An Outline of Urology

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Preface

The purpose of this book is to give clinical surgical students an outline of diagnosis and management of disease of the genito-urinary system. With this in view, descriptive text has been curtailed to the minimum and liberal use has been made of line diagrams and radiographs. Over the past decade methods of investigation of the urinary tract have developed rapidly and it is essential that medical students should have a working knowledge of the newer techniques. The basic format of the book is a brief description of the pathology and clinical features of urological disease with a more detailed appraisal of diagnostic methods employed and a report on the current treatment of any particular urological condition. The book should be useful to the clinical student and junior house officer as a ready reminder of present-day urological practice and as a volume for reading in preparation for examinations in surgery.

I am indebted to Dr Glas Griffiths and Dr Richard Harding, of the Department of Radiology of the Royal Gwent Hospital, for providing radiographic material and isotope scans. Mr Geoff Lyth has revised many of my line diagrams and prepared six new sketches. Mr Nigel Pearce and staff of the Department of Medical Illustration, Newport Hospitals, have been extremely helpful in reproducing radiographs, scans and line diagrams. My secretary, Mrs Sharon Smith, has shown inestimable patience and industry in typing the manuscript. I am extremely grateful to her and to John Wright & Sons for their advice and co-operation in producing the proofs and publishing this Outline textbook on urological surgery.

D.E.S.

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1

General considerations

• A. Applied Anatomy of the Urinary Tract

The Kidney

The kidneys are retroperitoneal organs lying opposite the 12th thoracic and upper three lumbar vertebrae, the left kidney being 2–3 cm higher in position than the right. The right kidney has the 12th rib in posterior relation to its upper third, whilst the 11th and 12th ribs lie behind the upper half of the left kidney (*Fig.* 1.1). Trauma, haematuria and radiological fractures of the 11th or 12th ribs indicate renal contusion or laceration. The relations of the structures in the renal hilum from the front to back are the vein, the artery and the renal pelvis–VAP (*Fig.* 1.2). The renal pelvis is accessible from the back or laterally, whilst an anterior approach is used for exposure of the vessels in the renal hilum.

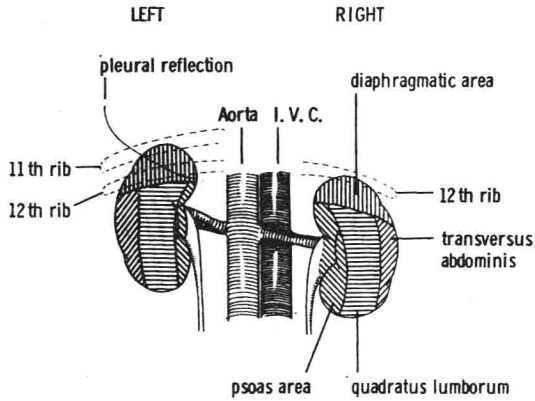

Fig. 1.1 Posterior relations of the kidneys (note pleural reflection behind upper pole of the left kidney).

The Ureter

The intra-abdominal ureter runs along the tips of the transverse processes of L2, L3, L4 and L5 lumbar vertebrae, crossing into the pelvis at the mid-point of the sacro-iliac joint, deviating laterally towards the ischial spine and then

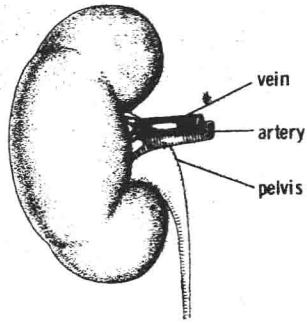

Fig. 1.2 Relations of the structures in the hilum of the kidney viewed from the front.

ascending forwards and medially to the base of the bladder. Radio-opaque calculi must be looked for along this line (*Fig.* 1.7). In the female the terminal 2 cm of the ureter are closely related to the vaginal fornix, especially on the left side where it may be at risk during gynaecological and pelvic surgical operations. The normal ureter exhibits three sites of natural narrowing—the pelvi-ureteric junction A, the bony pelvic brim A_1 and within the bladder wall B (*Fig.* 1.3).

Calculi within the ureter tend to lodge and ureteric strictures tend to occur at these three sites. Medial deviation of the abdominal ureter may indicate a caecal or ascending colon tumour on the right and a descending or pelvic colon tumour on the left. Medial deviation and obstruction of both ureters may be due to fibrosis, as in tuberculosis or retroperitoneal fibrosis. Lateral displacement of one or both ureters within the abdomen is diagnostic of a midline retroperitoneal lesion such as an aortic aneurysm or retroperitoneal tumour.

The Bladder and Prostate

In the neonatal period and infancy the urinary bladder is mainly abdominal in position and clothed with peritoneum over the upper two-thirds of its external surface; it is often easily palpated on abdominal examination. The bladder descends into the bony pelvis in childhood and in the adult only the upper one-third anteriorly and the posterior two-thirds (recto-vesical pouch) are covered with peritoneum. Trauma such as a pelvic fracture usually damages the extraperitoneal surface of the bladder (*Fig.* 5.4), except when the bladder is full of urine. The prostate gland and pubo-prostatic ligaments invest the lower trigone, bladder neck and first part of the urethra, anchoring these structures at fixed points, the rest of the bladder being mobile and contractile. Pelvic fractures produce a urethral rupture by a sheering-rotational force on this fixed point of the prostatic urethra (*Fig.* 1.4). The lateral lobes of the prostate gland are easily palpable by digital examination of the rectum. Eighty per cent of carcinomas arise in the postero-lateral aspect of the prostate gland and should be accessible to diagnosis by a rectal examination.

The Urethra

The male urethra is 18–20 cm long and exhibits three points of natural narrowing—the bladder neck C, the perineal membrane (at the apex of the prostate gland) C_1 and the external urinary meatus D (*Fig.* 1.3). The narrowest point in the

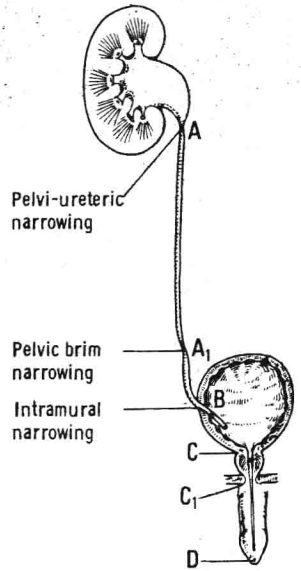

Fig. 1.3 Points of natural narrowing in the urinary tract.

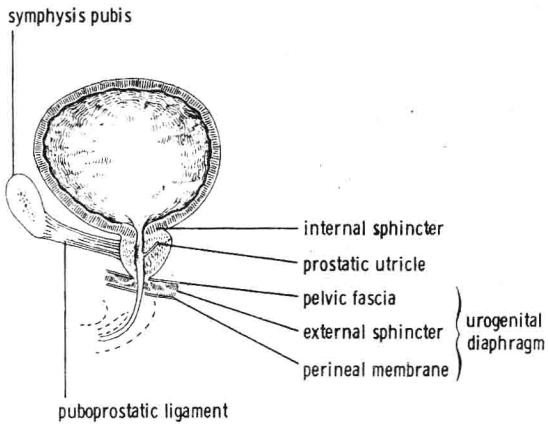

Fig. 1.4 Sagittal section of bladder, prostate gland and sphincters.

male urethra is at the perineal membrane, with the narrowest segment in the terminal 1 cm of the urethra within the glans penis. An instrument which negotiates the terminal urethra will usually pass into the bladder without difficulty. Strictures of the urethra due to infection, such as venereal disease, or due to instrumental damage tend to occur at these points of natural narrowing within the male urethra.

Lymphatic Drainage

The scrotum, penis and penile urethra as far as the perineal membrane will drain into the associated inguinal lymph nodes. The testis and cord will drain into the external iliac and para-aortic lymph nodes. The prostate, bladder and pelvic ureter will drain into the internal iliac and para-aortic nodes. The kidney and upper ureter will drain into nodes along the vena cava and to the para-aortic nodes (*Fig.* 1.5). Malignant tumours of various sections of the genito-urinary tract may be expected to metastasize to the appropriate group of regional lymph nodes.

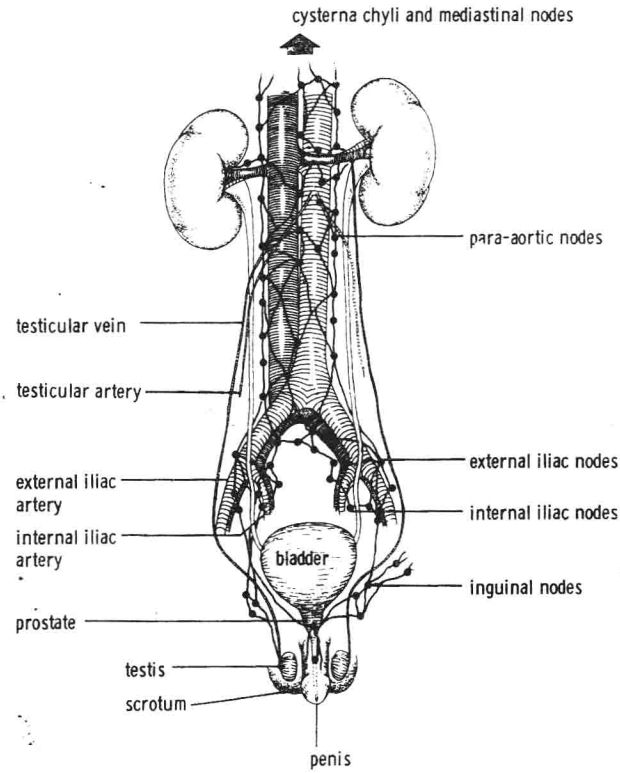

Fig. 1.5 Lymphatic drainage and arterial supply of the genito-urinary tract.

• B. Basic Renal Physiology

The functional unit of the kidney is the nephron, each kidney containing one million units. The head of the nephron in the renal cortex is the glomerulus, which acts as a filter for a perfusate of protein-free plasma to pass from the glomerular capillaries into Bowman's capsule. The capsular space within the glomerulus is continuous with the renal tubule, which is constructed in three functional segments—the proximal convoluted tubule, the loop of Henle and the distal convoluted tubule—each with its own specific function. The perfusate passes into collecting tubules and collecting ducts (*Fig.* 1.6), which discharge urine

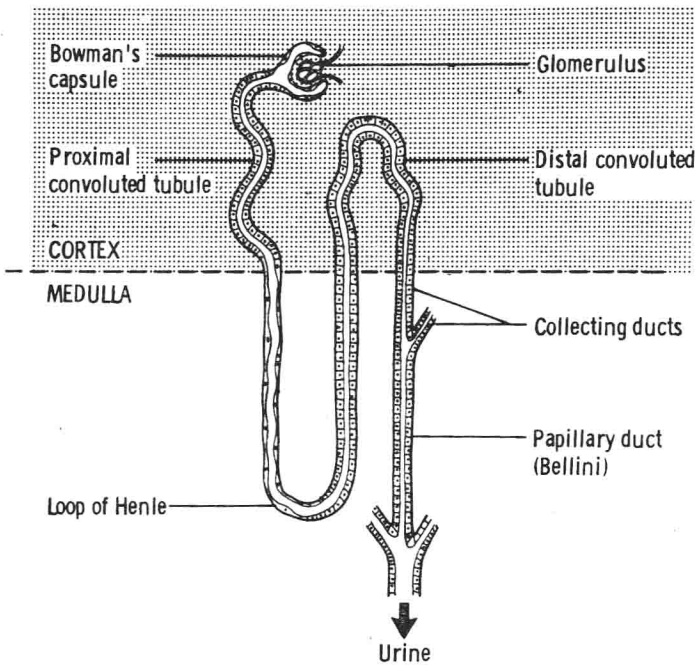

Fig. 1.6 The nephron.

into the renal calices via the papillary ducts (ducts of Bellini). Glomerular function separates an ultra-filtrate from the circulating plasma in the glomerular capillaries. Filtration pressure drives the ultra-filtrate onwards through the renal tubules, where selective reabsorption and selective secretion modify the concentration of the filtrate to produce urine.

The kidneys have two functions in human physiology—regulatory and endocrine.

Regulatory Functions.

1. Regulation of composition of body fluids by a complex combination of filtration, reabsorption and secretion of the solutes sodium, potassium,

chloride, bicarbonate, phosphate, calcium, glucose, amino acids, urea and uric acid.
2. Maintenance of acid–base balance by bicarbonate reabsorption and excretion of excess acid in the urine.
3. Regulation of volume of extra-cellular fluid by control of excretion of sodium chloride.
4. Extraction of a number of amino acids for the synthesis of ammonia.
5. In starvation, the kidneys release glucose into the circulation.

Endocrine Functions

1. Secretion of renin—neuro-hormonal regulating mechanism which, with angiotensin and aldosterone, controls body water and sodium content, potassium balance and arterial blood pressure.
2. Secretion of erythropoietin involved in normal replacement of red blood cells and for accelerated erythropoiesis in stress states such as haemorrhage, altitude exposure and haemolysis.
3. Secretion of prostaglandins—affect smooth muscle contraction in the uterus and gastro-intestinal tract, increase salt and water clearance by the kidney, increase thyroid function and inhibition of lipolysis.
4. Synthesis of 1,25-dihydroxycholecalciferol from vitamin D—important in the regulation of calcium transportation in the body.

The functions of the various sections of the nephron are complex and interrelated.

1. *The glomerulus* has two simplified basic functions:
   Regulatory: Acts as a filter.
   Endocrine: Site of secretion of renin, erythropoietin, prostaglandins and breakdown of vitamin D.
2. *The proximal convoluted tubule*—reabsorption of main bulk of solutes in ultra-filtrate.
3. *The loop of Henle*—maintains osmolarity of the fluid and releases sodium chloride.
4. *The distal convoluted tubule, the collecting tubules and collecting ducts*—involved in concentration or dilution of urine and in fine regulation of sodium excretion, in secretion of hydrogen ions and in regulation of urinary potassium concentration.

Tests of Renal Function

The use of haematological and biochemical methods for estimating renal function has been largely superseded by DTPA radio-isotope scanning and differential renal function scans (p. 14). The scan is an invasive technique but does not involve the use of iodine-based contrast medium, thus eliminating the problem of iodine sensitivity.

Clearances of the endogenous markers urea and creatinine are useful indicators of renal function. The urea level (normal 2·3–6·9 mmol/l) is elevated with impaired renal function but may also be raised in other conditions, e.g. dehydration, intestinal haemorrhage and cardiac failure. The normal blood creatinine level is 50–120 μmol/l, often elevated in failing or obstructed kidneys. The creatinine clearance test is used on occasions for estimating renal function. Blood and urine samples are assessed for creatinine content over

a period of 24 hours in a fasting patient. A delay in clearance of creatinine from blood into the urine is indicative of impairment of renal function.

C. Clinical Examination of the Genito-urinary Patient

Symptomatology

The four principal complaints are:

1. Pain in the kidney and ureter—renal pain: ureteric colic.
2. Pain on passing urine—dysuria.
3. Blood in the urine—haematuria.
4. Disorder in passage of urine—frequency: incontinence: difficulty or inability to micturate.

The characteristics of these complaints are:

1. Renal pain:
   A dull boring ache in the loin with anterior radiation under the costal margin and often aggravated by jolting movements such as car journeys or jogging.
2. Ureteric colic:
   The most violent pain a human can experience: occurring in waves, associated with clinical shock and vomiting and often referred to the groin or testis in the male and the groin, vagina or labia in the female.
3. Bladder pain:
   Dull and located in the suprapubic area: with dysuria and frequency, indicates cystitis. Bladder pain in acute retention of urine is severe (bursting). The chronically distended bladder is painless.
4. Dysuria:
   Pain or discomfort passing urine: referred to the end of the penis in the male. Terminal dysuria indicates inflammation of the bladder neck or prostate gland. Dysuria is commonly accompanied by frequency.
5. Haematuria:
   Painful macroscopic bleeding indicates inflammation of the bladder or prostate. Tumours of the urothelium—painless haematuria. Large blood clots in the urine—bladder origin. Spindle-shaped clots with ureteric colic—renal origin (clot colic).
6. Frequency:
   A normal young adult micturates four to six times in 24 hr and not at all during sleep. Older patients may void seven or eight times during the day and once or twice at night. Nocturia refers to voiding in excess of two times during sleeping hours. Frequency is a prominent symptom in bladder outflow obstruction (prostatism). Frequency invariably accompanies dysuria in infection.
7. Incontinence:
   Involuntary loss of urine from the bladder. In urge incontinence the patient is unable to get to the toilet in time to empty the bladder. Prostatic patients may have terminal incontinence (dribbling) with loss of some residual urine

after the act of micturition is complete. Stress incontinence on straining, coughing or sneezing occurs in the female patient with uterine prolapse. True incontinence appears in patients with congenital or acquired neurogenic bladder lesions—no control by the patient over the act of voiding. Overflow incontinence occurs in the chronically obstructed bladder.

8. Difficulty with micturition:
   Encountered in patients with bladder outflow obstruction or urethral strictures. Patients complain of difficulty in starting, a 'thin' or poor stream during the act and terminal dribbling or incontinence at the end of the act. Complete inability to void urine occurs in acute retention of urine.

Physical Examination

Physical examination of the genito-urinary patient must include a general medical assessment combined with a specific examination of the genito-urinary system.

General Physical Examination

1. Cardiovascular and pulmonary systems with recording of blood pressure.
2. Conjunctivae, palms of hands and finger nails for evidence of anaemia.
3. Tongue inspected and breath smelt to detect the mawkish odour of uraemia.

Examination of the Genito-urinary System

1. Smell:
   Uriniferous odour of patients' underclothes, indicating incontinence.
2. Inspection:
   From the front, side and back with the patient standing and recumbent.
   In infants, inspection is the most reliable method of spotting an abdominal mass.
   Bulging in the loins or a midline suprapubic swelling.
3. Palpation:
   Enlargement of the kidneys, liver, bladder and intra-abdominal masses.
   The kidney must be enlarged two or three times its normal size to be bimanually palpable; the left kidney is palpated from the patient's left side.
   The distended bladder is visible and palpable in most patients but difficulty may arise in obesity.
4. Percussion:
   Size of enlarged kidney and bladder—dull to percussion.
   Abdominal ascites—shifting dullness.
5. Auscultation:
   Over the aorta and renal vessels.
   A bruit indicates an aortic aneurysm, stenosis of the renal artery or renal arteriovenous fistula.
6. External genitalia:
   Easily accessible for inspection: excoriation and brown discoloration of skin in incontinent patients.
   Prepuce, glans penis and external meatus inspected for meatal stenosis, phimosis, hypospadias and penile tumours.

Testis, epididymis and cord inspected for cysts or tumours.
Groins examined for lymphadenopathy or hernia.
Scrotal swelling—a hernia, hydrocele or tumour. A hernia is reducible; a hydrocele transilluminates in a darkened room.

7. Rectal examination:
   Mandatory in the male.
   Excludes pathology within the rectum.
   Determines size, contour and consistency of the prostate gland.
   Fixation of the rectal mucosa, obliteration of the median sulcus between the two lobes of the prostate and a hard rock-like gland—diagnostic of prostatic carcinoma.
8. Pelvic examination
   Mandatory in the female.

• D. Investigation of the Urinary Tract

The genito-urinary tract can be accurately and completely assessed by a combination of haematological, bacteriological, biochemical, radiographic and endoscopic examination.

Urine

1. The end product of renal function.
2. Volume voided at each micturition—normally 250–300 ml.
3. Volume excreted in 24 hr—average 1200–1500 ml.
4. Concentration of urine sample (hygrometer)—normally 1010.
5. Reaction of urine (pH)—litmus test—acid red: alkaline blue.

Colour of Urine

1. Dark golden brown—bile.
2. Cloudy with white deposit
   Phosphates (clears on acidification).
   Infection of urine.
3. Pink or port wine—blood (beware betroot or rhubarb).
4. Deep red—phenolphthalein.
5. Greenish tinge—methylene blue: de Witts pills.
6. Normal yellow urine becoming deep red on standing—porphyrinuria.

Smell of Urine

Ammoniacal or 'fishy' odour—infection with *Bacillus, Proteus* or *Pyocyaneus*.

Ward Testing—Labstix

Urine may be tested for bile, blood, protein, ketones.

Laboratory Tests of Midstream Specimen

1. Red blood cells—microscopic haematuria—pathology of urinary tract (exception menstruating females).
2. White blood cells—over 5 cells/mm^2—infection.
3. Chemical constituents—oxalates, phosphates, cystine.

4. Bacilli—*Mycobacterium tuberculosis*.
5. Cytology—malignant cells of urothelial origin.
6. Culture:
   Infective organisms—sensitivity of organisms determined for a range of antibiotics. Lowenstein culture for *M. tuberculosis*.

Note:
Examination of the urine is undertaken on a midstream specimen after cleansing the prepuce and glans penis in the male and swabbing the vulva in the female. In neonates and infants, suprapubic aspiration of the bladder may be necessary to obtain a clean sample of urine.

Blood

1. Haemoglobin estimation:
   Male 14 g per cent.
   Female 12·5 g per cent.
2. White cell count:
   Elevated polymorphonuclear count in infection.
3. Erythrocyte sedimentation rate:
   Normally under 12 mm/hr—non-specific indicator of pathology.
4. Blood urea. Normally 2·3–6·9 mmol/1—elevated in renal failure and obstructive uropathy,
5. Serum creatinine. Normally 50–120 μmol/1—elevated in obstructive uropathy.
6. Serum calcium. Normally 2·15–2·60 mmol/1—elevated in hyperparathyroidism.
7. Serum alkaline phosphatase. Normally 30–115 IU/1—elevated in skeletal metastases.
8. Prostatic acid phosphatase. Normally 0–4·0 IU/1—elevated in carcinoma of the prostate.
9. Culture. Positive in septicaemic patients.

Renal Function Tests

The only test of value in clinical urology is the creatinine clearance test (p. 6). Renal function and differential function of each kidney are assessed by renal nuclear imaging (p. 14).

Radiological Investigation of the Urinary Tract

Accurate diagnosis of pathological lesions in the urinary tract is nearly always possible by a combination of invasive and non-invasive techniques, some of which have a therapeutic application.

Plain Films of the Abdomen

The film must include the lower ribs, the bony pelvis and the external genitalia. The plain film is examined for position, shape and size of the kidneys, evidence of calculi or calcification and the presence of skeletal metastases. Interpretation of a plain abdominal X-ray is illustrated in *Fig*. 1.7.

Excretion Urography (Intravenous Urography): IVU

A routine examination in urological practice After 12 hr limitation of fluids,