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Anal sphincter controlled urinary diversion: an experimental study

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Objective We aimed to make a continent neobladder from the caecum and the ascending colon, using the distal ileum as a neourethra which was pulled through the anal sphincter.

Method The experiment was carried on six street dogs of which 2 were males and 4 females.

In the first stage, only urethral replacement with an ileal segment was done and pulled through the anal sphincter in a female dog to see if anal sphincter would do any help for continence.

An ileocaecal segment was used as a neobladder and neourethra in the second step of our experimental study.

Results The dog in which the first operation was made gained continence on the 12th postoperative day. No residual urine was found by catheterisation performed after urination. In controls, neither the stoma nor the anastomosis site developed stenosis. The other 5 dogs became continent 12 to 20 days after the catheters were removed, and a great deal of residual urine volume remained in the neobladder.

Conclusion Anal sphincter controlled urinary diversion using ileocaecal segment offers us a new hope to achieve continence in the bladder replacements.

Key words Urinary diversion, anal sphincter, continence

Introduction

If the bladder and posterior urethra were removed or the bladder and the urethra were not functional due to any reason, a reservoir would be needed to store urine with a conduit to empty it. Collection of faeces and urine in the same reservoir, especially in a large bowel segment, revealed concomitant metabolic and infective disorders. Various innovative surgical techniques were advocated for separating the faecal and urinary streams, employing ureterosigmoidostomy principles. In each of these operations, ureters were implanted to the rectal stump. The proximal sigmoid colon was managed by terminal sigmoid colostomy or, more commonly, by bringing the sigmoid to the perineum (1). In the latter method, the anal sphincter was utilized in an effort to achieve both faecal and urinary control.

The principles of continent urinary diversion in children and adults are to create a large capacity, low pressure reservoir, obtain a reliable continence mechanism and provide an easily catheterizable stoma (2). In 1980 Mitrofanoff described the original appendicovesicostomy procedure. Refashioned appendix was used as a port for intermittent catheterization. The principle included the use of a smaller caliber tube implanted with a tunneled antirefluxing anastomosis into a large volume, compliant urinary reservoir (3).

The aim of our study was to make a continent neobladder from the caecum and the ascending colon, using the distal ileum as a neourethra which was pulled through the anal sphincter. Thus, either the ileal segment would be functional as a catheterizable continent conduit or voiding would be possible through it as if a native urethra was present.

Material and Method

This investigation conformed to the "Guide for the Care and Use of Laboratory Animals" published by the U.S. National Institues of Health (NIH publication No: 86-23, revised 1985).

The experiment was carried on six street dogs of which 2 were males and 4 females, and aged between 2-5 (mean 3 ± 0.4) and weighting between 17-21 kgs (mean 18 ± 1.6). Anesthesia was performed using ketamin 20 mg / kg and xylazine hydrochloride (Rompun) 3.5 mg / kg intramuscularly, and ketamin 5 mg / kg was repeated at the peroperatuar second hour. Operations were performed via abdominoperineal approach.

The study was planned to be performed in two steps. Only urethral replacement with an ileal segment was done and pulled through the anal sphincter in a female dog to see if anal sphincter would do any help for continence (n=1). Then the procedure was performed in male and female dogs with the intestinal replacement of the bladder (n=5). All dogs were weared pads in order to detect whether or not the continence was achieved.

The dogs were observed during the six months.

First surgical step: The urethra was separated from the bladder and ligated. Circular muscles of the bladder neck were left intact. A 15 cm ileal segment was clamped and transected protecting its mesentery together with the arterial blood supply. The proximal end of the ileal segment was anastomosed to the bladder neck by running 2/0 chromic sutures (Picture

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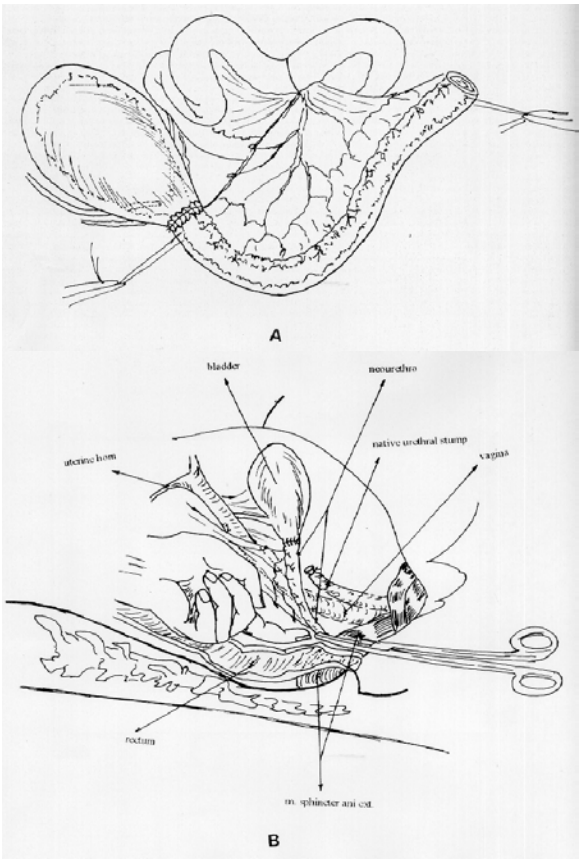
1A). Twenty eight F Petzer catheter was inserted through the neourethra into the bladder. A wide tunnel was then carefully opened by blunt finger dissection between the posterior wall of the vagina and anterior wall of the rectum. This tunnel was in a way the space occupied by prostate and urethra in the male dogs.



Picture 1. **A**-Anastomosis of the native bladder with a separated ileal segment, **B**-Opening of a tunnel between the rectum and the external anal sphincter.

A semicircular transverse perineal incision 2 to 3 cm anterior to the anal verge was made. The sphincter and anterior wall of the rectum was identified by blunt dissection (Picture 1B). The distal end of the small bowel together with Petzer catheter was grasped and pulled down by a bowel clamp inserted through the space between the sphincter and rectum into the previously prepared tunnel. Thus the neourethra passed the vagina surrounding it. Care was paid not to tense the mesentery and not to divide the central tendon anterior to the sphincteric region. The 2 cm distal end of the bowel was placed subcutaneously. Nonabsorbable interrupted sutures were used, employing a rosebudding suture technique to create a protruding stoma, between the margins of the skin incision and the seromuscular layers of the small bowel (Picture 2).

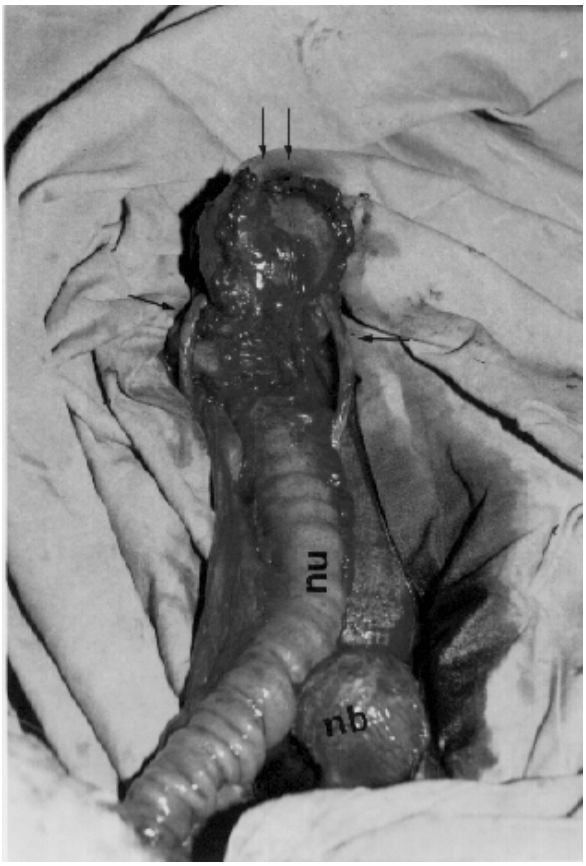
After being sure about the absence of leakage thorough the anastomosis site, retrograde cystography was performed and the catheter was removed on the 7th postoperative day.

Second surgical step: The ileocaecal segment was used as a neobladder and neourethra in the second step of our experimental study. Ascending colon was transected just below the right flexure, with a 20 cm segment of terminal ileum. Distal stump of the colon and ileum were sutured end to side. The ileocaecal segment was dropped inferior to the ileocolic anastomosis.

Picture 2. Completed rosebudding stoma (20 days after the operation). **arrow:** vagina, **arrows:** anus

Caecum and ascending colon were incised to detubularize on the antimesenteric surface. The ileocecal valve remained intact. The ureters were implanted to the caecum using Leadbetter's procedure, and 4 F ureteral catheters were inserted into them. Ureteral catheters were pulled out of the neobladder through a 26 F Petzer which was inserted into the ileal segment used as neourethra. Running 3/0 polyglactin sutures were used to close the neobladder in two layers after folding the distal right colonic segment over and onto the caecum (Picture 3). After performing cystoprostatectomy in the male dogs the distal stump of the ileum was pulled down into the space prepared likewise in the first step. Only cystectomy with excision of the posterior urethra was performed in the female dogs. The tunnel was only between the anterior wall of the rectum and the

external anal sphincter. Perineal ileostomy was performed as described before. The catheters were removed on the 7th postoperative day.



Picture 3. Neourethra and detubularized neobladder with the ureterocaecal implantation. **arrows:** neobladder, **arrow:** ureter, **nu:** neourethra **(The distal end of the neourethra will be pulled down the perinea), nb:** native bladder **(it will be excised later)**

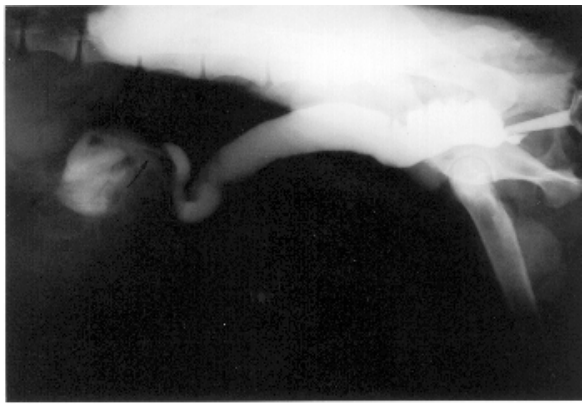
Antibiotics were given to all dogs for seven days beginning with the operation day, and the stoma and the neourethra was cleaned and washed with diluted polyvinylpyrolidone iod solution twice daily.

Results

The dog which underwent the first operation was not continent for five days following the removal of the catheter. However, it gained continence on the 12th postoperative day. On the neourethrocystography performed at the same day, the bladder and anastomosis site between bladder neck and ileum was seen perfectly. No residual urine was found by catheterisation performed after urination. But, the urination lasted for 2 or sometimes 3 minutes because of hesitancy or interruptions. In controls performed following this date, stenosis did not occur either in the stoma or in the anastomosis site. Except for the first 5 days of postcatheterisation, neither urinary nor faecal incontinence occurred. This sample provided us that the anal sphincter was sufficient to achieve urinary continence.

Laboratory results which were obtained in the postoperative third week demonstrated that the totally blood and urine parameters were normal except pyuria.

The other 5 dogs (2 male and 3 females) which underwent bladder replacement operation became continent 12 to 20 days after the catheters were removed. During this time, quite a high amount of mucus streamed through the stoma. Although the dogs could partially urinate during defecation, especially in the end of the defecation, a great deal of residual urine remained in the neobladder. Thus, we evacuated urine and intestinal mucus through 18 F Nelaton catheter three times a day. This application was performed by assistant veterinary doctors of the Veterinary Faculty for the last three months. On retrograde neourethrocystography taken on the 10^{th} postoperative day, the neobladder had adequate capacity with no reflux to the ureters (Picture 4). Unfortunately, intravenous urography could not be performed in these dogs, because of difficulty of this technique.



Picture 4. Retrograde neourethrocystography: The neobladder had adequate capacity with no reflux to the ureters. Arrow shows the site of intact ileocaecal valve

On the first postoperative day, blood urea was 32 mg / dl, creatinin 1.8 mg / dl, Na 142 mEq / L, K 4.9 mEq / L and Cl 121 mEq / L. On the third day, blood parameters were 29 mg / dl, 1.7 mg / L, 145.2 mEq / L, 4.2 mEq / L and 112 mEq / L, respectively. Blood pH, calcium and phosphor were found 7.22, 7 mg / dl and 9.4 mg / dl respectively. The entire blood parameters except calcium and phosphor regressed to the normal levels within one-week medical therapy. Laboratory findings were similar in 5 dogs. These laboratory findings remained almost the same during the six-months observation. All dogs survived, at the end of the six months.

Discussion

Several techniques have been developed recently to create catheterizable conduits, including the Mitrofanoff (4), Benchekroun (5) techniques and servomechanism sphincter (6). However attempts to provide spontaneous urination was limited. Three operation techniques were described in this issue by Gersuny, Duhamel and Heitz-Boyer and Hovelacque (1). In each of these three procedures, a combined abdominoperineal approach is required. These operations are not easy to perform in patients who have not undergone cystoprostatectomy, as exposure in the region of the rectal sphincteric mechanism is achieved more simply when these structures have been removed. During the cystectomy, rectal vasculature must not be damaged. On the other hand, the presence of the vagina serves as a potential barrier to appropriate surgical exposure in the female patients (1). Another interesting procedure was described recently by our study group using vagina as a reservoir and levator ani muscule fibers for continence (7,8).

In Gersuny's technique, the proximal stump of the sigmoid colon is brought down through the anterior portion of the anal sphincter, and anastomosed anteriorly to the anal verge. But, in Duhamel's technique, the proximal sigmoidal stump is brought down from the posterior of the rectum, and it is anastomosed posteriorly to the anal verge. These procedures have never been well accepted in the United States, owing to the urinary and faecal incontinence (1).

When the Heitz-Boyer technique is employed, in which injury to the sphincteric mechanism is less common, because the rectal wall is left adherent to the deep and superficial anal sphincters, the proximal sigmoidal stump is brought down submucosally within the posterior rectal wall beginning 5 or 8 cm apart from the anal verge (1).

Our operation was somewhat the modification of Gersuny's technique where ileal neourethra was brought down through the anal sphincter instead of proximal sigmoidal stump. Additionally we performed a 2 cm subcutaneous perineal tunnel before suturing the ileal stump. The opening of the neourethra faced to the front allowing easy catheterisation if necessary. Ileum is not as tick as the sigmoid colon, and thus it does not give harm to the anal sphincter mechanism as sigmoid does. As perineal ileostomy was made in the manner of a protruding stoma, the stomal stenosis probably did not occur during the six months observation. In our study, a compliant reservoir was fashioned from the caecum and the ascending colon and a catheterizable conduit from the distal ileum. But the conduit was functional similar to the native urethra because the neourethra was made from the ileum with intact ileocaecal valve and was passed through the external anal sphincter. In this procedure, ileocaecal valve works as bladder neck or internal sphincter. If the ileocaecal valve is augmented (9), the dogs might have difficulty in voiding since the bladder or the neobladder made from the colon are parallel to the ground in dogs. But, this procedure may provide support to the anal sphincter which helps to gain continence, in human beings. Conduit peristalsis is upwards the caecal neobladder as well. But, it led to a great deal of residual urine in the bladder of 5 dogs. If this situation occurs in human beings as well, then, only a longer ileal segment may be used to make both reservoir and conduit. Proximal part of this ileal segment may be prepared as a reservoir and distal part as a conduit to achieve an isoperistaltic conduit. However, H. Stephen Watson et al. reported that the conduit peristalsis was not of great importance for Mitrofanoff conduit continence (3).

Terry W. Hensle et al. reported that they used the ileocaecal valve as a continence mechanism with a catheterizable tapered ileal stoma (2). These authors also reported that using the native bladder as part of the continent diversion in children with myelomeningocele was convenient. In the first step of our study, besides the native bladder being used as reservoir, the dog could urinate voluntarily owing to the anal sphincter used as continence mechanism.

In this type of operations, continence was defined as being dry on a three-hour intermittent catheterization regimen without the need for pads (10). No spontaneous mucus stream occurred after removal of the catheter as we used the distal ileum with the ileocaecal valve as conduit.

When the small caliber catheters were used to catheterize the appendiceal conduit (Mitrofanoff conduit diversion), they would be less effective at evacuating and irrigating out accumulated mucus secretion. Furthermore, since the catheter enters from above, it will be naturally more difficult to remove secretions that pool in the dependent portion of the bladder (10). Sometimes, appendix may be rather short or is not present due to appendectomy before or, it may be fibrotic in adults (11). Ureters, an ileal segment and / or modified Mitrofanoff procedures may be used as a conduit in cases the appendix has insufficient length. But, in these circumtances, the anal sphincter controlled ileal continent conduit with the perineal stoma may also be used.

If these procedures were applied in humans, male or female, we believe that they might probably urinate as the body of humans are erect and they usually urinate in sitting position. Valsalva and

Crede's maneuvers help them to urinate as well. Of course anal sphincteric tone must be judged competent before electing these operations (1).

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