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Research Article

Briefly about The Ureter

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Abstract

Every man has two kidneys. Each kidney has a ureter, which drains urine from a central collection point into the bladder. From the bladder, urine is excreted through the urethra from the body through the penis in men and the vulva in women. The most important role of the kidneys is to filter metabolic waste products and excess salt and water from the body and help remove them from the body. The kidneys also help regulate blood pressure and make red blood cells.

Keywords: Kidney; Obstruction; UTI; Injury

Introduction

The ureters are tubular structures responsible for the transportation of urine from the kidneys to the bladder. The length ranges from 22 to 30 cm, and they have a wall made up of multiple layers. The innermost layer is made up of transitional epithelium, surrounded by the lamina propria, which is a connective tissue layer. These two layers make up the mucosal lining. The next layer is made of smooth muscle that, as mentioned previously, is continuous with that of the calyces and the renal pelvis. However, one slight difference is that within the ureter, the smooth muscle layer is divided into an inner longitudinal and an outer circular layer. These muscular layers allow peristalsis of urine. The outermost layer is the adventitia, which is a thin layer enveloping the ureter, its blood vessels, and lymphatics. The ureter is often divided into three segments: the upper (proximal), middle, and lower (distal) segments. The upper segment starts from the renal pelvis to the upper border of the sacrum. The middle segment is the part between the upper border and lower border of the sacrum. The lower segment is from the lower border of the sacrum to the bladder.

Anatomy

Each ureter lies posterior to the renal artery and vein at the ureteropelvic junction [1]. They then descend anterior to the psoas major muscle and the ilioinguinal nerves, just anterior to the tips of the lumbar transverse vertebral processes. Approximately a third of the way down, the ureters are crossed by the gonadal vessels. They then cross the bifurcated common iliac arteries and run along the anterior border of the internal iliac artery toward the bladder, which it pierces in an oblique manner. It is this oblique entry of the ureter into the bladder, the intramural segment of the ureter that acts as a nonreturn valve preventing vesicoureteric reflux. This valve can be congenitally defective such as that seen in those with short intramural segments, or rendered ineffective as a result of injury, such as surgery or disease, all of which leads to reflux. Many congenital abnormalities of this oblique tunnel are seen in association with a duplex kidney and ureterocoele. In its lower third, the ureters pass posterior to the superior vesical branch of the internal iliac artery also called 'umbilical artery'. On the right side, the ureter is related anteriorly to the second part of the duodenum, caecum, appendix, ascending colon, and colonic mesentery. The left ureter is closely related to the duodenojejunal flexure of Treitz, descending and sigmoid colon, and their mesenteries.

Obstruction

The diagnosis of obstruction cannot be made on the basis of haematological or biochemical tests [2]. There may be evidence of impaired renal function, anaemia of chronic disease, haematuria or bacteriuria in selected cases. Ultrasonography is a reliable means of screening for upper urinary tract dilatation. Ultrasound cannot distinguish a baggy, low-pressure, unobstructed system from a tense, high pressure, obstructed one, so that falsepositive scans are seen. A normal scan usually but not invariably rules out urinary tract obstruction. If obstruction is intermittent or in its very early stages, or if the pelvicalyceal system cannot dilate owing to compression of the renal substance, for example by tumour, the ultrasound scan may fail to detect the problem. Radionuclide studies may be helpful. If obstruction has resulted in prolongation of the time taken for urine to travel down the renal tubules and collecting system (obstructive nephropathy) this can be detected by nuclear medicine techniques and is diagnostic. Conversely, in the presence of a baggy, low-pressure, unobstructed renal pelvis and calyceal system, nephron transit time will be normal, but pelvic transit time prolonged. If doubt exists, frusemide may be administered; satisfactory 'washout' of radionuclide rules out obstruction and vice versa. Relative uptake of isotope may be normal or reduced on the side of the obstruction and peak activity of the isotope may be delayed. In general, absence of uptake of radiopharmaceutical indicates renal damage sufficiently severe to render correction of obstruction unprofitable. Isotope studies may thus provide a guide to the form of surgery to be undertaken. Antegrade pyelography and ureterography are extremely useful in defining the site and cause of obstruction and can be combined with drainage of the collecting system by percutaneous needle nephrostomy. The risk of introducing infection is less than with retrograde ureterography in which technique instrumentation of the bladder is followed by injection of contrast into the lower ureter or ureters. This technique is indicated if antegrade examination cannot be carried out for some reason or if there is a possibility of dealing with ureteric obstruction from below at the time of examination. Ureteral obstruction occurs in 2–10% of renal transplants and often manifests itself as painless impairment of graft function due to the lack of innervation of the engrafted kidney [3]. Hydronephrosis may be minimal or absent in early obstruction, whereas low-grade dilatation of the collecting system secondary to edema at the ureterovesical anastomosis may be seen early post-transplantation and does not necessarily indicate obstruction. A full bladder may also cause mild calyceal dilatation due to ureteral reflux and repeat ultrasound with an empty bladder should be carried out. Persistent or increasing hydronephrosis on repeat ultrasound examinations is highly suggestive of obstruction. Renal scan with furosemide washout may help support the diagnosis, but it does not provide anatomic details. Confirmation of the obstruction can be made by retrograde pyelogram but the ureteral orifice may be difficult to catheterize. Although invasive, percutaneous nephrostomy tube placement with antegrade nephrostogram is the most effective way to visualize the collecting system and can be of both diagnostic and therapeutic value.

Blood clots, technically poor reimplant, and ureteral sloughing are common causes of early acute obstruction after transplantation. Ureteral fibrosis secondary to either ischemia or rejection can cause intrinsic obstruction. The distal ureter close to the ureterovesical junction is particularly vulnerable to ischemic damage due to its remote location from the renal artery, hence compromised blood supply. Although uncommon, ureteral fibrosis associated with polyoma BK virus in the setting of renal transplantation has been well-described. Ureteral kinking, lymphocele, pelvic hematoma or abscess, and malignancy are potential causes of extrinsic obstruction. Calculi are uncommon causes of ureteral obstruction. Definitive treatment of ureteral obstruction due to ureteral strictures consists of either endourologic techniques or open surgery. Intrinsic ureteral scars can be treated effectively by endourologic techniques in an antegrade or retrograde approach. An indwelling stent may be placed to bypass the ureteral obstruction and removed cystoscopically after 2–6 weeks. An antegrade nephrostogram should be performed to confirm that the urinary tract is unobstructed prior to nephrostomy tube removal. Routine ureteral stent placement at the time of transplantation has been suggested to be associated with a lower incidence of early postoperative obstruction. Extrinsic strictures, strictures that are longer than 2 cm, or those that have failed endourologic incision, are less likely to be amenable to percutaneous techniques and are more likely to require surgical intervention. Obstructing calculi can be managed by endourologic techniques or by extracorporeal shock wave lithotripsy.

UTI

Urinary tract infections (UTIs) are the most common bacterial infection in the paediatric population [4]. The incidence is initially higher in boys, affecting up to 20.3% of uncircumcised boys and 5% of girls at the age of 1. There is a gradual shift, with UTIs affecting 3% of prepubertal girls and 1% of prepubertal boys. The National Institute for Health and Care Excellence (NICE) have defined a recurrent UTI as two or more episodes of pyelonephritis, or one episode of pyelonephritis plus one or more episodes of cystitis, or three or more episodes of cystitis. Diagnostic investigations include urinalysis, which may require suprapubic bladder aspiration or bladder catheterisation in infants. A urine culture and microscopy should be carried out if there is evidence of infection. The role of further imaging is to differentiate between an uncomplicated and complicated UTI, but should also be considered in those with haematuria. A UTI is complicated in the presence of an abnormal urinary tract including upper tract dilatation, atrophic or duplex kidneys, ureterocoele, posterior urethral valves, intestinal connections, and vesico-ureteric reflux (VUR). NICE guidelines recommend an urgent ultrasound of the urinary tract for all those with recurrent UTI under six months. For children six months and older, NICE in the UK recommends an ultrasound within six weeks of the latest infective episode. All children with recurrent UTIs should be referred to a paediatric specialist and have a dimercaptosuccinic acid (DMSA) scan within four to six months of an acute infection to evaluate for renal scarring. European Association of Urology (EAU) guidelines recommend a renal tract ultrasound in febrile UTIs if there is no clinical improvement, as an abnormal result is seen in 15% of these patients. Routinely repeating a urine culture in children treated with an antibiotic based on previous urine culture susceptibilities is not necessary [5]. Approximately 10%–30% of children develop at least one recurrent UTI, and the recurrence rate is highest within the first 3 to 6 months after a UTI. Renal scarring increases with an increasing number of febrile UTIs and with delayed treatment; therefore, parents should be counseled regarding the high risk of recurrent UTI and seek prompt evaluation for subsequent febrile illnesses in their child. Children who had a febrile UTI should routinely have their height, weight, and blood pressure monitored by their primary care provider. Children with significant bilateral renal scars or a reduction of renal function warrant long-term follow-up for the assessment of hypertension, renal function, and proteinuria.

Colic

Urolithiasis represents the commonest cause of acute ureteric colic, with calcium stones accounting for approximately 80% of cases [6]. Ureteric calculi have a prevalence of approximately 2–3% in Caucasian populations, with a lifetime risk of 10–12% in males and 5–6% in females. They are more common in developed countries, in men, in those with a positive family history, and in those with inadequate daily water intake. Ureteric colic typically presents with acute severe loin pain – which patients often describe as unrelenting despite a number of postural changes – and haematuria. Vomiting is often a feature of severe uncontrolled pain. Most patients with renal colic present because of severe uncontrolled pain and do not have signs of overt sepsis. Opiates are commonly given, although diclofenac sodium has been shown to be at least as effective for pain relief, particularly via rectal administration. Despite initial concerns, diclofenac sodium therapy has not been associated with renal toxicity in patients with pre-existing normal renal function. Fever, tachycardia, tachypnoea and hypotension suggest sepsis secondary to an infected, obstructed kidney, which represents a life-threatening condition. Immediate management comprises prompt resuscitation, establishment of intravenous (IV) antibiotics, rapid diagnosis and decompression of the obstructed renal system, usually by ultrasound-guided percutaneous nephrostomy. Early involvement of urology and critical care services is essential in such patients. The management of ureteric calculi depends upon factors relating to the stone and the patient. Pre-eminent stone factors are size and site. It has been shown that 71–98% of stones <5 mm will pass spontaneously, whereas rates of spontaneous passage for stones >7 mm are low. Stone passage is also related to location in the ureter; 25% of proximal, 45% of mid and 75% of distal ureteric stones will pass spontaneously. In patients in whom stone passage is deemed likely, a trial of conservative management should be employed. Exceptions include patients with a functional or anatomical solitary kidney, bilateral ureteric obstruction, uncontrolled pain, or the presence of infection. Patients without contraindications should receive diclofenac sodium 50 mg tds, which has been shown to reduce the frequency of recurrent renal colic episodes. Recent evidence suggests that additional treatment with smooth muscle relaxants is associated with increased rates of stone passage over analgesics alone. A recent meta-analysis of studies using either nifedipine or tamsulosin, showed an approximate 65% greater chance of stone passage when such agents were used compared with equivalent controls. Intervention is generally reserved for large stones (>7 mm), conservative treatment failures and those with contraindications to a watchful waiting approach. Options include extracorporeal shock-wave lithotripsy and retrograde ureteroscopic stonefragmentation.

A stone can traverse the ureter without symptoms, but passage usually produces pain and bleeding [7]. The pain begins gradually, usually in the flank, but increases over the next 20–60 min to become so severe that narcotics may be needed for its control. The pain may remain in the flank or spread downward and anteriorly toward the ipsilateral loin, testis, or vulva. A stone in the portion of the ureter within the bladder wall causes frequency, urgency, and dysuria that may be confused with urinary tract infection. The vast majority of ureteral stones <0.5 cm in diameter pass spontaneously. Helical computed tomography (CT) scanning without radiocontrast enhancement is now the standard radiologic procedure for diagnosis of nephrolithiasis. The advantages of CT include detection of uric acid stones in addition to the traditional radiopaque stones, no exposure to the risk of radiocontrast agents, and possible diagnosis of other causes of abdominal pain in a patient suspected of having renal colic from stones. Ultrasound is not as sensitive as CT in detecting renal or ureteral stones. Standard abdominal x-rays may be used to monitor patients for formation and growth of kidney stones, as they are less expensive and provide less radiation exposure than CT scans. Calcium, cystine, and struvite stones are all radiopaque on standard x-rays, whereas uric acid stones are radiolucent.

Ureteral Stone Disease

Nephrolithiasis occurs with an estimated overall prevalence of 5.2% and there is evidence that stone disease is on the rise [8]. However, many stones in the kidney go undetected because they cause no symptoms or obstruction. Conversely, ureteral stones rarely remain silent, and they have greater potential for causing pain and obstruction. As such, ureteral stones that fail to pass spontaneously require surgical intervention. Although the introduction of medical expulsive therapy (MET, the use of pharmacological agents to promote spontaneous stone passage) has changed the natural history of ureteral stone disease, not all ureteral stones respond to MET. Indications for surgical intervention to remove ureteral calculi include stones that are unlikely or fail to pass spontaneously with or without MET, stones that cause unremitting pain regardless of the likelihood of spontaneous passage, stones associated with persistent, high-grade obstruction, stones in patients with an anatomically or functionally solitary kidney or in those with renal insufficiency or stones in patients for whom their occupation or circumstances mandate prompt resolution (i.e. pilots, frequent travelers, etc.). Once the decision has been made to intervene surgically for a patient with a ureteral stone, treatment options include shock-wave lithotripsy, ureteroscopy, percutaneous antegrade ureteroscopy and open or laparoscopic ureterolithotomy. Although special cirumstances may dictate the application of percutaneous antegrade ureteroscopy or ureterolithotomy (large, impacted stones, stones in patients with urinary diversions or stones that fail less invasive approaches), the two most widely practiced treatment modalities for ureteral stones are shock-wave lithotripsy (SWL) and ureteroscopy (URS). Both are associated with high success rates and low morbidity. However, the optimal treatment for ureteral stones remains controversial because of passionate advocates on both sides of the controversy. Proponents of SWL cite the noninvasiveness, high patient satisfaction and ease of treatment, while URS advocates favor the short operative times, high success rates and short time interval to become stone free.

Cystoscopy

Cystoscopic examination of urethra and bladder should be systematic [9]. The female urethra is only 2.5–4 cm long. Urethral mucosa should be examined for strictures, diverticular opening, or polyps, and the bladder neck is visualised as scope enters and exits the bladder. Base and trigone of the bladder are initially inspected. Trigone lies proximal to the bladder neck; it is the triangular area bounded by the inter-ureteric ridge and the bladder neck at the base of the bladder. One of the most common features of the trigone is squamous metaplasia, present in up to 50% of the women. It is a benign feature with no malignant potential. In staging for cervical cancer, when imaging suggests stage 3 or 4 disease, cystoscopy is indicated. The bladder base and trigone appearance such as bullous edema, inflammatory changes, or infiltration has to be documented, and in case of infiltration, biopsy should be part of the evaluation. Ureteric orifices are slit-like openings easily identifiable by the presence of efflux on either side of the inter-ureteric ridge. The ureteral orifices location, number, nature of ureteric efflux (clear, blood stained), and any anatomical distortion is noted. In a woman with anterior vaginal wall prolapse or an underlying cervical mass, identification of trigone or ureteric orifices may be difficult. In such cases, placing a finger inside the vagina and elevating the bladder base with a finger will be helpful. Blood stained ureteric efflux denotes upper tract pathology and further assessment of the ureter and kidneys is indicated, either by ultrasound or a CT scan of the kidneys, ureters, and bladder (CT KUB). In intra-operative or post-operative ureteral integrity assessment, presence of just ureteric peristalsis does not rule out ureteral injury. Checking for ureteric efflux after administration of methylthionium chloride or indigo carmine (5ml) IV is effective in confirming ureteral patency.

Injury

Most ureteral injuries are iatrogenic in the course of pelvic surgery [10]. Ureteral injury may occur during transurethral bladder or prostate resection or ureteral manipulation for stone or tumor. Ureteral injury is rarely a consequence of penetrating trauma. Unintentional ureteral ligation during operation on adjacent organs may be asymptomatic, though hydronephrosis and loss of renal function results. Ureteral division leads to extravasation and urinoma. If the ureteral injury is not recognized at surgery, the patient may complain of flank and lower abdominal pain on the injured side. Ileus and pyelonephritis may develop. Later, urine may drain through the wound (or through the vagina following transvaginal surgery) or there may be increased output through a surgical drain. Wound drainage may be evaluated by comparing creatinine levels found in the drainage fluid with serum levels; urine exhibits very high creatinine levels when compared with serum. Intravenous administration of 5 mL of indigo carmine causes the urine to appear blue-green; therefore, drainage from an ureterocutaneous fistula becomes blue, compared to serous drainage. Anuria following pelvic surgery not responding to intravenous fluids may rarely signify bilateral ureteral ligation or injury. Peritoneal signs may occur if urine leaks into the peritoneal cavity.

Conclusion

The ureter starts from the renal pelvis, descends down the retroperitoneal space of the abdominal cavity and enters the pelvis, where it ends by pouring into the urinary bladder. Therefore, it distinguishes the abdominal and pelvic part. The boundary between these parts is the so-called terminal line. When entering the pelvic cavity, the ureter forms a border curve and in this narrowed part the kidney stone can be stopped. The curvature of the ureter is projected on the anterior abdominal wall in the area of the Hale topographic point. Urinary tracts pass through the bladder wall obliquely. When the bladder wall is stretched, the fold of its mucosa acts as a valve and prevents the return of urine to the ureters and the possible spread of infection from the bladder to the kidneys.

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