X-RAY EXAMINATION OF THE URINARY TRACT.

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WITH the gradual improvement in radiological technique during the past twenty years, X-ray examination has assumed a greater importance in the diagnosis of disease of the urinary tract than almost any other ancillary method. Indeed, no investigation of the urinary tract from the surgical aspect can be regarded as complete without X-ray examination. In many cases the diagnosis is settled by that means, and in others the field of possibilities narrowed by exclusion, say, of calculus, hydronephrosis, &c.

Preparation of the Patient.—This is of some importance. It is desirable that the patient's alimentary canal be as empty as possible; both fluid, fæcal and gaseous contents may obscure the radiographic picture. With modern technique, in which great contrast is the desideratum, any considerable collection of gas in the colon might literally "black out" the renal areas in the negative. The routine preparation is as follows:—

(1) An aperient on the day before. Salines should not be used, because of their composition and tendency to cause gaseous distension. Castor oil is probably the most satisfactory.

(2) On the day of the examination an enema may be given, if the result of the aperient has not been satisfactory. As little food as possible should be taken, the quality being unimportant.

(3) The bladder should be emptied immediately before the examination.

Technique.—In general, screen examination is of no value. As a routine, radiograms should be taken to include the whole tract. A low kilovoltage, in the region of 70 kv.

peak, double screens, and the Bucky grid are essential points in the production of radiograms of the necessary quality.

URINARY CALCULUS.

The presence or absence of a urinary stone of any considerable size can be determined radiographically with as great certainty as in almost any diagnostic procedure in medicine or surgery. The occurrence of a stone so transparent as to cast *no* shadow in a radiogram is sufficiently rare to excite comment when it does occur. The shadow cast by a calculus depends on its radiopacity compared with that of the soft tissues (the latter being equal approximately to that of water), and depends on three factors: its size, its structure, and its chemical composition.

The effect of the first two is obvious; the larger the stone the denser the shadow, and the more porous the stone the less dense.

Chemical Composition.—The radiopacity of an element, i.e., its capacity for arresting X-rays varies directly with its atomic number. The higher the atomic number, the greater is this capacity.

Below is appended a table of atomic numbers of importance in radiology.

H. 1.	Na. 11.	K. 19.	Ba. 56.
He. 2.	Mg. 12.	Ca. 20.	Pb. 82.
C. 6.	Al. 13.	Br. 35.	Bi. 83.
N. 7.	P. 15.	Ag. 47.	
O. 8.	S. 16.	I. 53.	

An atom of any element is composed of an equal number of protons and electrons. Hydrogen contains one of each. In all the other atoms the arrangement is in the form of a nucleus containing all the protons and half the electrons, the remaining, or planetary, electrons being arranged planet-wise in shells round the nucleus. The atomic number corresponds with the number of planetary electrons. It is supposed that the rays are arrested by striking the electrons, and that the more there are of them the more radiopaque the substance is.

The soft tissues are composed in the main

of C, H, O and N, all of them elements with a low atomic number. Any calculus containing in quantity elements of a higher atomic number will cast a shadow in a radiogram.

Types of calculi with reference to their opacity :—

Pure Uric Acid Stone.—No shadow.

Ammonium Urate Stone.—A faint shadow.

Phosphatic Stone. — A moderate shadow.

Oxalate Stone.—A dense shadow, because of a large percentage of calcium.

Cystine and xanthine stones, if pure, cast no shadow, but usually they contain some calcium.

Virtually the opacity of a stone depends on its calcium and phosphorus content, as do the bones.

POINTS IN THE RADIOGRAPHIC DIAGNOSIS OF CALCULI.

Kidney.—The shape is usually angular if small, in which case they are commonly multiple. If large, they are branching, and tend to form a "cast" of the renal pelvis and calyces. They are typically uniform in texture. A satisfactory radiogram will show the outline of the kidney, and the shadow must be within this area.

Ureter.—As these are formed in the kidney the shape is that of a small renal stone. They are in the line of the ureter. This passes down across the tips of the transverse processes of the lumbar vertebræ, over the line of the sacro-iliac joint, and finally sweeps round medial to the shadow of the brim of the true pelvis to reach the bladder. If the stone is oval the long axis should be in that of the ureter. Passage of an opaque ureteric catheter will indicate the site of the opacity relative to the ureter.

Bladder.—Vesical calculi cast their shadow a little above the symphysis pubis, and in or near the mid-line. If the bladder be full

they can be displaced from side to side by moving the patient. If the stone be in a vesical diverticulum no displacement takes place. Their shape is usually round, oval or ovoid, and a common and typical appearance is lamination of their shadow.

DIFFERENTIAL DIAGNOSIS OF URINARY CALCULI.

The following may simulate urinary calculi :—

Renal.

Intestinal Contents, Enteroliths, Shot from Game.—Re-examination after further preparation will distinguish between these.

Calcified Abdominal Glands.—These typically show an irregular density and outline, which distinguishes them.

Calcified Gall-stones.—These are commonly ringed, and, if multiple, faceted. A lateral radiogram shows them in the anterior part of the abdomen, while renal stones lie posteriorly.

Calcified Tuberculous Kidney.—Here the shadows are mottled and diffuse.

Papilloma of Skin on Back.—Inspection will exclude this.

Ureteric.

Calcified Abdominal Glands.

Tip of Lumbar Transverse Process.—This may be very dense compared with the rest of the transverse process, and if, as it not infrequently is, in the form of an accessory epiphysis, may closely simulate a stone.

Calcareous Iliac Artery : Calcified Sacro-sciatic Ligament.—These give irregular striated shadows.

Phleboliths.—These are the commonest source of confusion. They occur very frequently in the iliac veins in the pelvis. If single and in the ureteric line they cannot be distinguished from ureteric stones without the use of an opaque catheter. As a rule they are multiple, and their irregular distribution gives the clue to their nature.

Bladder.

Prostatic Calculi and Calcification.—The shadows are rather low for the vesical area, lying as they do behind the symphysis, and if the calculi are multiple, or the calcification extensive, the prostate is outlined.

Fæcal mass in rectum, particularly if opaque medicines, such as bismuth, have been taken. A purge, followed by re-examination, will settle the matter.

Calcified Fibroid.—The irregular striation will usually distinguish this rather rare condition.

Pelvic Dermoid.—If this contains teeth or bone, a shadow will be cast. The recognition of a tooth crown decides the nature in these cases.

Calcareous Seminal Vesicles.—A rare condition, giving an irregular shadow.

Phlebolith.

Foreign body, introduced by a hysterical patient. This may form the nucleus of a stone.

OTHER RADIOGRAPHIC AIDS IN DOUBTFUL CASES OF CALCULUS.

Opaque Catheter.—The tip of an opaque catheter may not coincide with the shadow of a renal calculus, but should at least be near it. The shadow of the catheter *must* coincide with that of a ureteric stone, and moreover, must coincide in radiograms taken from varying angles.

The only exception to this rule would be a small calculus lying loose in a grossly dilated ureter.

Pyelography.—The opaque injection will blot out the shadows of renal calculi, or show them in relief if they are large and transparent.

Technique of Pyelography.

The patient must be conscious, as the breath must be held during the exposure, as the surgeon requires to know the onset of pain in the loin as an index of distension of the renal pelvis. The administration of hyoscine and morphine makes it difficult to obtain breath-held skiagrams, if the amnesia is considerable. Spinal anæsthesia is satisfactory but abolishes the pain on distension of the renal pelvis. After preliminary cystoscopy the opaque catheter is passed and 6 to 10 c.c. of a sterile solution of sodium bromide or sodium iodide is run in. No considerable pressure should be used, and

the administration should be stopped when lumbar pain occurs, or when 10 c.c. has been given. In some cases of hydronephrosis renal pain does not occur with distension, and it is therefore unwise to inject more than 10 c.c. unless an appreciable quantity of urine has been previously drawn off from the renal pelvis.

After a satisfactory outline of the renal pelvis has been obtained, the ureter can be outlined fully by withdrawing the catheter almost out of the ureter, and then, while the exposure is being made, keeping the ureter distended by pressure from the syringe.

The pyelogram is of value in demonstrating the following conditions.

Hydronephrosis.—A pyelogram will give clear and unequivocal evidence of hydronephrosis in all but the very earliest cases. The earliest change is clubbing of the calyces, broadening and shortening of the calycal necks, and gradual distension of the renal pelvis. The junction of ureter and pelvis becomes demarcated, and the ureter and lower margin of the pelvis form an increasingly acute angle. Finally the whole becomes converted into a more or less loculated sac.

Calculous Pyonephrosis.—A pyelogram will show the latter element, and so will indicate the operation of choice.

Renal Neoplasm.—A pyelogram may show definite changes, the following being the most characteristic:—

- (1) Partial or complete obliteration of calyces and/or renal pelvis ("filling defect").
- (2) "Spider pelvis," in which the calyces become narrow pointed processes.
- (3) Irregular enlargement, from traction and ulceration of portions of the pelvis and calyces.

The "spider pelvis" appearance may also be seen in polycystic disease and atrophic pyelonephritis.

Congenital and Postural Abnormalities of the Kidney.—These include such conditions as nephroptosis, horse-shoe kidney, double kidney, torsion of the kidney, kinking of the ureter, and as a rule give evidence of their presence in a pyelogram. In horse-shoe kidney the lower part of the pelvis and inferior calyx may be prolonged downwards and inwards as a process lying behind the ureter, which it may partially obstruct.

Cystography.

This is used to demonstrate the position and size of a vesical diverticulum. Radiograms should be taken in two planes after filling the bladder with a 5 per cent. solution of sodium bromide.

Intravenous Urography.

During the past year a new method has evolved by which the urinary tract may be outlined in a radiogram. Forty grm. of of "Uroselectan" (an iodine-phenol-pyridine compound) dissolved in 80 c.c. of double-distilled water, and sterilized in the autoclave, are injected intravenously. Within fifteen minutes the uroselectan is being excreted by the kidney in sufficient concentration to cast a shadow. The kidney substance is increased in density and the renal pelvis, ureter and bladder are visualized. The shadow is not nearly so dense as in a pyelogram, and meticulous technique is essential. Radiograms are taken fifteen, forty-five and seventy-five minutes after injection. The method also affords a chemical method of estimation of renal efficiency.

It is still in the experimental stage, but with improved technique it will probably tend to replace pyelography in those cases in which cystoscopy is not necessary for diagnosis.

REVIEWS.

HANDBOOK OF THERAPEUTICS. By David Campbell, M.C., M.A., B.Sc., M.D., Pollok Lecturer in Materia Medica and Pharmacology in the University of Glasgow; Assistant Physician to the Western Infirmary of Glasgow, &c. Edinburgh: E. and S. Livingstone. 1930. Pp. 411. Price 12s.

As the author points out, the teaching of treatment is apt to be neglected in the medical curriculum. In this book, which is written for the practitioner and serious student, a reasoned view of the various therapeutic methods are given.

The first seven chapters are devoted to the principles of treatment. They include an account of the prescription, how it should be written, incompatibles and the general action of drugs. The effect of diet,

spa treatment, local applications, massage, light and electricity are all considered briefly but plainly. One chapter deals with treatment by vaccine, sera and foreign proteins.

The later chapters discuss the treatment of individual diseases, which are considered in detail. There is an excellent chapter on emergency therapeutics, and the book concludes with an appendix dealing with the doses, incubation and quarantine periods.

The book can be recommended to students and practitioners, who will find in it much useful and practical information. There are many illustrations and charts, which are well produced and help to explain the text.

CANCER OF THE LUNG AND OTHER INTRA-THORACIC TUMOURS. By Maurice Davidson, M.A., M.D., B.Ch.(Oxon.), F.R.C.P.(Lond.), Physician to the Brompton Hospital for Consumption and Diseases of the Chest, and Dean of the Brompton Hospital Medical School: Physician to the Miller General Hospital for South-East London; Consulting Physician to St. Luke's Hospital, Chelsea. Bristol: John Wright and Sons, Ltd. 1930. Pp. 170, with 60 illustrations. Price 17s. 6d.

As the author explains, the object of this book has been to correlate the different aspects of primary lung cancer, and at the same time to indicate the varieties and scope of treatment nowadays applicable to this condition; in view, moreover, of the fact that a comprehensive study in book form of the subject has not previously been published in the English language, we feel that Dr. Davidson's monograph should be granted a very cordial welcome at the present time.

The opening chapter is devoted to historical details and statistical records which the author lucidly interprets as proving not only an absolute but also a relative increase in lung cancer.

The pathological aspect is dealt with clearly and comprehensively, and the somewhat vexed question of ætiology is reviewed with commendable precision.

There follows an excellent account of the clinical manifestations of primary lung cancer which summarizes the observations of famous clinicians past and present, also