TUBERCULOSIS OF THE KIDNEY.*

BY

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TUBERCULOSIS of the kidney illustrates the advance in diagnosis and treatment in renal surgery in the last twenty-five years. The mortality of nephrectomy for tuberculosis of the kidney between 1890 and 1900 was 25.4 per cent.¹ At that time no adequate means of ascertaining the presence and condition of the second kidney were generally employed. The use of the ureteral catheter and the tests of the renal function, together with a more accurate knowledge of the pathology of renal tuberculosis, have reduced the operation mortality to 2 or 3 per cent.

SURGICAL PATHOLOGY.

Renal tuberculosis is a disease of young adult life, and occurs most frequently between the ages of 20 and 40. It is rare in children, and in them is more frequently bilateral in the early stages. The disease is uncommon over 50 years, and at this age is more chronic than in middle life. The male sex is more frequently affected than the female in a ratio of about 2 to 1. In adults chronic renal tuberculosis is unilateral in from 80 to 90 per cent. of cases in the early stage.

Source and Route of the Infection.

In the strict meaning primary tuberculosis of the kidney cannot be said to exist. A primary focus is always present elsewhere in the body, although it may not be discovered clinically. Braasch² places the coincident lesions discovered in 346 operated cases at 71 per cent. Others have found a lower proportion of coincident lesions in clinical work. Thus Persson³ states the figure at 50 per cent., and in 193 cases operated on by myself 48.1 per cent. had evidence of obsolete tubercle elsewhere in the body.

A history of pleurisy and clinical evidence of obsolete pulmonary tuberculosis is common, while *post-mortem* evidence shows that tuberculous glands of the mediastinum are present in a large proportion of cases. Active pulmonary tuberculosis is found coincident with renal tuberculosis in a small number of cases (5.3 per cent.).

Tuberculous lesions—which must, equally with renal tuberculosis, be secondary—are found in other parts of the body. The exact relationship of these to the renal lesion is not always clear, but some of them may be the immediate source of the tubercle bacilli that infect the kidney. In order of frequency these are genital tuberculosis in the male and tuberculosis of bones and joints. In my cases submitted to operation there were tuberculous lesions of the epididymis in 23.3 per cent., of the prostate in 15.3 per cent., and of the seminal vesicles in 7.3 per cent.

There are three possible paths—namely, the ascending or urinary by the lumen of the ureter, the lymphatic, and the haematogenous.

There is experimental evidence that, under certain conditions, ascending infection by the lumen of the ureter may occur (Wildbolz⁴); there is histological evidence that lymphatic infection along the ureter may take place (Bauereisen,⁵ Walker⁶); and there is pathological evidence that supports lymphatic infection from the thorax (Brongersma⁷). The weight of evidence at the present time supports the view that in renal tuberculosis the tubercle bacillus is blood-borne.

VARIETIES OF RENAL TUBERCULOSIS.

It is possible to reduce the many varieties of renal tuberculosis that have been described to three: (1) miliary tuberculosis, (2) chronic renal tuberculosis, and (3) tuberculous nephritis.

Miliary Tuberculosis.

This is an acute condition in which both kidneys are strewn with tubercles. It is part of a general tuberculosis, and is of no surgical interest.

Chronic Renal Tuberculosis.

Under this head are included almost all forms of renal tuberculosis that come under the care of the surgeon. It includes the conditions known as apical tuberculosis, ulcerocavernous tuberculosis, tuberculous hydronephrosis, caseous tuberculosis, nodular tuberculosis, and tuberculous abscess.

The first change, in the great majority of cases, takes place at the apex of a pyramid. There is a small loss of substance surrounded by a zone of inflammation. The ulceration spreads outwards towards the base of the pyramid, and a cavity communicating with the calyx is formed; the lining of the cavity is a layer of necrotic or caseating tissue. Beyond this is a zone of inflammation which may show grey tubercles, and occasionally there is a complete zone of grey gelatinous tubercles. Outward from the zone of inflammation isolated tubercles are dotted in normal renal tissue or arranged as one or more streaks radiating to the surface of the kidney. On the surface of the kidney groups of tubercles are seen in areas corresponding to the subjacent tuberculous pyramids. One or several, or all the pyramids may be affected in different degrees. Another pathological process may now become prominent: in the wall of the calyx at its neck, or the division of the pelvis at its outlet, or in the wall of the pelvis, fibrous thickening develops and contracts until the passage is finally occluded. If now the urinary secretion in the section that is gradually being occluded is maintained, a localized cyst or partial or total hydronephrosis develops. If, on the other hand, the secretion of urine is abolished, a caseous mass surrounded by fibrous tissue is formed and the whole kidney may be converted into a mosaic of these caseous masses. The ureter is greatly thickened and rigid in a large proportion of cases. There is ulceration, necrosis, and caseation of the mucosa, and tuberculous infiltration with the formation of thick layers of fibrous tissue in the middle and outer coats. Stricture formation may affect one or several parts of the tube, and dilatation of the tube occurs above.

Tuberculous Nephritis.

In cases of pulmonary tuberculosis the urine may contain albumin and tube casts, and these may also be present in the urine of the second kidney in chronic renal tuberculosis. In the latter condition the symptoms usually clear up after removing the tuberculous kidney. This condition has been regarded as due to toxic nephritis, and *post-mortem* examination has shown that there was either interstitial or parenchymatous nephritis, but that tuberculous changes were absent. Recently Heyn⁸ and others have described kidneys where nephritis of this character was present and tubercle bacilli were found in the kidneys without any specific tuberculous changes. In a woman, aged 37, I removed the left kidney for intermittent haematuria when no bacilli were present in the urine. The kidney was small and showed interstitial nephritis and minute cysts, and scattered throughout were giant celled systems. This case might be regarded as unilateral chronic miliary tuberculosis of the kidney.

SYMPTOMS.

The symptoms of renal tuberculosis do not at first, and may not at any time, directly refer to the kidney. I have placed them in the order of frequency in which they occurred in the cases under my care: (1) bladder symptoms, (2) changes in the urine, (3) loss of weight, (4) haematuria, (5) renal pain, (6) palpable renal swelling and thickened ureter.

In the majority of cases irritability of the bladder with increased frequency of micturition is the first and for a long time the only symptom of which the patient complains. The irritability is slight and variable, depending on the weather and diet. It increases until urine is passed every twenty or thirty minutes day and night, accompanied by pain before and after micturition. The urine in the early stage is increased in quantity; it is pale, faintly acid or neutral, and contains albumin and a small amount of suspended pus and fine white flakes. In uncomplicated cases a few tubercle bacilli are found, but no other bacteria.

Slight terminal haematuria is frequently observed, and an attack of haematuria is occasionally an early symptom.

* A paper read in opening a discussion on this subject in the Section of Surgery at the Annual Meeting of the British Medical Association at Edinburgh.

Rarely, severe attacks of haematuria are a prominent feature. Continuous slight loss of weight is as a rule observed, but there is no rapid or severe emaciation in uncomplicated renal tuberculosis. Renal pain is usually insignificant, and may be entirely absent. With severe haemorrhage there may be ureteric colic from clots. Fever is absent in most cases, but a slight persistent rise of temperature to 99° or occasionally to 100° F. may be observed. A high temperature, if present, is a symptom of either a mixed infection or of general tuberculosis. The kidney is felt enlarged in a small number of cases of uncomplicated renal tuberculosis. Even when it is considerably enlarged it may be adherent high up under the diaphragm and not be felt.

A thickened tuberculous ureter may be detected on deep palpation at the level of the brim of the pelvis in a thin subject, on rectal examination in the male subject, or as a thick cord in the lateral fornix on vaginal examination. It is a characteristic of renal tuberculosis that the disease may have advanced so far as completely to have destroyed one kidney without causing symptoms that attract the attention of the patient. The symptoms may vary, and in some cases may disappear for considerable periods. In the majority of cases, however, the symptoms are slowly progressive.

SPONTANEOUS CURE AND CLOSED RENAL TUBERCULOSIS.

A condition of clinical importance has received the name of "closed renal tuberculosis" or "autonephrectomy." The latter term is incorrect and unscientific. With this, and inseparable from it, must be discussed the question of spontaneous cure of renal tuberculosis.

A tuberculous lesion of the kidney may be arrested as the result of one of two processes—namely, (1) healing of the tuberculous lesion with disappearance of the tubercle bacillus and replacement of the ulcer by a scar, and (2) exclusion of the tuberculous focus by a ring of fibrous tissue.

1. I have searched for many years in the kidneys I have removed for tuberculous and other diseases for evidence of healing of a tuberculous lesion without destruction of the segment of the kidney affected or of the entire kidney. I have only met with one example, and this, although it appeared perfectly healed to the naked eye, still showed some giant cell systems microscopically.

In this case I removed the right kidney of a woman, aged 40, for acute haematogenous pyelonephritis due to staphylococcal infection. One of the pyramids in the middle third of the kidney showed the apex cleanly scooped out. The calyx was normal, and to the naked eye there were no signs of inflammation. The lining of the cavity was smooth. The pathological report was as follows: "The cavity which occupies the position of the apex of a calyx is in part lined by epithelium-like cells, but at one spot the lining is composed of granulation tissue in which a few giant cells are still to be found. Apart from this there is no evidence of tubercle."

2. The form in which the activity of a tuberculous lesion of the kidney is arrested by exclusion of the focus is not uncommon (10 per cent. of renal tuberculosis—Braasch⁹), and has received the clinical name of "closed renal tuberculosis." It was first described as a clinical entity by Zuckerkandl,¹⁰ and later described fully by Smirnow.¹¹ I have seen three varieties of change in the kidney that have produced this clinical phenomenon—namely, (1) tuberculous hydronephrosis, (2) massive caseous tuberculosis of the kidney, and (3) occlusion of an ulcero-cavernous focus. The whole of the kidney, or only a part of it, may be affected by the closure.

Clinical Aspect of Closed Renal Tuberculosis.

In some cases of renal tuberculosis there has been bladder irritability for a time, but this has been neglected and has disappeared, and the condition known as closed renal tuberculosis, where the infected area is shut off from the urinary tract, has developed. No further symptom may arise, and the presence of a closed tuberculous kidney may be unsuspected during the life of the patient and be accidentally discovered after death.

The discovery of closed renal tuberculosis may be made during the routine examination of a candidate for life

insurance, or during the investigation of some condition independent of the urinary disease. Examination of the urine and x-ray examination and cystoscopy are the methods by which attention is drawn to the renal disease. There may be albuminuria, or a trace of pus, or some red blood corpuscles, and the x rays may show the shadow of caseous masses in the kidney. The kidney may be enlarged, and a thickened ureter may be felt on abdominal, rectal, or vaginal palpation. Cystoscopy and chromocystoscopy show a closed and dragged out ureter. The discovery of closed renal tuberculosis on one side may be made during the examination of a case of tuberculosis of the other kidney.

When the closed focus affects only a part of the kidney the diagnosis becomes very difficult, and may be impossible apart from operation. The x rays and pyelography may, however, give information that leads to a diagnosis. Closed tuberculosis in one part of a kidney with active open tuberculosis affecting the remaining portion of the organ is not uncommon, and accounts for the variation and even temporary disappearance of symptoms.

A very important question arises in regard to these cases of "closed renal tuberculosis": Is the tuberculous infection of these kidneys permanently inactive, or is it still potentially active? Where one portion of the kidney is the seat of "closed tuberculosis" the remaining part of the kidney may continue to function and remain healthy, and at a later date become infected with tubercle. I removed a kidney where the upper one-third was a closed tuberculous hydronephrosis and the apex of one pyramid of the lower third showed early tuberculous ulceration. There had been a trace of pus but no bacteria found in the urine seven years previously. For nine months before operation there was loss of weight, pyuria, and tubercle bacilli in the urine.

Infection of the urinary tract may occur from a tuberculous focus which has been closed. In the following case the exciting cause of the reopening of the tuberculous focus was an injury.

A man, aged 40, had had haematuria fifteen years previously. Three weeks before I saw him he fell heavily down a flight of stairs. Six days later frequent micturition and haematuria suddenly developed and the urine was found to contain tubercle bacilli. The left ureter was oedematous, and near it was a small patch of tubercles.

Nephrectomy showed a large kidney converted into a series of round cysts, and at the lower pole there was a tuberculous cavity communicating by a narrow neck with the pelvis. Acute inflammation of the pelvic mucous membrane spread from this opening into the lower part of the pelvis and down the ureter.

Persson mentions a case where a fracture of the pelvis was followed by miliary tuberculosis and an autopsy revealed an unsuspected renal tuberculosis. Braasch investigated five kidneys the seat of closed renal tuberculosis by inoculation of guinea-pigs, and found that in four the tuberculous infection was dead; in one it was still active. Wildbolz found in the wall of a closed renal tuberculosis fresh tubercles in spite of the fact that the contents were sterile. In a case described by Kapsammer¹² spontaneous healing had lasted for many years, but eventually a perinephric abscess developed and caused death.

These cases show, and the experience of other observers confirms the view, that closed renal tuberculosis is a potential source of further infection.

DIAGNOSIS.

1. Symptoms.

The spontaneous development of signs of cystitis insidious in its onset in a young adult suggests the presence of urinary tuberculosis. Discomfort, pain, and tenderness of the kidney, and enlargement of the organ, may be present. These symptoms do not, however, necessarily prove that this kidney is tuberculous or that the other kidney is healthy. The symptoms may arise in a kidney which is hypertrophied and healthy or recently infected with tubercle when the other kidney has been destroyed by tubercle without any symptoms being noticed by the patient.

2. Aseptic Pyuria and Albuminuria.

Where there is pyuria and the urine is sterile it is practically certain that tuberculosis is present. Pus may be absent in closed renal tuberculosis. Albuminuria is a constant symptom, and its absence will raise a doubt as to whether tuberculosis is present even when other signs point to the condition.

3. The Tubercle Bacillus.

The discovery of the tubercle bacillus is the final proof of urinary tuberculosis. The proportion of cases in which the bacillus is found in the urine is given by Persson as 85 per cent., by Beer¹³ as over 70 per cent., and by Wildbolz as 90 per cent. Hattinger¹⁴ found the bacillus forty-two times in the first smears and six additional times in second smears, and only failed in four cases. The tubercle bacillus is usually present in small numbers, and there may be a difficulty in finding it, so that repeated examinations are required. Hyman and Mann¹⁵ state that large numbers of bacilli are more likely to be found in the earlier than in the later stages of the disease. Animal inoculation should always be made where a doubt exists.

In regard to the discovery of the tubercle bacillus in urinary tuberculosis we must contemplate two possible conditions: (a) the tubercle bacillus is not demonstrated but the symptoms point to tuberculosis; (b) the bacillus is demonstrated but other proofs of tuberculosis are wanting.

(a) The Tubercle Bacillus is not Demonstrated.

Failure to discover the tubercle bacillus in the urine does not exclude urinary tuberculosis. In 295 cases of proved tuberculosis of the kidney Persson found that the tubercle bacillus was demonstrated microscopically in 78.3 per cent. and by guinea-pig inoculation in a further 7.1 per cent.—in all 85.4 per cent. of cases. In 193 cases in which I performed nephrectomy for renal tuberculosis the tubercle bacillus was found in the urine in 155 (80.3 per cent.). There are several reasons for the failure to demonstrate the tubercle bacillus in 20 per cent. of cases of renal tuberculosis. The search must be made by a competent bacteriologist, and much time and care must be spent on it; the number of bacilli may be very small and their appearance in the urine intermittent; repeated search in specimens taken at different times is therefore necessary. Again, the tuberculous focus may be shut off from the urinary tract (closed tuberculosis); when the renal lesion is closed but there is tuberculous ulceration of the bladder repeated examinations frequently fail to discover the tubercle bacillus, and the same may be true when tuberculous ulcers persist in the bladder after nephrectomy. Finally, the tubercle bacillus may not be pathogenic to the guinea-pig. Cases of renal tuberculosis in man have been described by Löwenstein¹⁶ and Joannovic where the bacillus of fowl tubercle has been found. This type of tubercle bacillus is non-pathogenic to guinea-pigs. Hryntschak¹⁷ ascribed the failure to discover the tubercle bacillus to this cause in some cases of human tuberculosis of the kidney.

In cases where the tubercle bacillus is not demonstrated in the urine the diagnosis may be made by the symptoms, the presence of tuberculous lesions elsewhere in the body, and especially in the male genital system, the discovery of a thick ureter, the demonstration of x-ray shadows thrown by caseous masses in the kidney, or by the help of cystoscopy. In 38 of my 193 cases the tubercle bacillus was not found in the urine, and the diagnosis was made by the cystoscope in 30 of these (15.5 per cent.).

(b) The Tubercle Bacillus is Present in the Urine.

The demonstration of the tubercle bacillus in the urine is usually regarded as diagnostic of tuberculous disease of the urinary tract. The tubercle bacillus may be discovered in the urine when no other symptoms of urinary tuberculosis are present—a condition termed "tuberculous bacilluria."

In such cases the question arises whether a lesion of the kidney insufficient to give rise to symptoms exists, or whether it is possible for tubercle bacilli to pass through the kidney without producing a focus of tuberculous disease.

Foulerton and Hillier¹⁸ were the first to show that tuberculous bacilluria without a tuberculous lesion of the kidneys might occur in cases of pulmonary tuberculosis. Kielleuthner¹⁹ confirmed the observations of Foulerton and Hillier, and proved that in his cases no genital source for the bacilli existed. Hobbs²⁰ found tubercle bacilli in the urine of 6 per cent. of phthisical patients. Kielleuthner found that in all cases where a tuberculous bacilluria was

present there was albumin in the urine, and other observers have noted the presence of albumin and tube casts.

It seems probable, therefore, that a non-specific nephritis is present in all cases where tuberculous bacilluria is found. The bacilluria in these cases is probably not continuous, and may have a short duration. Nitch relates a case where tuberculous bacilluria was found in clear urine, and continued for two and a half months and then ceased, and the patient was well eleven years later.

The presence of the tubercle bacillus in the urine cannot of itself be regarded as a proof of tuberculous disease of the kidney. In clinical work the additional proof required of a tuberculous lesion in the kidney is the presence of pus in the urine. When pus is present, even in microscopic amount, it is proof that there is a tuberculous lesion; where it is absent and closed tuberculosis can be excluded there is no surgical tuberculous lesion of the kidney.

4. Complement Fixation Reaction.

Dr. Megumi Takahata²¹ has recently reviewed the value of the complement fixation reaction of the urine in urinary tuberculosis, and found this test accurately indicated the affected kidney in unilateral renal tuberculosis. Kilbane used the von Pirquet test and found it positive in 8 out of 10 cases of renal tuberculosis. In the great majority of cases the accurate methods of diagnosis render these tests superfluous, but cases may occasionally arise where the complement fixation test may be of value.

5. Cystoscopy.

It is frequently possible by means of the cystoscope alone to diagnose renal tuberculosis. Changes easily recognized by the trained observer occur at the ureteric orifice and in the bladder. In 30 of 193 cases in which I performed nephrectomy for renal tuberculosis the diagnosis was made by the cystoscope, search for the tubercle bacillus having failed. Space does not permit of a description of the cystoscopic appearance in the bladder.

While examination of the ureteric orifice usually gives definite information as to the presence of tuberculous disease of the corresponding kidney, there are cases where this may be unreliable. The ureteric orifice may be normal when the kidney is infected, and, on the other hand, the ureteric orifice may be involved in an area of tuberculous inflammation of the bladder, and the kidney be free from disease.

The observation of a stained ureteric efflux by cystoscopy after injection of indigocarmin (chromocystoscopy) has little value in deciding whether the kidney is tuberculous. A deeply stained efflux may be seen when the kidney is infected.

6. Catheterization of the Ureters.

By catheterization of the ureters a specimen of urine is obtained from each kidney. If one ureteric orifice is definitely tuberculous only the apparently healthy side need be catheterized, but where a doubt exists both ureters are catheterized. The urine so obtained is examined for (1) the presence of the tubercle bacillus, (2) other bacteria, and (3) the functional power of the kidney.

There are cases of advanced tuberculosis of the bladder where the ureteric orifices are involved in the inflammation and ulceration, and it is impossible to pass a catheter into the ureter. Several courses are open to the surgeon. He may await improvement in the bladder condition under the influence of tuberculin. This is problematical. The bladder may be opened and the ureters catheterized through the cystotomy wound. I have found this a difficult and unsatisfactory method with little advantage over cystoscopy. Bilateral nephrotomy is recommended by some surgeons. In practice the method is not satisfactory. A tuberculous lesion situated at the apex of a pyramid is difficult—and may be impossible—to see when the kidney is opened by nephrotomy. The damage to the kidney is a grave disadvantage when its neighbour is tuberculous.

Fullerton²² recommends that the ureter should be exposed at the brim of the pelvis by a muscle-splitting operation in the lower iliac region. The ureter is incised and a catheter passed up to the kidney and a specimen obtained, after which the wound in the ureter is closed with fine

catgut. If the ureter is found diseased it is not opened. I have used this method in a number of cases and found it extremely valuable. The exposure is not difficult, and I have had no trouble with healing after the operation.

7. X-ray Diagnosis.

According to Braasch²³ 20 per cent. of cases of renal tuberculosis have positive x-ray data of definite diagnostic value. Small irregular shadows may be found in the kidney area. They are thrown by caseous areas in a tuberculous kidney and are sometimes confused with stone shadows. The outline of these shadows is irregular and the density low and uneven. A heavy uniform shadow is thrown by a caseous mass in the kidney. In massive caseous tuberculosis of the kidney there is a closely set mosaic of rounded or oval shadows.

A thickened tuberculous ureter containing caseous material sometimes throws a shadow. Pyelography is occasionally used to estimate the extent of the tuberculous disease. The outline of the affected calyx or group of calyces is enlarged, blurred, and indefinite, and the pelvic outline may be irregular and the cavity dilated. It is only justifiable in rare cases.

TREATMENT.

The modern treatment of renal tuberculosis is nephrectomy in all cases where the second kidney is healthy and no definite contraindication exists. This treatment is based on three postulates of the surgical pathology of chronic renal tuberculosis:

1. Tuberculosis of the kidney is a progressive disease.
2. Tuberculosis of the kidney is unilateral in the early and bilateral in the late stage.
3. Removal of the tuberculous kidney prevents in most cases the infection of the second kidney.

Space does not permit of further discussion of these points.

As regards operation only nephrectomy need be discussed. Partial nephrectomy has been abandoned on account of the difficulty of ascertaining on the operation table how far the disease has invaded the kidney. Nephrotomy is only performed when, nephrectomy is impossible.

Indications and Contraindications for Nephrectomy.

1. *Extra-urinary Tuberculous Disease.*—Obsolete tubercle in other parts of the body (lungs, spine, or joints) is no contraindication to nephrectomy and has no adverse effect on the after-history of the case. When active tuberculous disease of bones or joints is present operation on the kidney should be postponed until the extra-urinary tubercle has been successfully treated. Where active tuberculous infection of the lungs is present operation on the kidney is contraindicated. Tuberculosis of the male genital organs (epididymis, prostate, and seminal vesicles) does not contraindicate nephrectomy. In several cases I have removed both epididymes, the prostate and the seminal vesicles, and the kidney with complete success.

2. *Bilateral Renal Tuberculosis.*—The removal of the kidney in which the disease is more advanced in bilateral tuberculosis is advocated by some surgeons. According to those surgeons active hyperaemia of the remaining kidney follows nephrectomy, which increases the resistance to the tuberculous infection. The tuberculous lesions become more localized and there is a greater tendency to connective tissue formation. In some cases cure of the condition is claimed.

Ekehorn²⁴ in bilateral renal tuberculosis exposed both kidneys and removed the more diseased of the two. In 20 cases the immediate result was diminution of pain and pyrexia. Subsequently 10 died, 5 were still alive, and 5 not traced. Two of the survivors were free from pain and able to work twelve years after operation, and a third five years after operation.

Braasch² reports 13 deaths within one and a half years following nephrectomy in 16 patients with bilateral disease. In a series of 62 bilateral cases Israel²⁵ found about 70 per cent. had died shortly after the nephrectomy.

The immediate post-operative mortality of nephrectomy in bilateral tuberculosis varies from 66 to 80 per cent., and the benefits gained in the few surviving cases have not been permanent. The procedure is only justified in the most exceptional cases where one kidney is proved to be the cause of profound toxæmia and the other kidney is in the earliest stage of tuberculous infection.

Technique of Nephrectomy.

The technique of nephrectomy for renal tuberculosis requires no description, but some points call for comment.

1. The Treatment of the Ureter.

Many methods of dealing with the tuberculous ureter have been used.

(1) The ureter is cut across below the kidney, the end seared with the cautery or with pure carbolic acid, and dropped back into the retroperitoneal space. In addition pure carbolic acid is injected into the ureter.

(2) The ureter is cut across below the kidney and the end sutured to the skin in the lumbar wound, or is brought up to the surface inside a drainage tube and fixed there.

(3) The kidney and ureter are removed by the lumbar-iliac incision (nephro-ureterectomy).

(4) The kidney is removed by the lumbar incision and the ureter cut across. A second small incision is made in the inguinal region through which the ureter is removed.

A ureter fixed in the lumbar wound retracts and infects the wound with tubercle. The injection of pure carbolic acid is not likely to destroy the tuberculous infection of the ureter and is somewhat dangerous.

In some patients it is possible to remove the ureter through the lumbo-iliac incision, suggested by Morris, but in the majority of cases it is not possible to remove the whole length of the ureter as far as the bladder by this incision. A stump of varying length is left attached to the bladder. The same limitations attend the removal of the ureter through a small incision in the iliac region.

The method that I have practised for many years, and that I have found satisfactory, is to remove the ureter as far as the brim of the pelvis through the lumbar wound, sear it with the cautery or with pure carbolic acid, ligature, and drop it into the retroperitoneal space. The patient is re-examined in six months, and if there is reason to believe that the disease is still active in the ureter and is infecting the bladder, extraperitoneal ureterectomy is performed through a median suprapubic incision. The cases in which ureterectomy is advisable are those where there is stricture at the lower end of the ureter and dilatation of the duct. The proportion of cases in which this is required does not exceed 8 per cent.

2. Closure of the Lumbar Wound.

In the majority of cases of nephrectomy for renal tuberculosis I close the wound without drainage at the end of the operation. Drainage may be necessary on account of oozing or of infection of the perinephric tissues with tubercle or other bacteria. Where all cases are drained a sinus persists in some, and may take months to heal. Infection from tuberculous deposits in the perinephric fat may be the cause of the sinus, but it is usually due to a mild post-operative staphylococcal infection.

Legueu²⁶ has shown that tuberculous deposits are found in the perinephric fat, and it is suggested that the fatty layer should be removed with the kidney. This is easy in the early stage of the disease, but impossible in advanced tuberculosis where there are masses of perinephric fat extending under the diaphragm.

It is an occasional experience to find that the wound heals completely by first intention, and a few weeks later one or more weak spots appear in the scar. These are small superficial areas of tuberculous infection, and should be treated by scraping, the application of iodine, and the administration of tuberculin.

Thévenot²⁷ describes a complete breaking down of the wound from tuberculous infection (*tuberculisation totale*), of which he has collected 11 examples. I have seen one case of this nature in which, after the wound had eventually healed, the patient died of general tuberculosis four months after the nephrectomy.

Effect of Nephrectomy on Tuberculous Infection of the Bladder.

A temporary increase in the bladder symptoms is not uncommon immediately after nephrectomy. Tuberculous cystitis and ulceration gradually subside, and the bladder eventually becomes free from tuberculous infection. Where the bladder infection was of comparatively recent date the

bladder symptoms entirely disappear and the full capacity of the organ is restored.

Where tuberculous cystitis has been established for some time the bladder seldom regains its full capacity after the cystitis has disappeared, and a frequency of two hours becomes permanent. Tuberculous cystitis and ulceration may persist for some years when the whole of the renal and ureteral infection has been removed. The urine in such cases may be clear and contain no tubercle bacilli and only microscopic pus.

The treatment of the bladder after nephrectomy for tuberculosis consists in the administration of soothing drugs, such as sandalwood oil, and the administration of tuberculin. Washing of the bladder had better be avoided, for it does not affect the tuberculous process and may cause a mixed infection. I have not seen any permanent benefit from the injection of strong solutions of mercury perchloride or carbolic acid. Cauterization of a tuberculous ulcer with the high-frequency cautery (étincillage) has been recommended by Heitz Boyer²⁸ and others, and is likely to be of assistance when the ulceration is superficial and limited.

Operation Mortality.

The operation mortality has fallen during the last twenty-five years, and statistics which include only cases of comparatively recent date have the benefit of more accurate methods of diagnosis, improved technique, and the fact that patients are now referred to the surgeon at an earlier stage of the disease than heretofore.

Persson calculated his operation mortality in 205 cases treated during thirty years as 7.3 per cent., whereas the 85 cases operated on in the last five years showed only 4.7 per cent. mortality.

The following are some recent series of cases:

	Cases.	Mortality.
Suter (1923) ²⁹	204	2.5 per cent.
Ferria (1923) ³⁰	89	6.5 "
Wildbolz (1924) ⁴	500	2.4 "
Hogge (1924) ³¹	100	7.0 "
Gayet (1924) ³²	100	5.0 "
Judd and Scholl (1924) ³³	863	2.7 "
Persson (1925) ³	205	7.3 "
Condamin (1926) ³⁴	172	2.9 "
Young (1926) ³⁵	112	0.89 "
Thomson-Walker (1927)	193	2.5 "

Late Results.

The late mortality of cases of renal tuberculosis where nephrectomy has been performed, if intercurrent disease be disregarded, depends upon tuberculous infection of the second kidney and tuberculous disease elsewhere in the body. Infection of the second kidney may have been present at the time of the operation, or the kidney may be infected later from the original source of the tubercle. When complete investigation of the urine of the second kidney is carried out by animal inoculation the risk of this is very small. It is more likely that infection of the second kidney is derived from the original source at the time or soon after the operation.

The number of cases in which the patient dies of general tuberculosis is considerable. Persson points out that acute miliary tuberculosis occurs twice as often during the first six months after the operation as in the total of the following years.

Of 193 patients on whom I performed nephrectomy for renal tuberculosis 5 died and 188 recovered.

Of the 188 survivors I was able to trace 111 and failed to obtain information in regard to 77.

Of the 111 survivors there are 67 well and without any symptoms of urinary disease at periods varying from 1 to 22 years after the operation (60.3 per cent.).

The period that had elapsed since the nephrectomy in these cases was: 1 year in 10, 2 years in 9, 3 years in 4, 4 years in 1, 5 years in 1, 6 years in 7, 7 years in 4, 8 years in 4, 9 years in 3, 10 years in 5, 11 years in 2, 12 years in 4, 13 years in 3, 14 years in 4, 15 years in 4, 16 years in 1, and 22 years in 1.

There were 25 patients (22.5 per cent.) who were in good general health but still had bladder symptoms. In some cases the frequent micturition was due to permanent contraction of the bladder without tuberculous disease; in other cases there was persistence of the tuberculous infection. The period of time that had elapsed since operation in these cases was 1 year in 6, 2 years in 5, 3 years in 1, 4 years in 2, 5 years in 3, 6 years in 1, 7 years in 4, 9 years in 1, 12 years in 1, 20 years in 1.

Thus there were 92 out of 111 cases traced (82.8 per cent.) where the patient was in good general health at periods varying from 1 to 22 years after the removal of the tuberculous kidney.

Of these 92 cases, 35 had been operated on three years or less from the time of the inquiry, and in 57, or 61.9 per cent., 4 years or more had elapsed since the operation. Of the 111 cases, the remaining 19 cases (17.1 per cent.) had died since the operation, 4 from intercurrent disease (2 one year and 2 twelve years after the operation) that had no relation to tuberculous disease, and 4 from unknown causes, but probably from tuberculous disease in some form (2, 3, 6, and 10 years after the operation). The remaining 11 cases died of tuberculous disease: 6 from general tuberculosis (2 one year, 1 two years, 2 three years, 1 eight years), 2 from tuberculous disease of the second kidney (3 and 7 years), and 3 from tuberculosis of the lungs (2, 4, and 8 years).

Of the 19 patients that died after the operation 11, or 57.8 per cent., died during the first three years. This agrees with the observations of Israel and of Persson, who found that 50 per cent. of the late mortality occurred during the first three years after the operation.

The late mortality from tuberculous disease of the remaining kidney in my cases is small—namely, 2 in 19 cases, or 10.5 per cent.

General tuberculosis caused death in 6 cases (31.5 per cent.), and 5 of these deaths occurred within the first three years. Tuberculosis of the lungs accounted for 3 deaths, 2 of which were in the second and fourth years respectively.

The following are some of the statistics of the late results:

Surgeon.	Cases Traced.	Dead.	Completely Well.	Improved but not Completely Well.
		Per cent.	Per cent.	Per cent.
Persson	182	24.7	57.1	5.8
Suter	197	29.9	41.6	25.3
Judd and Scholl	611	31.0	58.6	10.0
Nitch ³⁶	48	12.0	52.0	35.0
Wildbolz	—	19.4	61.5	—
Thomson-Walker	111	17.1	60.3	22.5

Non-operative Methods of Treatment.

I have treated a number of cases of renal tuberculosis with tuberculin (Koch's new tuberculin T.R.) without operation. These were cases where the patient refused operation or where the disease was bilateral and operation was contraindicated.

In adults I have seen no case of cure with tuberculin. There was frequently amelioration of the symptoms and improvement of the general health for several years, but the tuberculous disease persisted. In one child with bilateral tuberculosis the symptoms vanished, the general condition steadily improved, and pus and tubercle bacilli disappeared from the urine. In another boy the symptoms improved and the patient gained weight, but the tubercle bacilli and pus in the urine persisted and the tuberculous cystitis was unchecked.

In all cases of renal tuberculosis I give a course of two years of tuberculin T.R. after nephrectomy. This has a beneficial effect on the tuberculous infection of the bladder, and is given also with the hope that the primary focus of infection in the mediastinal glands or elsewhere will be influenced by it.

Sunlight and the Ultra-violet Rays.

Tuberculosis of the kidney cannot be cured by exposure of the patient to sunlight. I have seen a number of cases where this form of treatment has been used, but in none of these has there been the semblance of a cure. Cases have been recorded where the pus and tubercle bacilli have disappeared from the urine for some years after this treatment. Our knowledge of the pathology of renal tuberculosis shows that temporary occlusion of a tuberculous focus may take place without this treatment, but that sooner or later the tuberculous disease progresses and destroys the kidney.

The temporary improvement that may take place from treatment by sunlight unfortunately encourages the patient to resist operation or to postpone it, and thus much valuable time is lost.

Heliotherapy is a valuable method of treatment after operation for tuberculosis of the kidney, and it has also a useful field in cases where operation is contraindicated.

In an inquiry among the physicians of Switzerland, Wildbolz found that of 316 patients suffering from renal tuberculosis not operated upon 31.3 per cent. died within the first two years of the disease, and 27.2 per cent. within three to five years. More than half (58 per cent.) died within the first five years, and only 20 per cent. were alive after five years.

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STATISTICS OF POST-OPERATIVE SURVIVAL IN RENAL TUBERCULOSIS.*

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WHEN a patient is brought to the surgeon for renal tuberculosis two questions obtrude themselves: (1) Is the lesion confined to one kidney? and (2) Is cure without operation possible?

Recently I set out to investigate a series of 158 cases of tuberculosis of the bladder seen over a period of twenty years. It was found to be very difficult to trace these cases, but some useful information was obtained. One of the objects of the investigation was to compare the results of operation, when the kidney was affected, with those obtained by other measures, among which the most important and the most popular was the use of tuberculin.

Of the 158 cases there was definite evidence of kidney involvement in 141. In the remainder evidence was wanting—either on account of the difficulties associated with ureteral catheterization, or because, in the early days, it was assumed, probably without sufficient justification, that the bladder condition was secondary to involvement of the epididymis, prostate, or vesiculae. Further observation has shown that tuberculosis of the sexual organs frequently coexists with or follows renal tuberculosis. Thus there were 87 males in the series, and in no fewer than 29—that is, in one-third—there were deposits of tubercle in the prostate, epididymis, or vesiculae. In only 7 out of the 141 cases was there definite evidence, at the time of my examination, of a bilateral lesion—that is, in about 5 per cent.

In all cases an attempt was made to find a primary focus. A previous history of some tuberculous lesion was obtained in 26 per cent., and in 15 per cent. a focus was found at the time of examination in some part of the body outside the genito-urinary tract. In many cases, no doubt, hidden foci were present in glands, bones, etc., but they were not sufficiently obvious to arrest attention during an

ordinary clinical examination. This leads me to say that I have frequently been struck with the apparently robust health which many patients the subject of urinary tuberculosis enjoy. Many go on for years with much inconvenience and suffering before the general health becomes seriously impaired.

As opposed to the views I have long held regarding the localization of the infection to one kidney, and the prospects of cure without operation, a recent paper by Gilbert J. Thomas and Thomas J. Kinsella¹ is very interesting and instructive. These authors have conducted a research in a well equipped sanatorium in Minnesota for the treatment of tuberculosis. Their conclusions include the following:

They argue that tissue destruction with renal tuberculosis is a late lesion, and that this is the lesion most frequently seen by the surgeon. They bring evidence to prove that early renal tuberculosis may end in arrest or cure. They believe that tubercle bacilli are carried to the kidney by the blood stream, and that every renal infection with tubercle bacilli must be primarily bilateral. One kidney may not overcome the infection so well as its mate, and a destructive lesion develops. They have never been able to demonstrate a case of excretory bacilluria. They have never removed a kidney which eliminated tubercle bacilli that did not contain a lesion of tuberculosis, though in some instances serial sections were necessary before the lesions could be found. Repeated urological examinations revealed many cases of unsuspected renal tuberculosis among their patients, nine-tenths of whom had active pulmonary lesions.

I have had very little opportunity of examining patients representing this class of case. Those who have been referred to me have had what these authors term "tissue destruction," and in the large majority, as I have stated, I have been unable to find evidence of bilateral infection. It is quite true, of course, that the absence of pus and tubercle bacilli in the specimen obtained by ureteral catheter from a kidney is not conclusive proof of its freedom from disease. Foci may be present in the cortex, for instance, and may not communicate with the pelvis, or an abscess in the parenchyma may be shut off, only discharging into the pelvis at intervals; but the difference between the urines excreted by the diseased kidney and by the presumably sound kidney has been, in my experience, so definite and decided in almost every case examined that I cannot come to any other conclusion than that the disease is unilateral, clinically, at any rate, in the cases coming under my observation. The specimen obtained from the affected side, besides containing pus and tubercle bacilli, is, in nearly 100 per cent. of the cases, of a low specific gravity. In the early cases the low specific gravity is associated with an increased flow, which may be termed unilateral diuresis. In the later stages the urine, though still of low specific gravity, may become diminished in quantity, until finally no fluid at all is secreted, and the discharge from the kidney may be represented by a semi-solid ointment-like material; or the ureter may become impervious, and all connexion between the affected kidney and the bladder cut off. The low specific gravity in the late cases is due to renal insufficiency, a condition which it may be possible, by chemical analysis, to distinguish from the hyperactivity seen in the early stages.

I have been able to demonstrate by repeated ureteral catheterization in cases of renal calculus that pure reflex unilateral diuresis occurs, with low specific gravity, and dilution of the specimen from the affected side, and that, on removal of the cause, the rate of flow, the specific gravity, and the composition of the urine rapidly return to normal, and become identical on the two sides.²

A similar diuresis occurs in the early stages of tuberculosis, and appears to be due to reflex vaso-dilatation, in contradistinction to the vaso-constriction which gives rise to reflex anuria—a condition well known to occur in certain cases of calculus.

My colleague Dr. Mayrs of Queen's University, Belfast, has recently made analyses of the urines of 35 patients under my care with various unilateral kidney disorders. These analyses have been carried out in order to ascertain whether ureteral catheterization can throw any light on

* A contribution to a discussion on renal tuberculosis in the Section of Surgery at the Annual Meeting of the British Medical Association, Edinburgh, 1927.