problem; Lower Pole Study I (Albala et al., 2001) and Lower Pole Study II (Pearle et al., 2005). Lower Pole Study I compared ESWL to PCNL for 1-3 cm stones localised in lower pole calyx. PCNL was more successful (95% vs 37%) but had higher morbidity. Lower Pole Study II compared ESWL to Ureteroscopy for <1 cm stones in lower pole calyx. Ureteroscopy was more successful in stone clearance (50% vs 35%) but due to relatively small number of patients (n=67) this result failed to achieve statistical significance. Despite these two studies the question of the best treatment for <2 cm lower pole calyceal stones remains difficult to answer and proper patient counselling about pros and cons of each therapeutic option is crucial.

How is PCNL performed? The patient has been traditionally placed prone, but over the recent years it has been demonstrated that PCNL is also feasible in supine position. Ureteric catheterisation (with or without balloon) is performed primarily to fill the collecting system which facilitates puncture (contrast and methylene blue injected through ureteric catheter dilates and opacifies collecting system) but also to minimise migration of stone fragments into the ureter. The puncture can be made under combined ultrasound and X-ray control or under fluoroscopy. Ultrasound makes it easier to identify, and therefore avoid damage to, neighbouring organs. In rare cases with complex anatomy, CT-guided renal access may be an option (Turk et al., 2010). The most common access is through the posterior lower pole calyx. It is the safest access point due to absence of major blood vessels (so called Brodel's avascular zone) and low risk of pleural injury. In selected cases (e.g. complex staghorn stones) a supra-costal upper pole access or even multiple punctures have been used. After successful puncture of the renal collecting system, dilatation of renal tract is performed using Amplatz system, balloon or metallic dilators (choice depends on availability, experience and cost). After insertion of the nephroscope, the stone is disintegrated using ultrasound, laser, or pneumatic energy. Fragments are removed using suction (via ultrasound probe) or specially designed forceps. In complicated cases (or when second intervention is necessary), a self-retaining balloon nephrostomy tube tamponades the tract and maintains access to the collecting system. Although standard nephroscopes have shaft calibres of 24-30 F, "mini-perc" instruments are now available with shaft calibres of 12-20 F.

Mini-perc is the method of choice for PCNL in children (Turk et al., 2010). The value of mini-perc in adults hasn't been established (as treatment time increases with stone size and also with decreased instrument size- mini-perc in adults would be recommended only for <2 cm stones where many experts would argue that alternative options- ESWL or URS would be preferred). In uncomplicated cases, tubeless PCNL (with or without application of sealant or JJ stent) has been mentioned over the last few years as an alternative (Turk et al., 2010). The percutaneous route has also been used to treat PUJ (Pelvi-ureteric Junction) obstruction as a concurrent procedure to stone treatment.

The major complications of PCNL are infection, bleeding and internal organ injury. Many of the larger stones are either infection stones or cause obstruction. In view of this, peri-operative antibiotic prophylaxis is a standard of practice. The choice of antibiotic is guided by preoperative urine cultures and local antibiotic policies.

Bleeding following PCNL can be severe enough to require blood transfusion but rarely needs intervention such as embolisation or Nephrectomy. Internal organ injury can affect pleura (risk higher if attempting upper pole puncture), bowel (risk especially if bowel lies behind kidney- CT is therefore important to show the bowel position and plan the access) and rarely liver or spleen.

2.8 Relief of ureteric obstruction

Endoscopic placement of ureteric stents (ie Retrograde stent insertion) is the commonest method of relieving ureteric obstruction. Stents are either barium impregnated polymer compounds or metallic. Drainage occurs either through or around the tubes. The JJ shape contains coils at both ends to help retain the stent in its position. Retrograde stenting is used for both intrinsic and extrinsic malignant obstruction and less successfully for retroperitoneal obstruction due to fibrotic benign pathology. Prophylactic stenting is used prior to ESWL for large stones where the fragments could obstruct the ureter (ie Steinstrasse). Post-operatively stent placement is used to ensure urinary drainage following prolonged/ complicated ureteroscopy or PUJ procedures.

Retrograde stenting is performed usually under anaesthetic. The ureteric orifice is visualised at cystoscopy, it is then cannulated with an open-ended polymer catheter and retrograde studies are performed to outline the ureter and renal collecting system. A guide-wire is passed through the ureteric orifice into the collecting system (ideally upper pole calyx). The appropriate stent (dependent on patient height) is inserted over the guide-wire, under X-ray guidance, so that the upper end of the stent is in the correct position in renal collecting system. The guide-wire is then removed and both ends of stent subsequently coil (they have "memory").

The most common adult stents are 4.8-6 Fr and 22-28 cm long. Some stents have a hydrophilic coating (makes them more slippery and easier to insert), some are multi-length (no need to adjust according to patient's height). Endopyelotomy stents are wider towards the upper end (10-14 Fr)- to keep PUJ wide open while it heals.

The complications commonly associated with stent usage are storage LUTS (frequency, urgency) and haematuria. Stent migration is less common and can occur in both directions. Probably the biggest concern is stent calcification due to "forgotten stent". If only the lower end of the stent is calcified treatment can usually be completed endoscopically. Calcification of a stent above the bladder will require ureteroscopic lithotripsy, PCNL or even open surgery to facilitate removal.

3. Organ ablative surgery

While the majority of lower tract and stone surgical treatments are now performed endoscopically the field of organ ablation remains the domain of the “open” surgeon. However that is changing and started when the first laparoscopic trans-abdominal nephrectomy was performed in 1990 by Clayman and colleagues at Washington University. The progress of endoscopy techniques in organ ablative urological surgery is mirrored in the changed attitudes to laparoscopic nephrectomy and hence this procedure will be the focus of this section.

3.1 Laparoscopic nephrectomy

Following the initial nephrectomy, techniques have evolved so that laparoscopic radical nephrectomy is almost the standard procedure for T1- T2 tumours (those limited to the kidney and less than 7 cm *i.e.* T1 or less than 10 cm *i.e.* T2) where renal sparing procedures are inappropriate. In experienced hands T3 tumours (*i.e.* involving renal vein or vena cava) can also be removed using this endoscopic technique. The Oncological outcomes are almost identical with disease free survival rates of 94% and 95 % respectively for the open and laparoscopic approaches (Hemal 2007). When morbidity and return to normal function are analysed it appears that the laparoscopic approach to nephrectomy is better in all measured outcomes apart from a prolongation of operative time (Nandis 2008).

Indeed the debate around nephrectomy now centres on whether the NOTES approach to nephrectomy should be the method of choice. Preservation of renal tissue may be associated with an independent reduction in cardio-vascular and all causes mortality rates (Go 2004). This has led to the increased utilisation of partial nephrectomy for T1a (ie < 4 cm) lesions. While the open approach to partial nephrectomy is the more popular approach there are an increasing number of centres performing laparoscopic partial nephrectomy. For a more detailed description of laparoscopic techniques I would suggest Bishoff and Kavoussi's Atlas of Laparoscopic Urologic Surgery (2007) as an introductory text.

Currently, in the field of organ ablative urology, laparoscopic techniques (including robotics) are commonly being used for nephrectomy, nephro-ureterectomy and radical prostatectomy. Their use in procedures such as retro-peritoneal lymph node dissection or radical cystectomy remains to be proven.

4. Conclusion

To the reader of this chapter, it may appear that we have only provided a summary of modern urology. Of itself this impression should illustrate clearly the central place of endoscopy and endoscopic techniques in modern urological practise. Obviously we could not describe all endoscopic techniques used in urology but we have tried to describe the more commonly performed procedures. In places we have shown how developments are further improving efficacy of endoscopic techniques and increasing the range of conditions treated by endoscopic means.

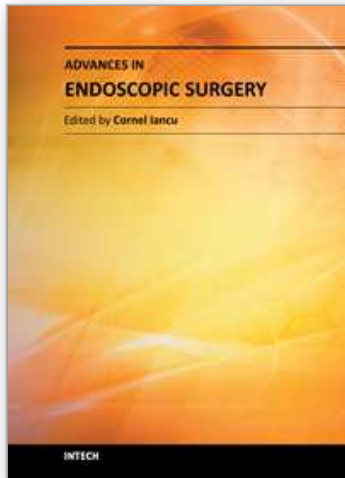
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