THE UNIVERSITY OF MINNESOTA

GRADUATE SCHOOL

Report

of

Committee on Examination

This is to certify that we the undersigned, as a committee of the Graduate School, have given Arthur Raymond Knauf final oral examination for the degree of

Master of Science in Urology

We recommend that the degree of

Master of Science in Urology

be conferred upon the candidate.

W. F. Braasch
Chairman

Gilbert J. Thomas.

H. E. Robertson.

Franklin R. Wright

Verne C. Hunt

Date May 16, 1922

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REPORT

of

COMMITTEE ON THESIS

The undersigned, acting as a Committee of the Graduate School, have read the accompanying thesis submitted by Arthur Raymond Knauf, for the degree of Master of Science in Urology. They approve it as a thesis meeting the requirements of the Graduate School of the University of Minnesota, and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science in Urology.

W. F. Braasch

Jerry F. Hunt

Franklin R. Wright

THESIS

THE LATE RESULTS OF OPERATIONS FOR THE CURE OF EXSTROPHY OF THE BLADDER

Arthur Raymond Knauf, B.S., M.D.

Submitted to the faculty of the Graduate School of the University of Minnesota in partial fulfillment of the requirements for the degree of Master of Science in Urology.

April, 1922.

All attempts at the cure of exstrophy of the bladder must aim at attaining continence of urine and freedom from bladder irritation.

The early methods of treatment consisted largely in efforts to remedy the condition by means of plastic operations. Wood, Roux, and others formed an anterior wall for the bladder by using skin flaps taken from the abdomen or scrotum. Thiersch dissected up the edges of the bladder mucosa and sutured them together, thus obtaining a cavity lined entirely by bladder epithelium. In order to facilitate the closure of the bladder Trendelenberg split the sacro-iliac synchondrosis and then applied pressure to both hips to force the pubic bones together, following this by a plastic on the bladder and urethra. He reported six cases with two deaths and absent or only imperfect control in the others. Berg modified this procedure by doing a vertical osteotomy of the ilium. Sonnenberg removed the entire bladder and implanted the ureters in the base of a newly formed urethra. The object of this was to facilitate the wearing of a properly fitting urinal. He reports nine cases without a death. Efforts at increasing the bladder capacity by utilizing a portion of the intestine were made by Rutkowski, Mikulicz and Berg.

In general, plastic operations for the cure of exstrophy of the bladder have been a distinct failure. Continence is practically never attainable. Stone formation and the accompanying severe cystitis often necessitate a cystotomy. Sinuses frequently persist and the patients usually require numerous operations at intervals of months or years before the desired results are obtained. They are also not without their risk. Ashhurst reports a 20 per cent mortality from them. For these reasons plastic operations have of late years been practically abandoned.

In order to obtain continence surgeons early tried diverting the urine to the intestines thus enabling them to make use of the rectal sphincter. They

were led to this by the cloacal condition present in birds. This was first successfully done by Simon in 1851. By a specially devised instrument he was able to pass a suture between the ureter and the rectum. Tying the suture resulted in a pressure necrosis with the formation of a fistulous communication between ureter and rectum. The flow of urine into the intestine was promoted by applying pressure over the ureteral openings in the bladder. The patient survived for nine months. At autopsy he was shown to have a pyelonephritis and numerous small hard concretions in both ureters. A short time later Roux transplanted the severed ureters into the bowel. Holmes in 1862 repeated with slight modifications Simon's operation but the result was fatal.

Thiersch in 1881 formed a vesico-rectal fistula by means of a clamp which he fastened on the adjacent bladder and rectum, forming a communication between them. The bladder was closed by suturing its edges together. The result was gratifying and the patient was able to retain his urine for three hours. Numerous modifications of this procedure were made. Tuffier incised the portion of the bladder between the ureteral meati. Through this opening he then picked up the rectum, incised it and sutured it to the bladder, mucosa to mucosa. Senn by transperitoneal operation sutured the sigmoid to the bladder. Three days later he incised the bladder and united its mucosa to that of the rectum.

Maydl in 1892 transplanted an oval portion of the trigone containing the ureters into the rectum. He hoped by this method to keep intact the ureteral sphincters and also to preserve the blood supply of the lower end of the ureter. By the action of the ureteral sphincters he expected to avoid the ascending infections of the kidney which were almost universal in experimental work. The operation became quite popular. Zesas collected ninety-seven cases from the literature operated upon by this method. Of these twenty-six died, a mortality of 27 per cent. Pyelonephritis caused the death of thirteen, peritonitis, six; urinary infiltrations, three; ureteral kinks, two; pneumonia, one; and chloroform

narcosis, two. He also cites twenty-four cases in which ureteral transplantations were made without the protection of any portion of the bladder mucosa. There were thirteen deaths in this series. At first sight this would seem a strong argument in favor of the Maydl operation. However, when one realizes that most of these latter cases were complicated by vesical carcinoma and vesical tuberculosis, the argument loses much of its force. It is well known at the present time that there really is no ureteral sphincter and that closure of the lower end of the ureter is obtained by the action of the muscular portion of the bladder wall through which it passes.

Buchanan collected eighty cases with a 28.7 per cent mortality. Of twenty deaths seven died of peritonitis and nine of pyelonephritis. In 152 cases of Maydl operations collected by Moorhead there were forty-four deaths. Of these twenty-one died of pyelonephritis, eight of peritonitis, one of chloroform narcosis, three of pneumonia, two of pulmonary embolism and in eight the cause of death was not mentioned. From these reports it will be seen that the operative mortality comes largely from two sources -- pyelonephritis and peritonitis.

The shock of the operation in the young and the presence of a pre-existing pyelonephritis distinctly influence the mortality. According to the statistics of Jelinek patients of five years and under show a 41 per cent mortality of whom 15 per cent die of pyelonephritis. Between the ages of six and ten years the mortality is 18 per cent and 3 per cent of these die of pyelonephritis. After this age the general mortality and that from pyelonephritis increases until for patients twenty-six years and over it reaches 72 per cent and 54 per cent, respectively.

Besides the immediate operative deaths there is an additional mortality from pyelonephritis in cases surviving the operation which has been placed at 10 per cent. Thus 25 per cent of all cases operated upon by this method die of renal infections. Buchanan has collected ninety-eight cases surviving the

Maydl or Bergenheim operations. Of these eleven died subsequently of ascending infection, two of pre-existing renal disease, seven of causes other than renal disease and two of unknown causes. Eleven cases were not traced. Sixty-four were well at the last report, of whom twenty-five have lived three or more years. Mugniery has lately reported the end results in five cases operated according to the method of Maydl by Novè - Josserand. Of these there was one death from peritonitis. One case has a mild renal infection. The other three are alive and in good health after twenty-two, seventeen and a half, and twelve years respectively.

Control, though acquired gradually, has usually been good following this procedure. Rarely have cases shown any signs of rectal irritation. Urinary and fecal fistulas have sometimes complicated the operation. Of three cases operated upon by this method at the Mayo Clinic two died with symptoms of renal insufficiency. An autopsy obtained on one of these revealed an inflammatory occlusion of both ureters at the site of implantation with bilateral hydro-ureter and hydronephrosis.

Following the Maydl operation numerous attempts were made to develop a technic which would diminish the risk of peritonitis and pyelonephritis. Moynihan in 1906 transplanted the trigone with a portion of the bladder wall into the rectum by an extraperitoneal method. He sought in this way not only to prevent peritonitis but also to increase the capacity of the bowel. Bergenheim,and independently of him London and Peters, implanted the ureters extraperitoneally into the rectum, taking a small rosette of bladder tissue with each ureter in order to preserve its valve action. Buchanan has collected twenty-six cases operated upon by this method with three deaths, two from pyelonephritis and one probably due to an embolism. London and Newland report the end result in two of their cases. One died twelve years later of pyelonephritis; the other died seventeen years later of pulmonary tuberculosis. No autopsy was obtained in this case. Stevens, using the same technic, reports a case well after five years

and having a 25 per cent phenolsulphonephthalein output.

More numerous were the efforts made to develop a procedure which would diminish the probability of the development of an ascending infection. Fowler, in 1898, formed a triangular shaped flap from the intestinal mucosa which was to act like a valve and cover over the ureteral opening in the intestine. Gersuny divided the bowel at the junction of rectum and sigmoid and then anastomosed the sigmoid to the rectum within the anal sphincter. Later the trigone was implanted into the blind end of the rectum. Heitz-Boyer and Havoleque, after dividing the sigmoid from the rectum brought it down and sutured it to the anal margin. The trigone was then transplanted into the rectum. Cuneo operated in a similar manner using an isolated loop of the ileum from which he formed a new bladder. The object of these procedures is to obtain a separation of the urine from the feces and at the same time retain both under the control of the rectal sphincter. The operations are technically difficult and frequently result in injury to the rectal sphincter. Six cases done by the Heitz-Boyer-Havoleque method gave a 50 per cent mortality. Two of them have a partial incontinence. In one the result was good.

Berg, in 1909, anastomosed an isolated loop of the small intestine to the sigmoid. Two or three weeks later an elliptical piece of the trigone containing the ureters was implanted into this. He reports five cases with two operative deaths. One patient died two months later, probably from pyelonephritis. In two the results were good. Borelius made a lateral anastomosis between two adjacent portions of the sigmoid and transferred the trigone to the top of the loop thus formed. This operation depends largely on the possibility of securing a loop of the sigmoid sufficiently large and movable. Müller, Flörcken and Werelius divided the sigmoid and then joined the proximal end to the rectum. The trigone was implanted into the blind end of the sigmoid. Subbotin and Diakonow form a fistulous track leading from the perineum between rectal mucosa and sphincter to

the base of the bladder. This track is then lined by a strip of bladder epithelium and the bladder closed by a plastic operation. Jelinek collected eight cases done according to the method of Subbotin. Of these three died from acute sepsis, three were in good condition and two could not be traced. In a similar manner Lerda formed a perineal fistula under the control of the rectum and lined it with Thiersch skin grafts.

Makkas, in 1911, following the suggestion of Verhoogen, sought to prevent the ascending infection by using the cecum as a urinary reservoir. He isolated the cecum anastomosing the ileum to the ascending colon and sutured the appendix to the skin. After a course of irrigations he transplanted the ureters into the cecum which readily dilates to hold 300 to 325 cc. Fründ reported five cases operated upon by this method. Two died as a result of the operation. One developed a permanent urinary fistula. The others were apparently well after one and two years respectively. The urine from both contained pus and colon bacilli. Filling the newly formed bladder with collargol resulted in a reflux up the ureters which were dilated in both cases. They were able to retain their urine from two to three hours. Schilling cited three cases examined after one, two and two and a half years respectively. The urine was not entirely normal in any of these. Only one had control.

Blair and Spannaus converted the terminal portion of the ileum into a urinary bladder, restoring the continuity of the bowel by an ileocolostomy, hoping that the ileocecal valve would prevent infection. Blair's patient survived for one year and then died of uremia. Spannaus' two cases survived but a few weeks and died with symptoms which he interpreted as being due to the absorption of toxic substances from the urine. He doubts the advisability of passing the urine through the upper intestinal tract. It is known that the entire urinary output in dogs can not be diverted to the upper intestinal tract as toxic symptoms develop which end in death. Cecil has recently reported a case

of traumatic unilateral uretero-intestinal anastomosis with severe nephritic symptoms which he thought were due to the absorption through the intestine of poisonous substances in the urine.

In order to prevent a contracture at the site of anastomosis which was a frequent occurrence in other operations Boari devised a button anastomosis similar to the use of the Murphy button in intestinal work. Zesas cites fourteen cases by various men using this method. Only five survived. Gangrene at the point of anastomosis was a common complication.

Oblique implantations of the divided ureters were made by Martin in 1899. Stiles implanted the divided ureters using a modification of the Witzel gastrostomy method with some success. In an effort to simulate the entrance of the bile and pancreatic ducts into the intestine Coffey in 1911 developed a technic which he hoped would diminish to a great extent the ascending infections which had been the most common cause of the large mortality of the previous operations. This operation, with changes as suggested by C. H. Mayo, has been adopted at the Mayo Clinic. The ureter is divided approximately one inch from the bladder. On the right side an incision one and one quarter inches in length is made in a longitudinal direction through the serous and muscular coats of the rectosigmoid. The mucosa is left intact except at the lower end where a puncture is made large enough for the passage of the ureter. The ureter is then inserted for a short distance into the lumen of the intestine. It is fixed by interrupted sutures passing through serosa, muscularis and wall of the ureter. Some weeks later the left ureter is implanted in a similar manner into the sigmoid. By this method the ureter is made to traverse one and one-quarter inches of the wall of the intestine and any pressure from within will tend to close the lumen of the ureter. Coffey states that in not one of nine dogs in which the complete operation as described by him was performed did ascending infection take place. He also made two bilateral and three unilateral transplantations in the human. In none of

these patients could he find any evidence of renal infection. One bilateral transplantation was in good health six years later.

Since the adoption of this method thirty-three patients have been operated on for exstrophy of the bladder at the Mayo Clinic. The operation was done in three stages. The right ureter was transplanted first. After a lapse of from ten days to two weeks the left ureter was transferred and at a later time the bladder mucosa was excised. Twenty-three cases are well from nine months to twelve years after operation. None of them complain of symptoms which could be attributed to renal insufficiency or pyelonephritis. Seventeen have survived the operation for three or more years. In six over five years have elapsed. One patient is married and has successfully passed through a pregnancy. Urinary control has been very satisfactory in all cases and these patients have been transformed into useful and self-sustaining citizens.

An opportunity was had to reexamine five of these patients at different intervals following operation. The histories of the cases follow:

Case No. 228976; male, age 19. Came to the clinic April 20, 1918, complaining of incontinence of urine which had been present since birth. For the last five years he had had recurring pains in the left upper absomen and in the left lumbar region. These had become quite severe during the last week when he also noticed a mass in the left upper abdomen. The patient stated he had lost twenty-five to thirty pounds weight in two months. Physical examination at this time revealed a typical complete exstrophy of the bladder. There was also a palpable mass in the left upper quadrant of the abdomen. The systolic blood pressure was 120; the diastolic 70. The leukocyte count was 18,200. A diagnosis of left pyonephrosis was confirmed at operation and a left nephrectomy was done. He made a good recovery and returned in August 1918 for a transplantation of the right ureter, having in the meantime gained fourteen pounds weight. At operation August 9, 1918, the ureter, though dilated to twice its normal size

was transplanted into the rectosigmoid by the Coffey method. From this procedure he recovered without incident. July 28, 1922, almost two years following the operation, he was reexamined. He stated that his general health had been excellent and that he had been able to work every day at his occupation of drug clerk. He had no pain in his back, chills, fever, nausea, vomiting, vertigo or edema at any time since leaving the hospital. There had been a gain of six pounds in weight. He urinated three to four times a day and occasionally once at night. The sphincter control was perfect. Except for a scoliosis and a widening of the pelvis the physical examination was practically negative. His blood pressure was 122 systolic and 78 diastolic. Urine obtained from the rectum contained a moderate amount of pus. The blood count showed 8,000 leukocytes and 78 per cent hemoglobin. Examination of the fundus of the eye was negative. The blood urea was 32 mg., the urea nitrogen 14 mg., and the creatinin 1.6 mg. The uric acid in the blood was somewhat elevated, being 8 mg.

Case No. 259298; female, age 19. Presented herself at the clinic February 11, 1919, complaining of an exstrophy of the bladder and incontinence of urine. One unsuccessful attempt at closure of the bladder by a plastic operation had been made a short time after birth. Examination revealed a complete exstrophy of the bladder. The opening of the right ureter was seen but the left could not be found. There was a lack of fusion of the pubic bones. Two vaginas were present, in the left one of which the cervix could be felt. At operation exploration revealed a complete double uterus, each with its ovary and tube. There was a large left hydroureter and hydronephrosis. The left kidney was fuctionless. The right ureter, which was normal in size, was transplanted into the rectosigmoid. The patient was discharged from the hospital on the twelfth day, having entirely recovered from the operation. She returned in September 1920, eighteen months later, apparently in perfect health. At no time had she been troubled with pain in her back, chills, fever, nausea, vomiting, vertigo or edema.

Her urinary control, which had not been very good following the operation, had been steadily improving so that she was passing her urine six to seven times a day and three to four times at night. Rarely was there any involuntary discharge of urine. She had been able to successfully take care of her household duties. Her physical examination was practically negative, except for the enlarged left kidney. The systolic blood pressure was 122, the diastolic 82. There were a few pus cells in her urine. The blood count showed 11,000 leukocytes and 74 per cent hemoglobin. Examination of the fundus of the eye was negative. The blood urea was 30 mg., the urea nitrogen 14 mg., the creatinin 1.5 mg., and the uric acid 1.6 mg.

Case No. 251343; male, age 23. Was first seen in November 1918. He complained of incontinence of urine which had been present since birth. The physical examination revealed multiple adenomata of the thyroid, bilateral inguinal hernia and a complete exstrophy of the bladder. The systolic blood pressure was 130; the diastolic 76. There was an 85 per cent hemoglobin and 10,000 leukocytes. The right ureter was transplanted into the sigmoid November 22, and the left, December 2. Both kidneys and ureters were apparently normal. He made a good recovery from the operations and a few months later the bladder was excised. Twenty-two months after the transplantations he returned to the clinic feeling perfectly well. He was employed as an operator of a stone crushing machine and had missed no time from his work. He had had no pain in his back, chills, fever, nausea, vomiting, headaches or edema. He urinated two to four times a day and once or twice at night. His urinary control was perfect. The physical examination at this time was practically the same as in 1918 except that in place of the exstrophied bladder he had a small ventral hernia. The urine obtained from the rectum contained a rather large amount of pus. The systolic blood pressure was 122, the diastolic 80. The blood contained 73 per cent hemoglobin and 9,700 leukocytes. The fundus of the eye was normal. His blood urea was 40, urea nitrogen 18, creatinin 1.3, and uric acid 1.4. Proctoscopic examination showed

a normal mucosa in the rectum and sigmoid. The opening of the right ureter was situated on a small papilla. There was no inflammatory area around it. A catheter passed up the ureter easily. A pyelogram gave a normal appearing pelvis, with sharply defined calyces and a moderate typically inflammatory dilatation of the ureter.

Case No. 238459; male, age 17. Was first seen in July 1918, suffering from incontinence of urine due to an epispadias, the urethral opening being just above the symphysis. He had previously had nine operations without relief. His urine was normal. The systolic blood pressure was 120, the diastolic was 80. Roentgenologic examination of the kidneys, ureters and bladder was negative. The phenolsulphonephthalein test gave a return of 60 per cent in two hours and ten minutes. On July 30, 1918, the right ureter was transplanted into the cecum by the Coffey-Mayo technic. His convalescence was marked by a continued elevation of temperature for two weeks following the operation. In September 1918 the left ureter was transplanted into the sigmoid. From this he developed a urinary fistula and an abscess in the left iliac region. The abscess was drained by reimplanting the left ureter into the posterior surface of the descending colon. The ureter was dilated to the size of a finger. There was also a left hydronephrosis and pyelonephritis. Following the reimplantation he made a rapid recovery. In August 1920 he returned for reexamination. His health was good. Except for a short time after leaving the hospital he had worked every day as a chauffeur. He had not been troubled with pain in his back, chills, fever, headaches, nausea, vomiting or edema. He passed his urine four to five times a day and once or twice at night. His physical examination was not noteworthy. The blood pressure was 126 systolic and 78 diastolic. He had 75 per cent hemoglobin and 7,800 leukocytes. The urine contained a moderate amount of pus. Proctoscopic examination was negative. The blood urea was 76, the urea nitrogen 36, the creatinin 2.4 and the uric acid 1.9 mg. Examination of the fundus of the eye was negative.

A letter in November 1921 stated that he was in good health and had successfully passed through an operation for acute appendicitis.

Case No. 93590; female, age 20, came to the clinic in October 1913, stating that she had no control of her urine. On examination she was seen to have a complete exstrophy of the bladder. Both ureteral meati were visible and functioning normally. The systolic blood pressure was 128. Except for an absence of the symphysis pubis the roentgenologic examination of the kidneys, ureters and bladder was negative. The right and the left ureter were implanted into the sigmoid on the ninth and twenty-fourth of December 1913, respectively. There was a slight rise in temperature for three or four days following each operation. In January 1914 the bladder was excised. The following October she entered a nurses' training school and has been following this profession since then. Her health has been fine. She has had no pain in her back, chills, fever, nausea, vomiting or edema. She urinates three to four times a day and once at night. Her sphincter control is perfect. She was reexamined in June 1920, almost seven years after operations. At this time her urine contained a moderate amount of pus. The systolic blood pressure was 126, the diastolic 72. She had a 75 per cent hemoglobin and a 8,000 leukocytes. Her blood urea was 56, the urea nitrogen 25, the creatinin 1.1 and the uric acid 3 mg.

These five patients are all in perfect health at the present time. None of them complain of symptoms which could be attributed to pyelonephritis or renal insufficiency. Two of them, however, show a definite nitrogen retention combined with pus in their urine, which would seem to indicate a renal infection. In a third case, the presence of a pyelonephritis is definitely shown by the pyelogram. In one patient a dilated ureter was found at operation. This with an increase in the uric acid content of the blood and the presence of pus in the urine is suggestive of the existence of a renal infection. In only one case were the blood nitrogen findings normal and so little pus was found in the urine

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as to give a reasonable doubt of the presence of a pyelonephritis.

From this it is evident that a symptomless phelonephritis exists in many cases which in the past have been reported as having no signs of an ascending infection. The effect of this pyelonephritis on the length of life of these patients is difficult to determine. It is a well known fact that many cases run a long chronic course and in the absence of acute exacerbations with little impairment of kidney function.

There is nothing to substantiate the view that these patients may suffer from a toxemia due to the absorption of poisonous substances from the urine as occurs when the entire urinary output is diverted into the duodenum. With the exception of fluids, absorption from the rectum and sigmoid is very slight. In the patients who were reexamined no evidence of a toxemia could be found. There was no elevation of blood pressure, no changes in the fundus of eye, no edema, and no symptoms suggestive of a toxic nephritis. The urinary output was not diminished, so that very little reabsorption could have taken place.

The results in general following the Coffey-Mayo operation have been satisfactory, though it has not prevented ascending infections as was hoped. Probably no method of uretero-intestinal anastomosis will do this as the ascending infection has been shown to take place through the lymphatics of the ureter and will occur whenever they are brought in contact with an infectious area. When one considers the favorable conditions already present for the development of pyelonephritis in all exstrophied bladders and that 50 per cent of these patients die before their tenth year it will be seen that some attempt must be made to remedy the condition, and of these the Coffey-Mayo method has proved the most satisfactory.

CONCLUSIONS

I. The end results of operation for exstrophy of the bladder by the Coffey-Mayo method of uretero-intestinal anastomosis are very satisfactory.

II. It does not prevent the development of a pyelonephritis which is usually symptomless.

III. Evidence of renal infection may be obtained in some cases by catheterization of the transplanted ureters with the aid of a proctoscope.

IV. Toxic symptoms due to the absorption of urine from the intestines do not develop when the urinary output is diverted into the sigmoid or rectum.

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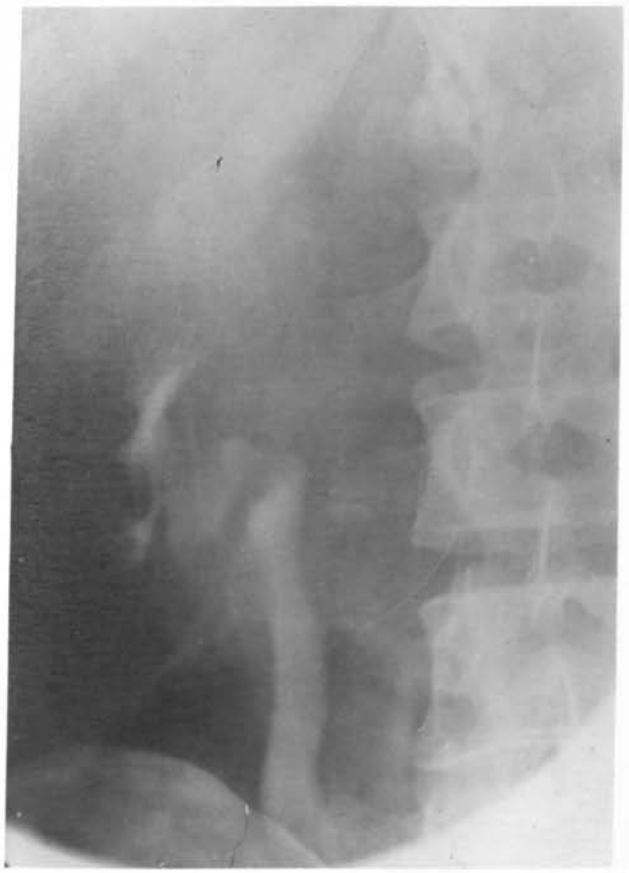

Pyelo-ureterogram taken twenty-two months after transplantation of the ureter into the rectum.

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