THE PRESENT STATUS OF THE DIAGNOSIS OF RENAL TUMORS*

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When one considers the high rate of mortality associated with renal tumors and the advanced stage of their development before a diagnosis is made, and that metastatic lesions are often the first sign of the disease, one is at once impressed with the importance of any new diagnostic developments in this field. A correlation of such information has been my aim in this presentation.

First of all, it is assumed that at the present time a roentgenologist undertaking the examination of a patient suspected of having a renal tumor is a capable clinician who is familiar with the history, symptoms and course of such lesions, together with the morphology, pathology and possibilities of behavior at any stage of their course and also with the pathologic conditions of the kidney and surrounding areas which must be taken into consideration in making a differential diagnosis. Many times by a process of elimination of possible causes of the symptoms a diagnosis of renal tumor may be made when a direct attempt at making such a diagnosis would fail.

The recent developments in the diagnosis of kidney tumors reported in the literature have been rather limited to case reports and to the emphasis of complications encountered accompanying such lesions. I have attempted to abstract from these reports such information as may be of aid to the roentgenologist in reporting his findings.

In summing up a paper on "Tumors of the Renal Pelvis," MacKenzie and Ratner[13] conclude:

"The disease is very often wrongly diagnosed and the diagnosis must be made from the history, symptoms, urinary findings, cystoscopic and pyelographic findings."

In the past many roentgenologists have been content to confine their diagnostic contribution solely to the field of roentgenology, anticipating that all other clinical help would come from the urologist. This has been a quite satisfactory arrangement since the urologist was usually the one who referred the patient and the only one capable of cystoscopic examination, catheterization of the ureters, and injection of the kidney pelvis before a pyelographic examination could be made. But with the newer development of excretion urography the roentgenologist has added responsibilities, for many patients are referred direct to him.

Many times all the information obtainable after such an examination will not be sufficient to solve the problem, but in such cases the fact

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that the patient has a definite kidney lesion can usually be determined and he can then be referred to a urologist for further examination.

The status of excretion urography in the diagnosis of renal neoplasm should be carefully considered. The situation of most palpable masses in the region of the kidney may easily be determined to be outside the kidney by an excretory urogram which usually shows clearly that the kidney pelvis and kidney are extrinsic to the palpable mass. The diagnosis may become difficult in the case of a tumor arising from the capsule or of a perirenal tumor attached to the kidney, and if there is no deformity of the pelvis neither excretory nor retrograde pyelography will be of much diagnostic value except in a negative way. Excretory urography often shows characteristic distortion of the pelvis and calyces in tumors of the kidney proper, together with a fair estimate of function in such a kidney.

Recently in a paper on renal tumors Wade[24] has stated:

"My theme in brief may be stated to be based essentially on the relative roles of infusion and excretion urography. Infusion urography indicates form. Excretion urography indicates function. The former is the primary diagnostic aid for the recognition of the presence of a tumor of the kidney. The latter, by indicating the state of the adjacent renal parenchyma, is a valuable aid in identifying the type of growth that is present.

"This knowledge not only permits of a more accurate preoperative prognosis but also thereby gives warning of some of the complications that may be met. Of these the most important are: the daughter tumor concealed in the ureter in a villous papilloma of the renal pelvis; the accessory venous circulation in the perinephric fascia due to a neoplastic thrombus in the renal vein in cases of hypernephroma or papillary carcinoma; the involvement of the renal pedicle and the adjacent lymph glands in cases of alveolar carcinoma.

"In other types of tumor, such as the epidermoid carcinoma and the embryonal carcinoma, and the rare tumors, information of similar value is also obtained. It amounts to this: 'The degree of malignancy of a tumor of the kidney is in inverse proportion to the functional activity of the organ as a whole.' "

In the discussion of this paper Dr. Braasch stated:

"My experience coincides to a very large degree with that of Mr. Wade as to the value of intravenous or excretory urography in the differential diagnosis of renal tumor. I will say, however, that if we relied upon the intravenous urography entirely, we would frequently find ourselves in difficulty. It may be quite misleading.

"I agree with Mr. Wade that unless a man is skilled in the diagnosis and interpretation of pyelography, he should not attempt to employ

intravenous urography. Unless the details of the pelvic deformity are clearly visualized, interpretation may be frequently misleading. I have observed a number of intravenous urograms in which we might infer that we are dealing with a normal pelvis, where neoplasm was found to be present when the retrograde method of pyelography was employed.

"Secondary infection or reflex irritation may affect the degree of visualization with intravenous urography, so that great care must be employed in its interpretation. The two methods of intravenous and retrograde urography are often very valuable when combined. Very often intravenous urography is distinctly better than the retrograde method, when there is obstruction at the ureteropelvic juncture or retention of urine in the pelvis."

Excretion urography has become one of the most important advances in roentgenology, not even surpassed by cholecystography. An excretory urogram may be safely done and all the necessary evidence found for the diagnosis of a renal neoplasm in most cases. Further examination by a retrograde pyelogram if catheterization of the ureter is possible may give much added information and should always be resorted to in all cases where there is any doubt about the diagnosis.

Careful attention to the technique of the latter examination is necessary. Wilson[26] in an excellent paper on the diagnosis of renal tumors warns against a mistaken diagnosis in an incompletely filled pelvis. This may come about either by failing to insert the catheter high enough, with a consequent reflux into the bladder, or by attempting to fill a kidney pelvis with an opaque medium, when it is already full of retained urine or blood clots. This pitfall may be obviated by draining the pelvis before a pyelogram is attempted and by repetition of the examination when there has been any question of the cause of a filling defect in the kidney pelvis.

Within the last decade another method of roentgenographic diagnosis of the kidney has received considerable mention in the literature, namely, pneumopyelography. All roentgenologists should be familiar with the advantages and disadvantages of this method.

Thompson[23] in 1922 wrote:

". . . The injection of gas into the renal pelvis for roentgenologic purposes has not been popularized to the extent that it deserves, . . . the technique of which is simple and the advantages numerous. . . . The injection of oxygen into the ureter or renal pelvis causes no shadow at all but creates a space which shows up black on the x-ray plate, and brings into relief not only the pelvis and calices, but also the kidney tissue, as it does not obscure the shadows caused by the tissues either in front or behind. For instance, the shadow of a stone in the ureter, pelvis or calix will not be obscured by the oxygen and the size, shape

and position of the stone can be easily determined. . . . So far in our group of cases only oxygen has been used in pneumopyelography which meets fully the requirements of a contrasting media, in that it is not toxic and not irritating and may even be beneficial in some cases. As oxygen is more permeable than any of the opaque solutions, it will pass obstructions or constrictions more readily than the solutions."

The author then describes his technique of examination, and illustrates one case of stone with hydronephrosis, the stone not having been demonstrated by pyelogram with an opaque medium, and concludes:

"1. Pneumopyelography is a simple, though uncommon, procedure and deserves a greater popularity.

"2. This procedure is attended by apparently no reaction and causes the patient less discomfort than the injection of an opaque solution.

"3. In certain cases it is a greater aid in roentgenographic diagnosis, than the opaque solutions."

Neuwirt[18] has stated that he regards this procedure as the method of choice in the diagnosis of nephrolithiasis.

"It will disclose the smallest stones more often and better than pyelography alone. Even simple incrustations stand out very clearly. Furthermore, one examination suffices to obtain all the information needed. The author has found it to be the only method which made possible a diagnosis of a tumor of the kidney pelvis or of the ureter. In cases of tumor of the kidney parenchyma, pyelography is the method of choice. Bleeding from the pelvis of the kidney is not a contraindication to the method."

Chauvin, Empéraire, and Esmenard[2] advise the injection of air under a constant manometric water pressure of 80 cm. They claim that it is painless and safe as it allows of a wide margin of safety from any possibility of air embolism. They say:

"The especial value of the method lies in the exact localization of calculi, and in the demonstration of those of little density, when an opaque medium merely conceals; further, papillomata of the renal pelvis are shown, and large hydronephroses may be filled with impunity."

Tasker in an abstract of an article by Bedrna and Simon[1] states:

"The author discusses the difficulty in the diagnosis of tumors of the renal pelvis from other causes of unilateral renal hemorrhage. Ordinary pyelography may show large tumors as a filling defect, but small papillomata are likely to be hidden by the shadow of the opaque fluid. When small tumors of the renal pelvis are suspected he advises pneumopyelography. Ordinary atmospheric air is injected by a 20 c.c.

syringe into the renal pelvis through a small ureteric catheter, the injection being made slowly. In 345 cases no complications followed.

"A difficulty in diagnosis by this method is blood-clot in the pelvis, as the shadow from the x-ray may resemble a papilloma. For this reason repetition of the pneumopyelography is advised after some days. If the shadow has not altered, a tumor is probable, but if due to blood-clot then the shadow will have altered or disappeared. Details of two cases are given in which this method enabled a correct diagnosis to be made."

Jeck[8] has reported a case of air embolism which proved fatal. This was the only death in his six years' experience with inflation of the bladder in cases of suprapubic cystotomy.

Mathé[16] reported a case of fatal air embolism from inflation of the bladder. The patient was a man, aged fifty-six, with hypertrophy of the prostate, chronic retention, an ulcerated bladder neck and a papillomatous growth on the base of the bladder about 4 cm. in diameter. A suprapubic approach was decided upon and the bladder was inflated with 300 c.c. of air. After a few seconds, and while the first sutures were being taken in the fundus, a hissing sound in the bladder was heard. The patient became cyanotic, the eyes fixed, the pupils dilated, and the pulse and respiration suddenly ceased. All attempts at resuscitation were futile. At necropsy, air was found in the iliac and mesenteric vessels, the vena cava and the renal veins. The lungs, liver and the right chambers of the heart contained coarse, frothy air. Following this fatal accident, Mathé made an extensive investigation of the problem during which time he sent out 2,050 questionnaires to surgeons doing genitourinary surgery in this country and abroad and received 791 replies. In 25,890 inflations with air, there were 34 cases of air emboli. He states that air under pressure in the normal bladder and ureter causes no harm, but says,

"The formation of emboli takes place by the entrance of air into the venous circulation either through an ulceration of the mucosa caused by some pre-existing pathologic lesion such as an ulcer, a tumor, a deeply congested area due to cystitis, etc., or through a laceration of the mucosa caused by over-distention of the bladder. . . . Once the veins of the bladder wall are ruptured, a minimum amount of pressure can cause penetration of air into the vesical veins and thence into the vena cava and right heart."

Lewis'[11] theory is that the air enters into the circulation by way of the pelvis of the kidney after having regurgitated through the ureter. Santini's[20] experiments did not support this theory. He injected air under considerable pressure into the healthy bladders of dogs and found that the healthy bladder invariably ruptured before air would enter the kid-

ney pelvis through the ureter. When he injected air into the abdominal portion of the ureter, he found that air could be introduced into the circulation by way of the renal parenchyma. Piddighe,[19] experimenting with 11 dogs, could not support the latter part of Santini's work. He injected air into the lumen of the ureter under considerable pressure for from fifteen to thirty minutes. This caused considerable increase in the volume of the kidney but death from air emboli could not be produced. Subsequent autopsies showed considerable dilatation of the pelvis and tubules, but in no case was he able to demonstrate air in the circulation. However, when the veins of the bladder wall were traumatized, inflation of the bladder with air under low pressure caused death in a few minutes. In these dogs, at necropsy, the usual pathologic picture of air emboli was found.

Mathé concludes:

"Rupture of the vesical mucosa by over-distension, or the presence of a pre-existing pathologic lesion such as marked inflammation, ulcer formation, or a new growth weaken the bladder wall thus favoring the entrance of air into the venous circulation."

This is a very excellent and comprehensive study of air emboli and includes a long bibliography. It includes a summary of 23 collected cases of air emboli with 18 deaths.

We are doing an increasing number of pneumopyelograms, particularly in cases in which pelvic papillomatous tumors are suspected. These have been performed with no discomfort to the patient. Our feeling is that if the catheter is not tightly gripped in the ureter, as occurs in case of a stricture or ureteral stone, there is little danger of creating a pressure in the kidney that would be at all hazardous, as the air will reflux into the bladder when the pelvis is filled. Roentgenograms are made while the air is being injected. This method of examination has some very distinct advantages in the diagnosis of pelvic tumors or kidney stones.

Pyeloscopy is another technique for the examination of the kidney which has been used by some workers for many years, but has not received widespread attention in the field of renal diagnosis. An excellent article by Herbst[6] outlines its particular sphere of usefulness and a statement which he quotes from Jona and Flecker would seem to have an important bearing on the diagnosis of tumors. They found that atropine definitely decreased the activity and produced relaxation of the pelvis to the point of painful distention which was in turn relieved by the administration of eserine. It seems reasonable that in cases in which function is not a consideration, or after the determination of function by excretory urography, repetition after the administration of atropine might better outline the deformity of the kidney caused by a renal tumor.

In another article by Manges, who introduced the pyeloscopic method in 1912, and who has had a long experience with it, its advantages in the diagnosis of renal tumors are outlined as follows:

"The fourth advantage comes in being able to palpate the movable kidney, and at the same time, see what the effect of palpation or manipulation is in the matter of rotating the kidney or determining the extent of its mobility. . . One also palpates tumor masses that are present in the abdomen and in this manner can determine very definitely whether the mass is attached to or a part of the kidney, even when there is not deformity of the pelvis and calices due to the involvement of the tumor."

The ambition of most clinicians is an attempt to determine the type of tumor with which they are dealing. This, of course, would be ideal but a glance at the great mass of controversial literature on the classification of renal neoplasms makes it an impossibility for all practical purposes at the present time. If the pathologists cannot agree on the type of tumor after examination of the sections, how much more difficult is it for the clinician and roentgenologist to determine the specific type of lesion? If one can determine the presence or absence of a kidney tumor along with a fairly accurate estimate of whether it is malignant or benign, an admirable service has been rendered to the patient and to the surgeon.

A recent article by Gottesman, Perla and Elson[4] illustrates the difficulties encountered in the diagnosis of specific tumors. They reported the pathologic findings in 44 cases of hypernephroma. Sixteen of these were found by chance at autopsy. Some of the specimens showed all gradations from benign structure to malignant hypernephroma in the same tumor. Cortical adenoma, typical hypernephroma, papillary and adenomatous malignant areas, and also carcinomatous and sarcomatous-like infiltrations were observed.

There apparently is no classification of renal tumors to which all are agreed. Graham[5] disposes of this subject in a practical manner:

"Comparative statistics concerning the incidence of the various types of renal neoplasms is increasingly difficult to obtain from the numerous clinics where comparatively large numbers of these cases are treated. This is due chiefly to differences in the interpretation of the two most frequently encountered types of neoplasms, namely, hypernephroma and carcinoma. It is not surprising, therefore, that in one clinic about 80 per cent of all malignant renal neoplasms may be classified as hypernephromata, and in another clinic less than 30 per cent are so classified. It is highly improbable that the Grawitzian tumor is less prevalent today than it was twenty-five years ago.

"*Hypernephroma.*—The type of lesion described by Grawitz is the most frequently encountered, and, therefore, is the most important neoplasm of the kidney. That it originates in adrenal cortical tissue, which is included in the kidney during its developmental period, has been disputed recently. Whatever may be the final judgment in the matter, segregation of this group of tumors seems amply justified by embryological, gross, microscopical, chemical and clinical considerations.

"*Carcinoma.*—Second in order of frequency and importance among renal neoplasms are the carcinomata, which may be considered under two groups: (*a*) those arising from tubular or glandular epithelium, and (*b*) those arising from the pelvic mucosa.

"(*a*) Probably the most important source of carcinomata in the substance of the kidney in adults is the adenoma, occurring with comparative frequency.

"When the adenoma becomes malignant (carcinoma), fairly well circumscribed or diffusely infiltrating neoplasms of considerable size may result. Clinical manifestations (pain, hematuria, palpable tumor), anatomical alterations, and abnormalities noted in roentgenograms and pyelograms naturally depend upon the location, size, and rate of growth of the tumor, and whether or not the pelvis is secondarily involved.

"(*b*) Carcinomata arising in the renal pelvis are of two types—papillomatous and epidermoid.

"*Sarcoma.*—True sarcoma in the sense of a malignant tumor arising from the supporting tissue (capsule, stroma, or adventitia of blood or lymph vessels) is rarely observed in the kidney as a primary tumor. A rather hurried search of the records of the Cleveland Clinic for the past eight years has failed to disclose a single case. It is more than probable that a large percentage of cases appearing in the literature under the heading of sarcoma would be more appropriately classified as cases of embryonal carcinoma or of mixed tumor of one type or another.

"*Mixed tumors.*—Mixed tumors constitute the third group of renal neoplasms in order of frequency and importance. They are not a homogeneous group and do not conform to a type. In this group are included tumors which are probably variable in derivation, and certainly variable in composition. The one feature that characterizes them as a group is the fact that they comprise the majority of renal neoplasms which occur in childhood.

"*Extra-renal tumors.*—*Lipomata* may develop in the peripelvic fat of normal kidneys and result in displacement of the organ and deformity of the pelvis. They may develop in the fat which is deposited in kidneys that are atrophic as a result of interference with the circulation or as a result of chronic infection, with or without calculus, or they may

develop in the perirenal fatty capsule and by their size misplace an otherwise normal kidney.

"*Fibromata, fibrolipomata,* or *fibromyxomata* may develop in the perirenal tissue. The myxomata may either be encapsulated or diffuse and may become sarcomatous. These tumors may displace, but usually do not invade, the kidney.

"*Retroperitoneal neoplasms* such as lymphoblastoma, common sarcoma, endothelioma, and tumors of the adrenal may simulate renal neoplasms.

"*Subhepatic, intrahepatic, subdiaphragmatic,* or *psoas abscesses* and *omental* and *mesenteric cysts* may simulate cystic tumors of the kidney."

I use Ewing's[3] classification of tumors of the renal pelvis which meets the need of the roentgenologist for it is convenient and workable.

Papilloma.—These are usually multiple and large papillomas may be surrounded by smaller ones. Papillomas may be associated with calculi. Papillomas are very vascular tumors and bleed easily. They are usually benign, but tend to become malignant and give rise to transplants along the ureter and in the bladder. They constitute about 50 per cent of the pelvic tumors of the kidney.

Papillary Epitheliomas. These are wartlike growths, which in the early stage involve the submucosa, but later extend into the renal parenchyma. Late stages of the growth may be accompanied by cortical cysts. These are very vascular tumors and hemorrhage is frequent. Papillary epithelioma makes up about 20 to 30 per cent of kidney pelvic tumors.

Alveolar Carcinoma. These are probably late papillomatous growths which have lost their papillomatous formation and form scirrhous type of growths. These are large tumors, have a high degree of malignancy, and metastasize widely.

Squamous Cell Carcinoma. This type of tumor forms a very small group. They are characterized by rapid growth, extensive metastases, infiltration of the surrounding tissues and kidney parenchyma, and rapid fatal termination.

Since the pathologists themselves have such difficulty in making an exact diagnosis in cases of kidney tumor, the roentgenologist cannot hope to report a specific type of tumor in a given case with any high degree of accuracy. And there are always certain cases in which some doubt remains even after the most careful clinical, roentgenologic and pathologic study, and it is literally impossible to make any accurate predictions regarding the final outcome.

The following cases will serve to emphasize some of the difficulties of diagnosis, and the necessity of giving a guarded prognosis even

though the histopathology of a given tumor is indicative of a relatively hopeful outcome:

CASE I. A woman, aged fifty-four, was referred to me for examination by Dr. W. E. Lower, on July 29, 1929. Her chief complaint was "weakness and fullness in the stomach." In January, 1929, she had influenza, and about this time had developed a frequency and burning on urination. She had become quite constipated, and had lost 40 pounds.

When she presented herself for treatment, there was a large mass in the left hypochondrium which extended to the crest of the ilium and across the midline into the right side of the abdomen. The clinical impression was that this mass was caused either by an enlarged spleen or left kidney. The renal function as determined by the phenolphthalein test was 70 per cent. The cystoscopic examination disclosed no abnormality, but urine specimens from both kidneys contained a moderate number of pus cells. The roentgenogram of the kidneys, ureters and bladder showed a large mass in the left kidney region which appeared to be extrarenal. The pyelogram showed hydronephrosis, and displacement of the ureter and the kidney beyond the right of the midline by a large mass. The pyelographic diagnosis was a probable tumor of the left kidney.

Operation was performed by Dr. Lower on August 14, 1929. A large mass measuring about 11 x 15 cm. was attached to the kidney. Visible renal tissue appeared grossly normal. The tumor surrounded and included the left kidney. The kidney was easily removed from the mass, leaving a well-formed depression. Toward the upper pole of the kidney, lying outside of the well-encapsulated main portion of the tumor, was a mass of fat tissue which was not encapsulated and had a consistency that suggested the possibility of myxomatous change. The blood supply of the whole myxomatous mass was not very abundant. Fetal lobulation persisted. One miscroscopic section was made up of myxomatous tissue. There was a fibrous capsule and external to this was a small amount of fat. Histologically it did not appear to be very malignant. Another section was made up of fibromyxomatous tissue, the fibrous predominating; a small amount of fat was scattered through the sections which histologically appeared benign. The diagnosis was perirenal myxoma.

This patient returned again to the Clinic, on September 11, 1933, with a recurrent, extensive, inoperable mass which practically filled the entire abdomen and probably involved the intestines. The chest roentgenogram showed no evidence of metastases.

This represents one of a group of tumors which are potentially malignant in that they recur locally but do not give rise to distant metastases.

CASE II. This patient was a man aged fifty-four, first observed in November, 1923, who complained that he had had a nervous breakdown six months previously, and that he felt below par on arising in the morning. During the day he felt well. He also complained of vague gastrointestinal disturbances which seemed to be associated with his nervousness. There were no genitourinary symptoms except that he had had one sharp attack of back pain sometime previously which had gradually disappeared and had not recurred. The physical and laboratory examinations gave no clue to his complaints and his hemoglobin was 90 per cent. He was reassured and advised to get additional rest in the belief that the condition was one of neurotic origin.

He returned again in August, 1927, stating that his endurance was poor and that he had had another attack of back pain during the previous year which had gradually improved and was then absent. Since this last attack of pain his appetite had been poor. He had nocturia, three times each night.

Physical examination showed nothing of significance except for a few pulpless teeth. The roentgenograms of the kidneys, ureter and bladder and of the lumbosacral region showed no abnormality. Cystoscopic examination revealed a mild trigonitis and slight prostatic hypertrophy. Since there was no clinical indication for a pyelogram, this examination was not done. Because of the vague symptoms of pain, gastric disturbances, listlessness, irritability, and his changed mental outlook, it was thought that the problem was chiefly a neurologic one.

He sought treatment again in November, 1927. At that time he had ascites and the liver was enlarged. The kidneys were not palpable and there had been no urinary symptoms except the frequency and nocturia. Exploration was resorted to and an inoperable tumor of the kidney was found. The operative diagnosis was hypernephroma of the right kidney.

This is a representative case in which the clinical history, vague symptoms and negative physical examinations certainly were not suggestive of a malignant condition, especially of the kidney. This patient developed metastases and ascites before such a lesion was suspected. Renal malignancies with such a history will probably be overlooked, unless a pyelographic examination is adopted routinely, which, most will agree, is impracticable. It also illustrates that a normal roentgen picture of the kidneys, ureters and bladder does not eliminate the possibility of a renal tumor.

CASE III. The patient, a physician, aged sixty-eight, had an unexplained fever which was intermittent and recurrent, sometimes rising as high as 101.5° F. He had examined his urine and had found some pus and albumin. He had some burning on urination and some diffi-

culty in starting his stream. He did not feel unwell. He attributed the fever to infected tonsils. Physical examination revealed a right upper abdominal mass which extended to the level of the umbilicus, and chronic prostatitis. The urine examination showed no significant abnormality except an occasional red blood cell in one of numerous specimens. The Wassermann and Kahn tests were positive. Syphilis had been contracted years previously during an operation on a luetic patient. The pyrexia, the abdominal mass, which was interpreted from palpation as being the liver, and the positive reaction of serologic tests led to the diagnosis of luetic hepatitis. He was given antiluetic treatment. Six months later an excretion urogram was made for renal function incident to a prostatic punch operation, and a large deformity of the right kidney was noted; this was interpreted as being due either to an anomalous kidney or to a tumor. A pyelogram was made and this showed, with greater detail, a very large deformity of the right kidney which was interpreted as a hypernephroma.

At operation an inoperable malignancy of the kidney was found which had invaded the perirenal tissues. The operative diagnosis was hypernephroma. The patient died five months later.

This case serves to illustrate the caution which one must exercise in forming any conclusions, from palpation alone, as to the origin and nature of abdominal masses. Only one of the so-called cardinal symptoms of renal malignancy was present, and its association with an infectious process which might produce enlargement of the liver, resulted in misinterpretation of the signs and symptoms.

In connection with these cases which have presented especially puzzling diagnostic problems, I am presenting the data which have accumulated in the study of a series of cases of renal tumor seen at the Cleveland Clinic.

In 100 proved cases of kidney tumor there were 55 hypernephromas, 20 carcinomas, 3 squamous cell carcinomas of the renal pelvis, 16 kidney tumors in children, 3 cases of fibromyxosarcoma, 2 of perirenal myxoma, and 1 sarcoma. The symptoms in their order of frequency were pain, a palpable mass and hematuria. All of these symptoms were present in 25 per cent of the cases. Of the patients with hypernephroma, 55 per cent had hematuria, 28.3 per cent of these without pain.

The clinical impression included kidney tumor in 80 per cent. In 20 per cent involvement of the genitourinary tract was not suggested by the symptoms. The plain stereoscopic roentgenogram revealed a diseased kidney and raised the question of tumor in 75 per cent of the cases of hypernephroma, in 30 per cent of cases of carcinoma and in 50 per cent of the childhood tumors. The cystoscopic examination

revealed little information in cases of hypernephroma except when blood was seen to come from the ureter. In the cases of carcinoma of the kidneys, 15.4 per cent showed transplants to the bladder. Pyelography yielded a correct diagnosis of tumor in 64 per cent of the total series and in 83 per cent of all cases in which a carcinoma was present. Excretion urography was used in only a small group of cases of kidney tumor but revealed the lesion in all instances in which it was employed.

Some recent cases culled from the literature and some additional reports from our own series serve to illustrate further some of the more rarely encountered complications and features of roentgenographic diagnosis of kidney neoplasms.

Meredith[17] has reported a case of kidney tumor complicated with a tuberculous infection. This patient had a papilloma of the kidney with transplants to the ureter and bladder accompanied by a tuberculous infection in the same kidney. Cystoscopic examination showed a papilloma of the bladder, and this, with the finding of acid-fast bacilli in the urine from this kidney, aided materially in making the correct diagnosis.

Kretschmer[10] reported a fibroma of the kidney in a man, aged thirty-eight. His chief complaint was painless and symptomless hematuria. Six years before, he had passed gross blood in the urine, followed one week later by severe pain over both kidneys and two months later he had passed a stone. The kidneys were not palpable. The physical and laboratory findings were normal, and the roentgenographic and cystoscopic examinations showed no abnormality. The right pyelogram showed a filling defect compatible with tumor. A diagnosis of a tumor of the right kidney was made and nephrectomy was performed. The kidney specimen was of about normal size. The pelvis was distended by a compact form, a grayish-white tumor 43 by 41 by 35 mm., which was attached loosely close to the large renal vessels at the root of the kidney, and all around the tumor there was peripelvic fat. There was very little compression of the renal substance by the tumor. Histologic examination showed the growth to be a fibroblastoma.

Kretschmer states that small fibromata under the capsule, in the cortex, or in the medulla at the bases of the pyramids are not infrequently found at autopsy but that they seldom cause signs or symptoms during life. "Large renal fibromata are also extremely rare and on account of their rarity they may be considered curiosities both from a clinical and pathological standpoint." He states that there have been only 11 cases of pure renal fibromata. Several theories are advanced to explain the etiology of these tumors. Ewing believes these fibromata have their origin in disturbances of development but quotes Genewein who thinks that they are not true neoplasms but are tumor-

like nodules arising from superfluous tissue. They may occur in any part of the kidney. Symptoms consist of a palpable mass, pain and hematuria. They vary considerably in size, even to filling the abdomen. The prognosis in such cases is good.

Mackey,[14] in 1930, reported a case of hemangioma and considered the whole problem by means of a thorough review of the literature. He stated:

"Haemangioma of the kidney is of relatively rare occurrence, and authors of wide experience frequently report only a single new case. Infrequent though it may be, it is a condition of surgical importance, for it appears that a large proportion of cases ultimately demand operation more or less urgently. In the cases published, an accurate preoperative diagnosis has seldom been made."

MacKenzie and Hawthorne[12] reported 2 cases of renal hemangioma in 1931. The first patient was a man, aged thirty-five, whose complaints were hematuria of ten days' duration, slight attack of pain in the left lower quadrant of the abdomen, and general weakness for two weeks preceding admission. There were no areas of abdominal tenderness and no masses were palpable. Both kidney areas seemed normal by palpation, and the cystoscopic findings were essentially normal. The urine contained red blood cells and a few pus cells. A pyelogram of the left kidney showed a dilated renal pelvis with distorted, irregularly placed and shaped calyces at the level of the second and third lumbar vertebrae. A left nephrectomy was performed. There was a moderate amount of perirenal infiltration and the cut surface of the kidney showed hemorrhagic areas just beneath the mucous membrane of the upper calyx. The kidney showed fetal lobulation; the cut section showed a dark hemorrhagic area at the upper pole, which was made up of larger and smaller blood channels, lined with endothelial cells and containing red blood cells. Between these channels there was a fibrous connective tissue. The patient was well seven years later at the time the report was made.

The second patient, a man, aged thirty, complained of hematuria and pain in the left groin and burning on urination. He had had one attack of hematuria eight years before, which had cleared up within several days not to recur again until ten days before his admission. There was tenderness on the left side about half way between the umbilicus and the anterior superior iliac spine. There were no kidney masses or tenderness. The voided specimen of urine contained blood cells. Cystoscopic examination showed that the left ureter was discharging blood. A pyelogram showed a markedly flattened middle calyx. A left nephrectomy was performed. At operation there was a marked adherent portion about the center of the kidney on the dorsal surface, the size of a silver dollar. There was also some depression

and discoloration. In the medulla, near the pelvis, there was a reddish hemorrhagic area, which histologically consisted of larger and smaller closely packed dilated venous sinuses, filled with blood. Sections of the retracted areas showed what appeared to be an infarction, with collapse of the parenchyma, distorted blood channels and cellular infiltration and fibrosis. The diagnosis was cavernous hemangioma.

Hemangioma of the kidney is rare, is usually single but may be multiple. These may be situated in the pelvis, medulla, or cortex although they are seldom observed in the cortex. Pathologic study of these specimens show them to be composed of large cavernous sinuses lined with endothelium and filled with blood. Hematuria is the only constant symptom and injury may play a part in its onset. Clinical symptoms arise from hemorrhage and are due to ulceration into the pelvis of the thin-walled vessels. Preoperative diagnoses are seldom made. Many cases were considered as essential hematuria. Jacobs and Rosenberg,[7] also Jenkins and Drennan,[9] claim that the pyelogram presents a mottled appearance due to the permeation by the pyelographic medium of the angiomatous spaces, and the interpretation is difficult because of blood clots in the pelvis.

Renal stones, by reason of chronic irritation, are said to be provocative agents in the etiology of cancer of the kidney pelvis. Martin and Mertz[15] collected 108 cases of renal malignancy associated with renal stones. The average duration of symptoms of carcinoma was five months in this series of cases. Squamous cell carcinomas are said to be associated with kidney stones quite frequently. Scholl and Foulds[22] in 1925 reported 5 cases of squamous cell carcinoma of the renal pelvis, 4 of which were associated with renal stones. One of these patients gave a history of intermittent kidney colic and hematuria for twelve years preceding the cancer. Wells[25] collected 11 cases in 1922, six of which were associated with urinary stones. Scholl[21] reported 2 additional cases in 1933. These cases will be abstracted briefly. A woman, aged fifty-seven, had had kidney stones for seven years. The left kidney was removed and showed a squamous cell carcinoma. The kidney contained many small tumors and many large nodules, measuring 3 to 4 cm. in diameter. This patient died two months later with metastases to the lungs, liver, pancreas and retroperitoneal lymph nodes. The right suprarenal gland had been replaced by the tumor. Scholl's second patient was a woman, aged sixty-seven, who had suffered from thyroid disease since the age of twelve. For two years before admission she had noticed a gradually enlarging mass in her left abdomen which was associated with pain. Physical examination revealed a large palpable mass in the left abdomen and the roentgenogram showed stones and a large calcified mass in the lower kidney pole. An attempted pyelogram showed the iodide solution interrupted at the cal-

cific area near the lower edge of the mass. Operation was performed and the kidney contained pus and stones. There was a squamous cell carcinoma of the renal pelvis which had extended into the surrounding structures too extensively to be removed.

The prognosis in cases of squamous cell tumor is poor. Four of the 5 patients reported by Scholl and Foulds died during the first four months, and one was alive six months after operation. Metastases develop early and extensively and the condition is rapidly fatal.

In the Cleveland Clinic series of 23 confirmed cases of carcinoma of the kidney there were 3 squamous cell or epidermoid carcinomas. One of the patients gave a history of passing calculi. The two other histories did not suggest a previous renal infection or stones. These 3 cases are presented briefly.

The first patient, a woman, aged forty-one, was first observed in August, 1924. She had noticed a mass in her right side in October, 1923. A roentgenographic examination at that time showed a large mass in the right abdomen but no stone shadows. One week before admission to the Clinic she had had chills, fever, and pain in the right abdomen which was followed by the passing of calculi and hematuria.

Physical examination revealed a large, tender, nodular mass in the right kidney region, and much pus and blood were found in the urine. The roentgenogram of the kidney, ureters, and bladder showed a greatly enlarged right kidney which was interpreted as a tumor and the cystoscopic examination revealed a cauliflower-like growth in the region of the right ureteral orifice. The ureteral orifice could not be identified and neither urine nor intravenously injected dye could be seen coming from this region. The right kidney function (estimated from the bladder urine with a catheter to left kidney pelvis) was 10 per cent, the left kidney function was 36 per cent.

Operation was undertaken, but the mass was of such huge size and was so adherent to the surrounding structures that removal was impossible. The patient died in the hospital one month later. Postmortem examination of the right kidney showed the kidney to be five or six times the normal size. The capsule was extremely thick and adherent. There was invasion through the capsule which extended down the ureter and also involved the retroperitoneal lymph nodes, the under surface of the diaphragm, and the liver. Palpation of the bladder did not reveal any tumors and there was only slight involvement of the ureter near the bladder. There was extensive malignant invasion in the region of the duodenum and the pancreas. The pelvis of the kidney was tremendously dilated and was filled with necrotic material, but contained no stones. The central portion of the kidney showed marked degeneration and hemorrhage. Microscopic examination disclosed deeply chromatic stratified squamous epithelial cells growing in

wild profusion in every direction and infiltrating deeply. Practically all the renal parenchyma had been destroyed. Pearl formations, degenerating and metaplastic cells were seen in great abundance. The diagnosis was squamous cell carcinoma of the kidney probably arising in the renal pelvis.

The second patient was a man, aged fifty-two, who was admitted to the Clinic on April 14, 1933, complaining of pain in the back, blood in the urine and nocturia, which had persisted for ten weeks. There was no history of previous genitourinary trouble or the passage of calculi.

The physical examination revealed a movable tumor in the right kidney region. Laboratory examinations showed numerous red and white blood cells in the urine and an increase of urea in the blood. A roentgenogram of the chest showed no evidence of metastasis. Considerable bladder trabeculation was apparent on cystoscopic examination and the specimen collected from the right ureter was bloody. The pyelogram showed marked compression and infiltration of the upper three-fourths of the kidney. This was interpreted as carcinoma of the kidney.

The patient was given a complete course of preoperative roentgen therapy and a right nephrectomy was performed April 28, 1933. The kidney was slightly enlarged but normal in contour. On the anterior surface of the kidney and extending out from the hilum was a bulging tumor measuring 7.5 by 6 cm. The upper half of the kidney cortex was considerably scarred. A few cortical cysts were present. The tumor had infiltrated and replaced the hilar and peripelvic fat and had sent branches up between the pyramids. It was not well circumscribed and diffusely infiltrating. There were no stones present. A large branch of the renal artery was infiltrated and occluded by the tumor.

Various sections through the kidney pelvis showed normal pelvic mucosa, complete loss of mucosa, metaplastic changes, ulcerated mucosa, and replacement of the mucosa by an infiltrating squamous cell carcinomatous growth. The tumor was diffusely infiltrating outward from the renal pelvis into the surrounding medulla, cortex and the peripelvic fat. There was marked atrophy and fibrosis of the kidney tissue and involvement of the renal vein and artery, both infiltration and thrombi. The microscopic diagnosis was squamous cell carcinoma of the right kidney originating in the pelvis.

The patient's convalescence was uneventful. One month after operation he reported for observation. He looked well, had a wonderful appetite, and had gained 6½ pounds. One month later he looked well but had begun to feel a little weak. Four months after operation a roentgenogram of the chest showed definite metastases, and the patient is now declining rapidly.

The third patient is a man, aged fifty-four, who presented himself on November 11, 1932, complaining of pain in the back and right hip, and blood in the urine. These symptoms had been present for three months. There was no history of previous kidney disease.

Physical examination revealed a small mass in the right kidney area and definite cachexia. There was a small amount of microscopic blood in the urine and an occasional pus cell. Cystoscopic examination showed no function from the right kidney with compensatory function of the left kidney. Both the pyelogram and the urogram were unsatisfactory for diagnostic purposes.

The preoperative roentgenograms of the chest and pelvis showed no evidence of metastases.

Right nephrectomy was performed on November 11, 1932. The kidney was densely adherent everywhere but particularly at the upper pole. The renal vein contained a thrombus of tumor tissue. The kidney removed was not enlarged nor deformed. There were a few small cortical cysts and the fetal lobular markings were fairly distinct. The pelvis was moderately dilated, the mucosa was rough and had small papillary-like projections. The peripelvic tissue was infiltrated with tumor tissue. All hilar structures were invaded by the tumor tissue, and the cortex and medulla were diffusely infiltrated. The ureter was stenosed. The renal artery and vein and the kidney capsule and perinephric fat were involved by the tumor.

Microscopic examination showed a thickened, somewhat papilliferous pelvic surface covered by single and multiple layers of rather large, atypical, epithelial cells, having an epidermoid appearance, but without keratinization. Extending outward from the pelvis, there were solid masses of epithelial cells of similar type diffusely infiltrating the medulla, cortex and capsule proper of the kidney. There was extensive fibrosis of the renal tissue. There was similar infiltration of the fatty extrarenal tissue.

In less than one month after operation, metastases were demonstrated in the upper ends of the femurs. These areas did not show bone changes before operation, but undoubtedly the pain which the patient complained of on admission was caused by metastases which could not be demonstrated at that time on the roentgenogram. These distant metastases occurred in less than four months after the first symptom.

The clinical course and the pathology in these 3 cases parallels the course of squamous cell carcinoma as described in the literature. This lesion is rapidly fatal and the prognosis is gloomy indeed.

Summary

A general review of various aspects of the problem of roentgenologic diagnosis of renal tumors is presented, in which the relative merits of

retrograde and excretory urography are discussed. Pneumopyelography, with its advantages and dangers, is reviewed.

The controversy regarding pathologic classification is cited, with some of the reasons for these difficulties.

Certain problems relating to the diagnosis of renal lesions presenting themselves in clinical practice are mentioned and illustrated by case reports from the literature and the files of the Cleveland Clinic.

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