

A FUNCTIONING ARTIFICIAL BLADDER: RESULTS OF 41 CONSECUTIVE CASES

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As we had announced in a previous publication,¹ it is our purpose to present here the late results which we obtained in formation of an artificial bladder from a segment of the sigmoid colon anastomosed to the urethra. Approximately 4 years have elapsed since the first procedure was carried out.

The operative results will not be analyzed from the standpoint of neoplasms because included in the series are cancers of different grades, some in very advanced stages. This same principle can be applied to results obtained from colo-cystoplasty.*

The operative stages (fig. 1) are fundamentally the same as we pointed out in a previous communication, but much has been accomplished since then in improving the technique:

1) For drainage of the intestinal segment, instead of the regular urethral catheter, we now substitute the T tube of Kehr (18F to 20F) usually employed in surgery of the biliary tract (fig. 2).

The transverse branches of the T tube are shortened in accordance with the length of the

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* We have used intestinal segments for either enlargement or substitution of the bladder in 85 cases. The ileum was used in 10, the ileopelvic colon in 75.

In the last group, 34 were subjected to bladder enlargement (colo-cystoplasty) for a benign lesion and in 41 the bladder and prostate gland were totally substituted because of a malignant lesion (colo-urethroplasty).

Both surgical interventions and results cannot be studied as a whole because they are not comparable, the same thing being true for partial and total cystectomy. They too are not related as far as their indications, extensiveness of the surgical act, and the surgical technique are concerned.

In colo-cystoplasty the intestinal segment has to be added like a patch to a reservoir. Therefore, this operation is somewhat technically simple to perform.

In colo-urethroplasty the intestinal segment is assuming all the original vesical functions thus being directly connected to the ureters and membranous or prostatic urethra. The operation is technically more difficult to carry out.

¹ Gil-Vernet, J. M.: Technique for construction of a functioning artificial bladder. *J. Urol.*, **83**: 39-50, 1960.

colonic segment, multiple openings being made upon them just to insure good drainage. This tube is inserted in a retrograde fashion with the aid of a urethral catheter. It is left in place for at least 14 to 15 days if there is no leakage of urine. Conversely, it is left in place until the fistula has closed.

2) Drainage of the pelvic excavation is provided by continuous suction (Redon's method) rather than the classical rubber tube drain. The essential point in this type of surgery is constant

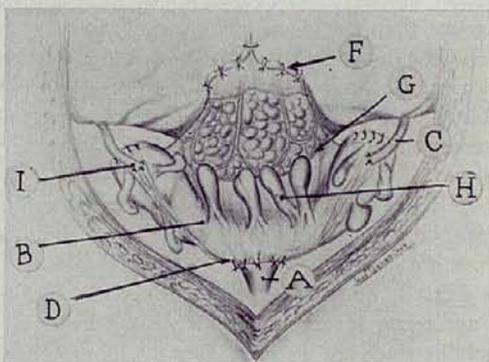


FIG. 1. A, apex of prostate or membranous urethra. B, sigmoid colon. C, ureter. D, urethrocolic anastomosis. F, suturing of anterior parietal peritoneum to serosal leaf of mesosigmoid. G, edge of serosal leaf incised for enlargement maneuver of mesosigmoid. H, epiploic appendice. I, ureterocolic anastomosis. Operation according to technique 2 (end-to-side).

control of the cavity's drainage system as well as suction of the extracavitary spaces. To forget this rule implies the failure of the whole procedure.

These particular drainage tubes are situated in such a way that two are placed between the intestinal segment and the rectum, and a third one between the intestinal segment and the abdominal wall (fig. 3). They are discontinued as soon as no drainage ensues, usually after 10 to 12 days.

This type of drainage, in any form of genito-

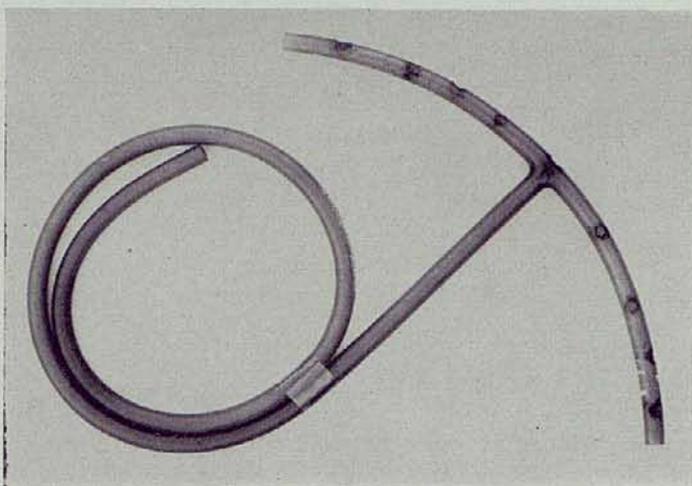


FIG. 2

urinary surgery, has proved to be more advantageous than the classical Penrose drain.

3) The anastomotic stoma of the intestinal segment (technique 2) must be as small as possible, about $\frac{1}{2}$ cm. in length. The smaller it is, the less chance there is for formation of a urinary fistula.

4) If the ureter is of normal caliber, it can be transplanted according to standard techniques (Nesbit's, and others). If the ureter is found to be dilated, we usually proceed by transplanting it according to our new method in which some metallic rings are utilized,² thus avoiding stenosis and ureteral reflux in the majority of cases.

5) The bowel continuity is well established by means of an end-to-end anastomosis, by suturing it in a single layer fashion using 3-0 silk. We believe that this avoids edema in the anastomosis which could be the cause of obstruction.

6) Lately we have performed systematically a temporary fecal diversion by means of a cecostomy. Since using it the postoperative intestinal complications (ileus, distension fecal fistula etc.) have disappeared completely. As soon as we feel certain that intestinal continuity has been achieved, we close the cecostomy.

This type of operation requires extremely meticulous attention in all its details. The slightest technical failure will show its deleterious effects, as a rule immediately, always in the long run.

² Gil-Vernet, J. M.: Personal communication to the 53rd French Urological Congress.

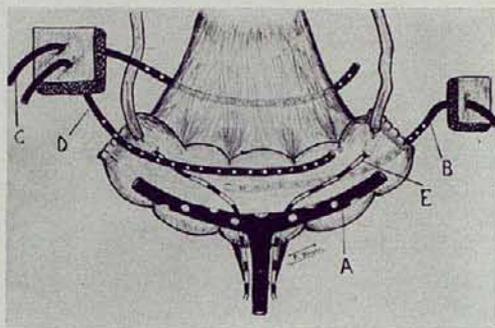


FIG. 3. *A*, Kehr's tube placed inside intestinal segment. *B*, drainage tube for continuous suction, situated behind intestinal segment. *C*, drainage tube situated behind meso of intestinal segment. *D*, drainage tube situated before intestinal segment. *E*, ureteral catheter.

In an earlier publication it was transcribed by error that 2 cm. of the mucosa of the intestinal segment should be excised from its ostium, when in reality only 4 mm. is resected in order to avoid its extrusion, which in turn is one of the principal causes of urinary fistula.

At the same time it was also transcribed that the average operative time was $3\frac{1}{2}$ hours when as a rule the procedure lasts approximately $4\frac{1}{2}$ hours, logically including at this stage pelvic lymphadenectomy and cellulotomy.

We have never had to abandon use of the sigmoid because of shortness of the mesocolon or due to retractile mesosigmoiditis.

In spite of having been faced with some shortness of the mesocolon, we have always been able

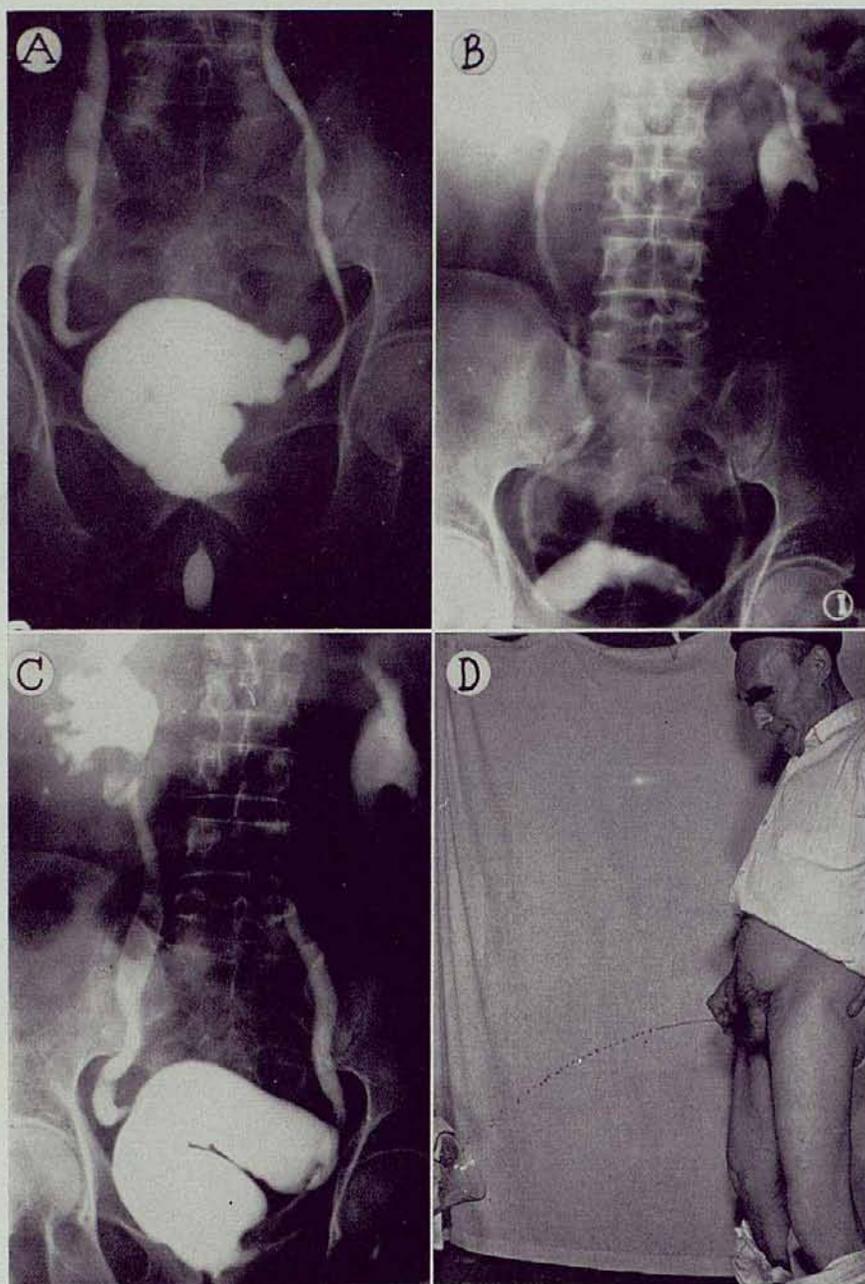


FIG. 4. Case 1. Technique 1 (end-to-end). *A*, retrograde urethrocytogram to maximum capacity 1 year after operation. Note ureteral reflux. *B*, excretory urogram $3\frac{1}{2}$ years after operation. Upper urinary tract remains normal. *C*, retrograde cystogram, maximum capacity ($3\frac{1}{2}$ years after operation). Active ureteral reflux persists. *D*, patient during act of micturition $3\frac{1}{2}$ years after operation. From functional standpoint, status is same as in preceding publication. Electrolyte disturbances and pyelonephritis absent.

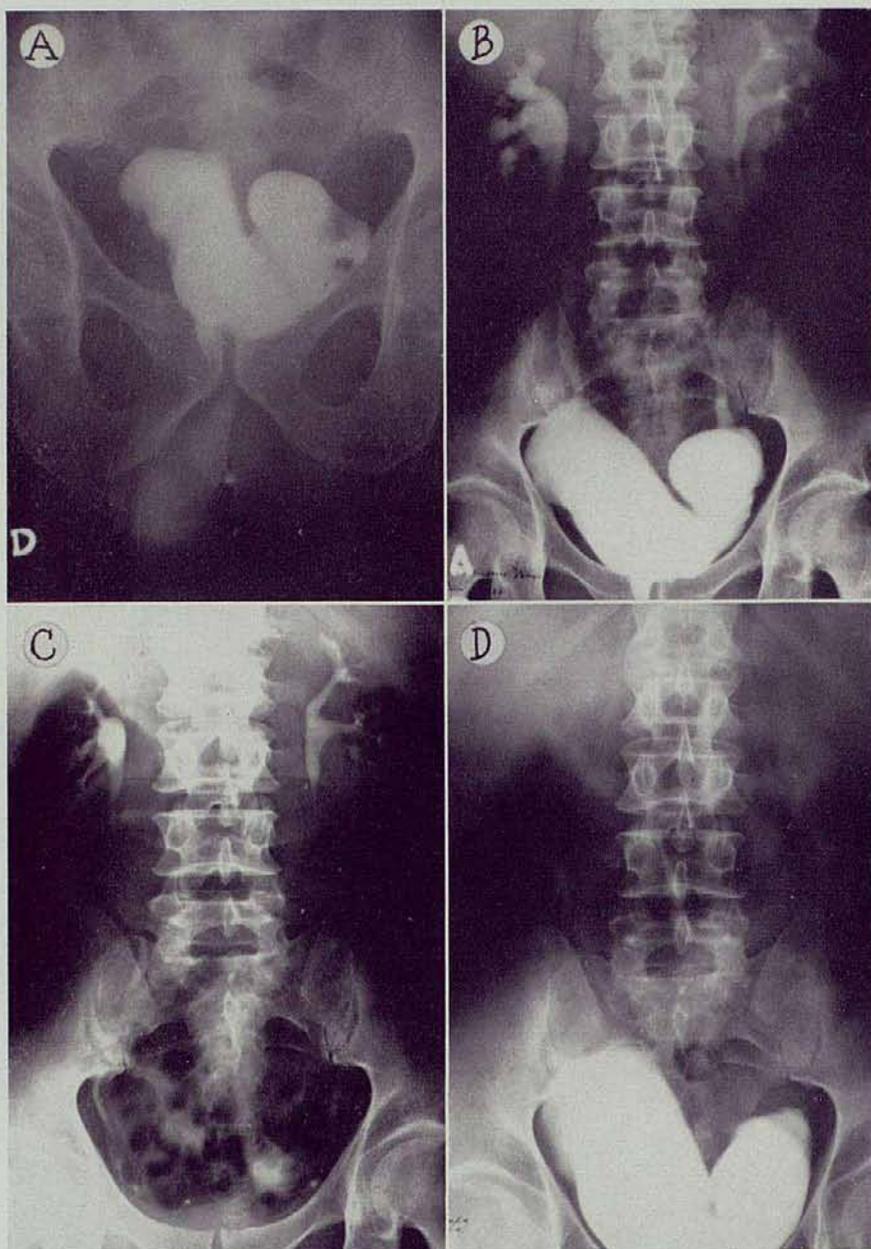


FIG. 5. Case 2. Technique 2 (end-to-side). *A*, cystogram 30 days after operation. *B*, combined excretory urogram and retrograde cystogram 1 year after operation. *C*, excretory urogram 3½ years after operation. Renal function as well as upper urinary tract in much better stage than in preceding publication. *D*, retrograde cystogram to maximum capacity 3½ years after operation. No ureteral reflux. General condition good. No infection or electrolyte disturbances.

to anastomose it to the urethra without undue tension.

Among the 75 colon transplants that have been done, the so-called retractile mesosig-

moiditis, which has been described by some surgeons, has not developed. Perhaps some have confused retractile mesosigmoiditis with the peritoneal coalescence which fixes the left or

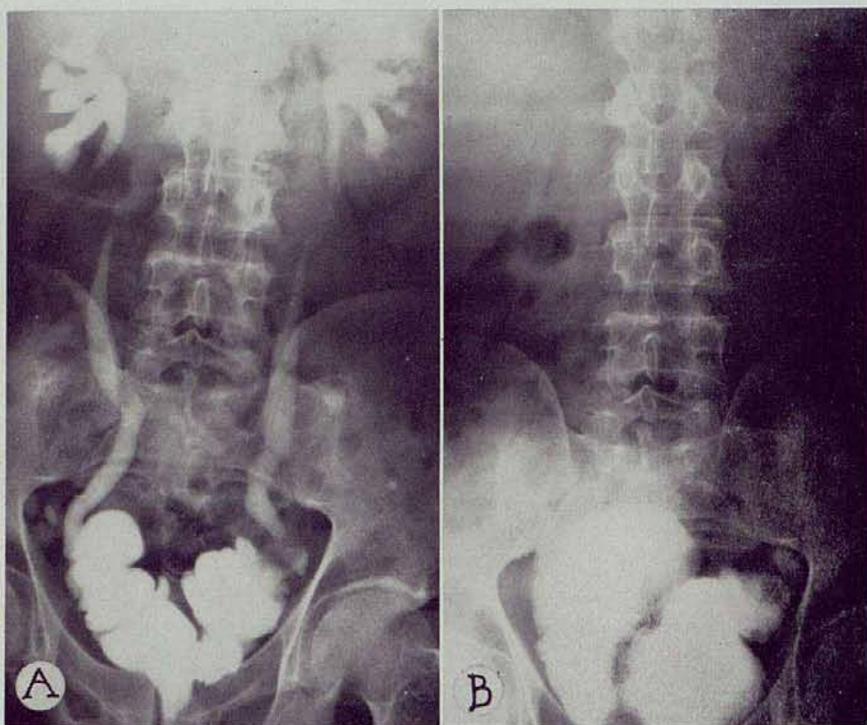


FIG. 6. Case 15. Technique 2. *A*, retrograde cystogram 6 months after operation. *B*, retrograde cystogram 3 years after operation. No ureteral reflux.

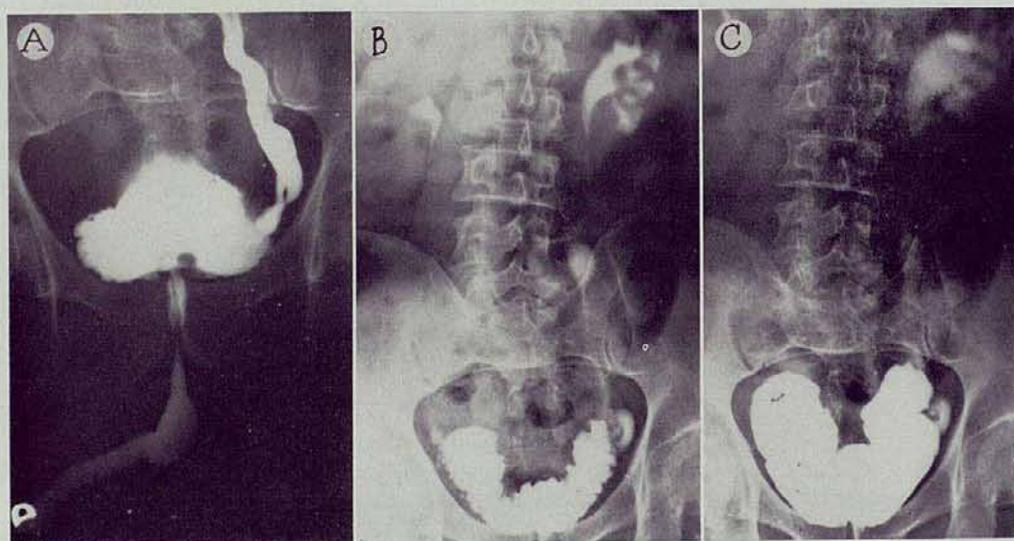


FIG. 7. Case 21. *A*, preoperative retrograde cystogram. Diffuse papillomatosis. Double ureter on left side with reflux. *B*, excretory urogram 5 months after operation. *C*, retrograde cystogram to maximum capacity 3 years after operation. Left ureteral reflux persists but not on right side.

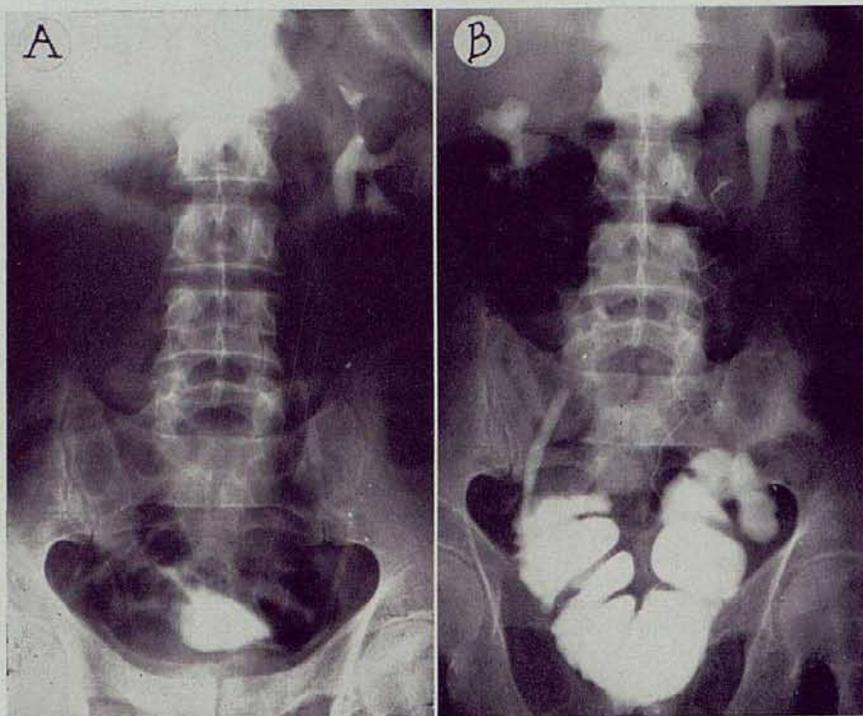


FIG. 8. Case 24. *A*, preoperative excretory urogram. Non-functioning right kidney from vesical carcinoma. *B*, excretory urogram 2 years after operation. Function of right kidney has returned.

lower leaf of the ileo-pelvic colon to the posterior parietal peritoneum and from which it can and should be systematically isolated.

We have operated upon 41 patients by this technique: 1 female and 40 male patients. In 15, the reason was recurrent diffuse papillomatosis with some evidence of degenerative change, after all other conservative methods had failed (transurethral electro-resection, partial cystectomy, radium and cobalt therapy).

The last 21 patients suffered from infiltrating neoplasms, stage B₁ and C. In five (young male patients) the neoplasm was stage D; therefore, the patients were treated with only palliation in mind.

Eleven patients were over 70 years of age; all had cardiovascular changes usually noted at this age.

A non-functioning kidney was present in 8 patients as a result of neoplastic infiltration.

All our patients have tolerated the surgical procedure well; none showed any evidence of shock.

In one case (bladder angioma) the operation was an emergency procedure because of profuse

hemorrhage with a red blood count of 1,300,000. The patient was discharged from the hospital in good condition 15 days after operation.

Among the 41 cases, 6 deaths have occurred: 2 patients died from paralytic ileus, two from myocardial damage, one from pelvic cellulitis, and one from staphylococcal enteritis due to the abuse of a wide-spectrum antibiotic.

It is worthwhile to contrast the procedure with colo-cystoplasty (enlargement of the bladder for a benign lesion, i.e. a small tuberculous bladder, inveterate interstitial cystitis, vesicovaginal fistula, etc.) in which no deaths have occurred in 34 cases within the past 6 years, either in the immediate postoperative period, or later.³ The complications have been fewer than following total bladder substitution for a malignant lesion.

COMPLICATIONS

Urinary fistula has developed in 12 cases. In 11 the fistulous tract was located at the level of the urethro-colonic anastomosis, and in another

³ Gil-Vernet, J. M.: Results of 34 cases of colo-cystoplasty. In press, *J. d'urolog.*

at the end of the intestinal segment. No fistula developed at the level of the ureteral anastomosis.

All eventually closed spontaneously after a more or less prolonged period of indwelling urethral catheter drainage except in 2 patients in whom re-operation was necessary, with uneventful recovery. There has been a remarkable decrease in the number of such fistulas after reducing the diameter from the ostium of the intestinal segments.

Fecal fistula developed in 1 case due to a technical defect in a diabetic who had a short colon. Operation was repeated (right colostomy) and the patient made an uneventful recovery.

Complications have been observed more frequently among patients with infiltrating carcinoma than with papillomatosis.

RESULTS AFTER 3½ YEARS

The mortality rate has been nil in cases of papillomatosis, and in 9 cases with infiltrating carcinoma. The cause of death in eight was metastasis. Only 1 death was due to ureterohydronephrosis. It is important to stress the fact that except for the last one, there has been no death from the operation.

Ureteral reflux and ascending pyelonephritic infection. Ureteral reflux has been observed in almost all of the cases (except for the ureters

that were transplanted with the aid of metallic rings).

Generally speaking, the peristaltic property of the ureter has improved after some months or years have elapsed; in other cases it has persisted as active reflux.

No symptoms of ascending pyelonephritic infection have been noticed in any of the cases of reflux, despite the presence in the new colonic bladder of large numbers of micro-organisms that apparently have no pathogenic activity.

In the isolated intestinal loop, ureteral reflux is of no significance.

Stenosis of the ureteral neostomies, observed in 3 cases, has been the cause of ureterohydronephrosis. These ureters were not transplanted in accordance with the metallic ring method.

Electrolyte disturbance. The majority of patients have been subjected to strict periodic control of their ionic values, CO₂ combining power and chlorides in particular.

No patients have shown any important disturbances of normal blood values even those where signs of renal insufficiency or of a non-functioning kidney were evident before surgery.

There has been no evidence of thirst or some other pathognomonic symptoms that would have indicated any absorption of the urinary constituents at the level of the intestinal segment of the sigmoid colon.

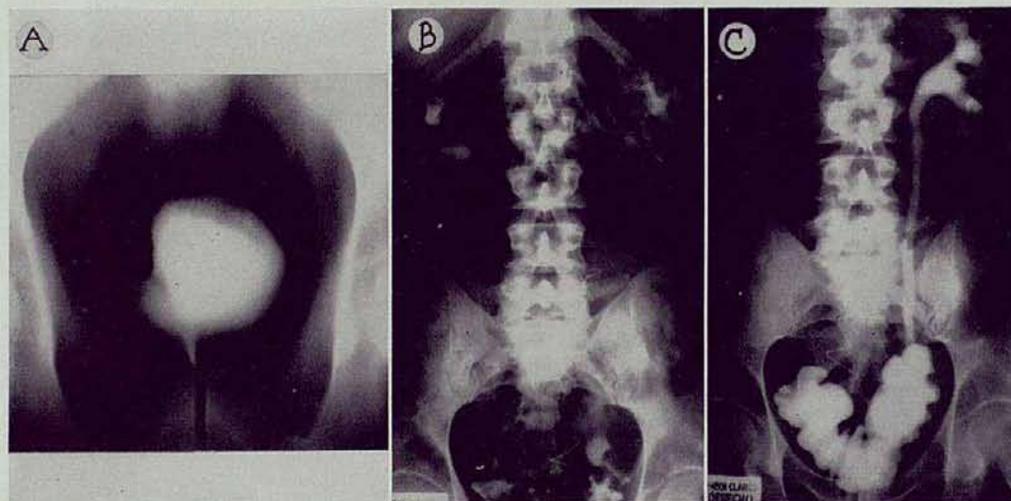


FIG. 9. Case 27. A, preoperative cystoparietogram. Infiltrating carcinoma. B, excretory urogram 1 year after operation. Good function from both sides. Right ureter transplanted according to metallic ring method. Left ureter transplanted according to mucosa-to-mucosa technique. C, retrograde cystogram 1 year after operation. Left ureteral reflux; ureter transplanted according to mucosa-to-mucosa technique. No reflux up right ureter because it was transplanted with aid of ring.

Mucus formation. Slight mucus formation has occurred within the first few weeks, i.e. during the adaptation stage, which practically diminishes or disappears some months later. There seems to be no physiological reason for formation of large amounts of mucus from an intestinal segment, but it demonstrates its intolerance to serve as a urinary reservoir and expresses at the same time the existence of enteritis due to maladjustment of the intestinal segment to the functional mutation.

Mucus formation has been more pronounced in those cases where the ileum was utilized for a bladder substitute.

Bacteriology of the artificial bladder. Urine cultures that have been periodically done during the second year period showed in 90 per cent of cases the presence of *B. proteus*, *B. coli* and *Micrococcus ureae*. All organisms showed marked sensitivity primarily to chloramphenicol.

It is worth mentioning here that despite its persistence, no patient has ever shown any complications of the infective type. Therefore,

we can assume that this type of flora is rather a saprophytic one and that it persists, despite all antibiotics, as ordinary flora.

FUNCTIONAL RESULTS (FIGS. 4-15)

Urinary control. The first 15 days, i.e. in the acute stage of adaptability of the intestinal segment or "protest" stage, are characterized by some impending and anarchic micturition every 15 to 30 minutes with shortness of the urinary stream, slight incontinence while in the supine position, although continent in the standing position and on walking.

Nocturnal enuresis is almost the rule.

In 5 cases there was good urinary control from the beginning plus periodic voidings every hour or hour and a half.

After the stage of accommodation, which usually takes from 3 to 6 months, the urinary condition becomes normal with voidings every 2-3 hours, forceful projection of the urinary stream and slight residual urine.

Beginning at the first and second year after-

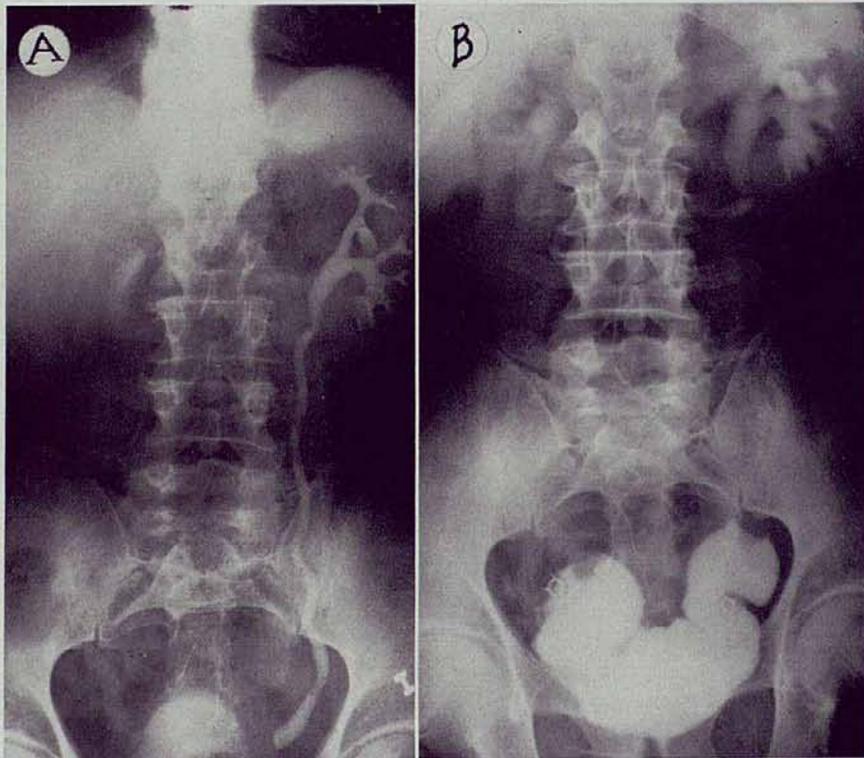


FIG. 10. Case 32. *A*, preoperative excretory urogram. Ureteral disturbance from vesical carcinoma. *B*, excretory urogram 2½ years after operation. Ureters transplanted according to metallic ring method.

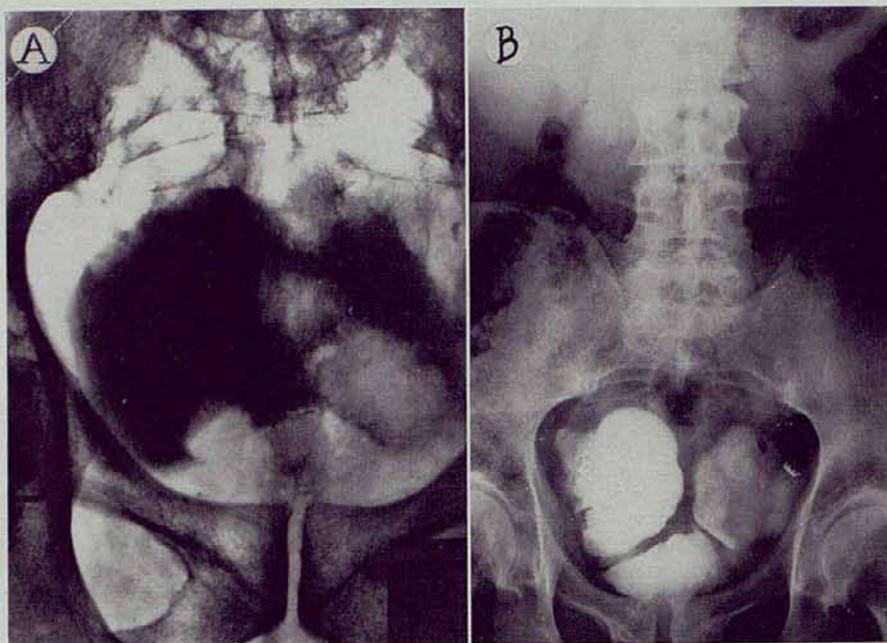


FIG. 11. Case 38. *A*, preoperative cystogram. Diffuse papillomatosis. *B*, cystogram to maximum capacity 2½ years after operation. No reflux.

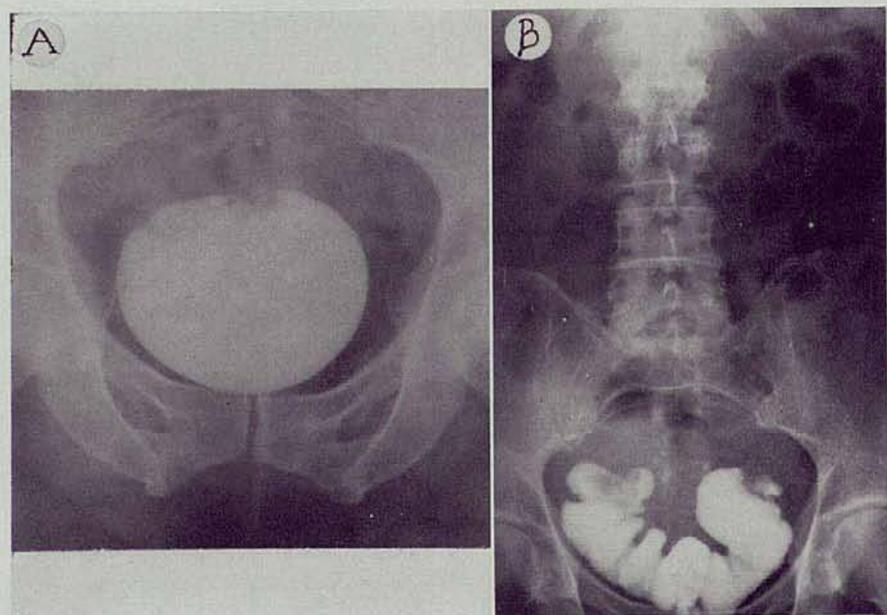


FIG. 12. Case 41. *A*, preoperative cystogram. Vesical carcinoma in female patient. *B*, postoperative cystogram 4 months after operation. Voiding every 2 hours.

wards, voiding occurs from every 3 to 5 hours without evidence of mucus and with excellent diurnal urinary control. At night and during the hours of sound sleep, there is some incontinence or voidings every 2 hours.

Only 3 patients have good nocturnal urinary control.

It is not possible to establish any connection between the degree of urinary control and the level where the urethra is anastomosed.

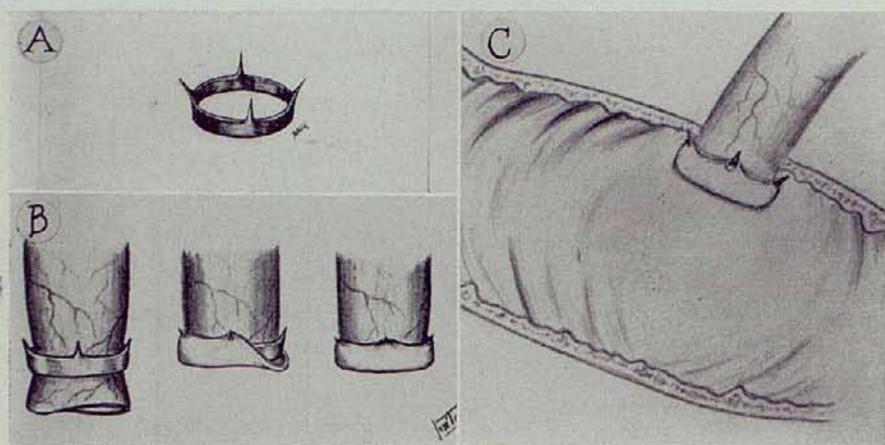


FIG. 13. *A*, metallic ring used in ureteral anastomosis. *B*, method of inserting ring. *C*, ureter, with ring in place, transplanted into isolated colonic loop.

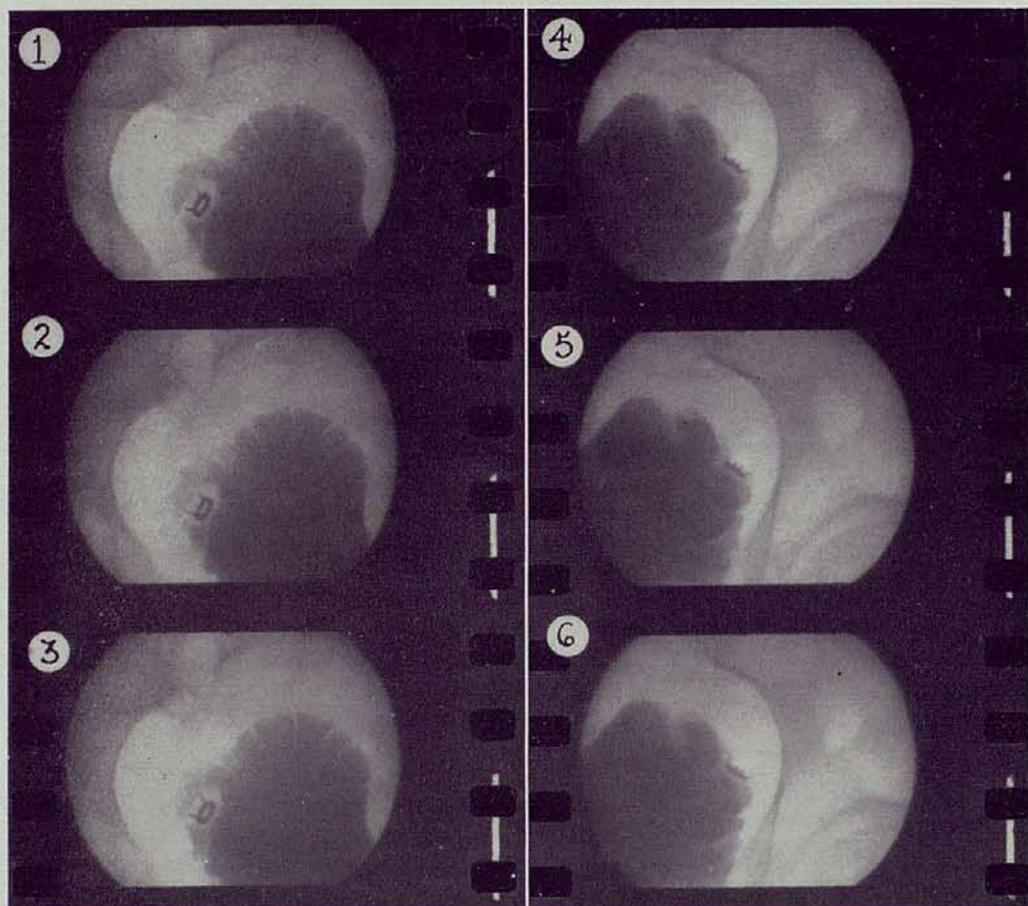


FIG. 14. Case 38. Cinematoradiography sequences. Maximal distention of new bladder. No passive ureteral reflux from any side.

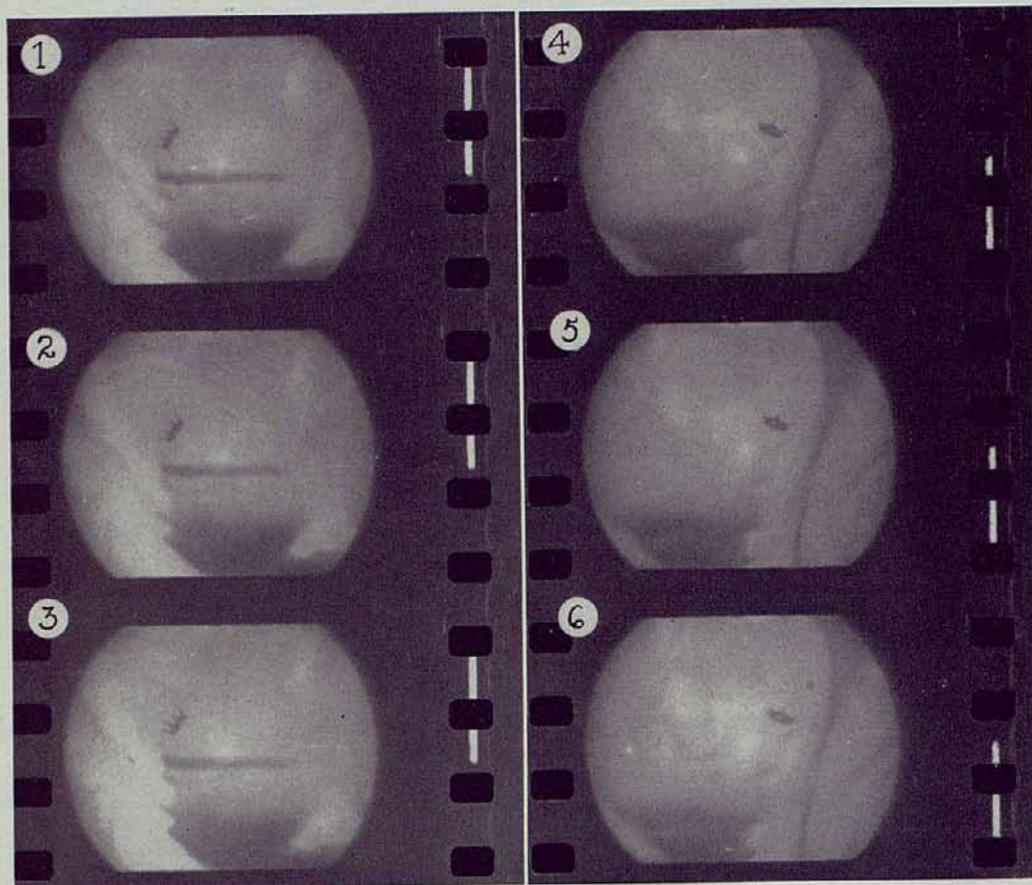


FIG. 15. Case 38. Sequences of act of micturition. No active reflux

In 23 patients the anastomosis was carried out with the apex of the prostate (below the verumontanum) and in 17 cases with the membranous urethra, and in a woman, directly with the internal sphincter.

The degree of urinary control seems to be related to the patient's age and the condition of the perineal musculature.

Both the external sphincter of the membranous urethra and the bulbocavernosus muscle are responsible for continence of urine.

As time passes, the new bladder distends and increases in capacity in proportion to the length of the intestinal loop which has been used.

The patient is fully aware at all times of each act of micturition.

The expelling force is such that the forceful projection of the urinary stream is far superior to that of a person with a normal bladder.

Residual urine is practically nil and in no case has it been more than 40 cc.

The patient voids at will.

The patients have returned to their usual occupations without any decrease in physical or intellectual capacities. One of these is a colleague who is wholly devoted to his medical practice.

Good functional results depend not only on surgical technique but also the patient's willingness to co-operate with the surgeon.

SUMMARY

We have presented the results obtained after 3½ years in 41 patients with vesical tumors who underwent total cystoprostatovesiculectomy, followed by construction of a functioning artificial bladder from an isolated sigmoid anastomosed to the urethra.

The functional results are good. The frequency of micturition is normal or almost so. There is perfect diurnal urinary control with some nocturnal enuresis in the majority of cases.

The best results, whether immediate or late, have been attained in those cases of recurrent diffuse papillomatosis.

The operative mortality rate has been low. No disturbances were observed in normal blood values, and no instance of renal insufficiency has been due to ascending infection.

The only problem not completely solved is

contracture of the uretero-colonic neostomies and reflux, although these complications have been remarkably reduced by using the new method of metallic ring anastomosis. These complications are without significance since an isolated intestinal segment is involved.

The operation has been well accepted by patients; they have not considered it a mutilating procedure.

Urinary diversion, which used to restrict the means of controlling tumors of the bladder, will henceforth not be a problem.