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ORIGINAL ARTICLE

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Construction of a continent outlet using an ileal valve, an in vivo animal model

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Abstract The efficacy of a new continent outlet mechanism using a simple ileal valve in a continent cutaneous urinary diversion was evaluated. In eight mongrel dogs, a 50 cm distal ileal segment was isolated. The distal 41 cm of the isolated segment was opened along the antimesenteric border while the proximal 9 cm was not detubularized. The distal 6 cm part of the non-detubularized segment was tapered over a 30 F catheter and closed with continuous 3/0 polyglactin sutures. In order to create a valve, this 6 cm tapered ileal segment was wrapped anteriorly by the most distal part of the detubularized ileal segment. The remaining part of the detubularized ileal segment was folded into a U configuration. The posterior plate was completed by joining the limbs of the U with running absorbable sutures. Afterwards, the reservoir was closed by folding the ileal plate in half in the opposite direction to which it was opened. The intact proximal 3 cm part of the isolated ileal segment was brought out to the abdominal skin. A pouchogram of the reservoir and video-urodynamic studies were performed to evaluate the efficacy of the continent outlet 18–20 weeks after surgery. Video-urodynamic studies and pouchograms of the reservoirs revealed no leakage from the continent outlet in any dog. Reservoirs had a mean capacity of 413 ± 51 ml (range 356–447 ml). When the reservoir was filled to maximum capacity, the average total reservoir pressure was 29 ± 4.7 cm H_2O (range 21–45). This procedure, using a single ileal segment for construction of the continent cutaneous urinary diversion, is simple and safe. The ileal valve mechanism serves as a reliable continent outlet system.

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Introduction

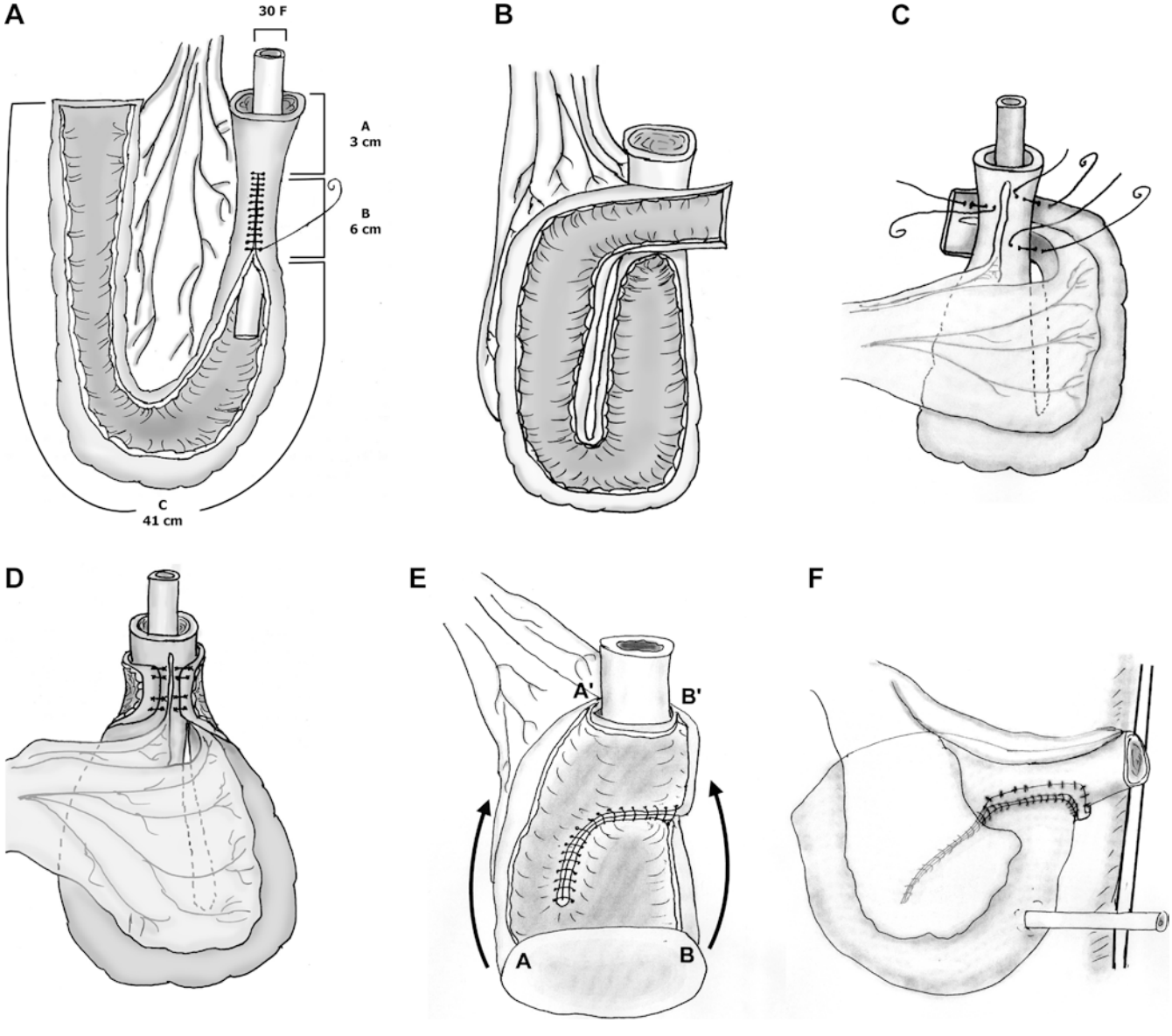
The issue of long-term continence remains a central focus in current attempts to popularize continent pouches. The ideal continent catheterizable outlet for cutaneous urinary diversion should provide complete continence without leakage, easy catheterization, an uncomplicated surgical technique and a low complication rate. A variety of techniques have been used to construct a continent valve in a continent cutaneous urinary diversion [3, 4, 10, 14, 16, 19, 22, 23]. However, a reliable mechanism which is easy to construct and has a low complication rate with universal applicability is not yet available. In order to eliminate the observed complications associated with the intussuscepted nipple valve in Kock pouch procedures, Stein and Skinner recently described the flap valve known as the T-mechanism as an antireflux and efferent continence mechanism in the continent cutaneous ileal reservoir (double T-pouch) [19]. On the other hand Abol-Enein and Ghoneim reported excellent results in 23 patients using a serous lined extramural ileal valve as a continent urinary outlet in continent cutaneous pouches [3]. Although these two groups reported excellent results, construction of the continent outlet with these techniques is not simple [3, 19]. A separate ileal segment is used for the creation of the outlet valve and mesenteric windows are created between the arterial arcades in both techniques. We tried to construct a new continent outlet using only one isolated ileal segment without creating mesenteric windows. Our technique relies on the flap valve principle similar to the serous lined extramural ileal valve.

We report on the surgical technique of a new outlet mechanism suitable for continent cutaneous urinary diversion.

Materials and methods

Surgery was performed on eight female mongrel dogs weighing 13–19 kg; general anesthesia induced by xyalazine hydrochloride (2 mg/kg) and ketamine hydrochloride (15 mg/kg) was used. A 50 cm segment of terminal ileum was isolated sparing the last 20 cm adjacent to the ileocecal valve and the continuity of the bowel was reestablished. The distal 41 cm of the isolated segment was opened along the antimesenteric border while the proximal 9 cm was not detubularized and a 30 F catheter was inserted into this non-detubularized ileal segment. Afterwards, the distal 6 cm part of the non-detubularized segment was tapered over a 30 F catheter by excising the side of the ileum farthest from its blood supply. The tapered segment was closed with continuous 3/0 polyglactin sutures (Fig. 1A). In order to create a valve, this 6 cm ileal segment was wrapped anteriorly by the most distal part of the detubularized ileal segment (Fig. 1B) and these two segments' seromuscular layers were sutured together using 3/0 interrupted silk sutures (Fig. 1C, D). The remaining part of the detubularized ileal segment was folded in the configuration of U. The posterior plate was completed by joining the limbs of the U with running absorbable sutures. Afterwards, the reservoir was closed by folding the ileal plate in half in the opposite direction to which it was opened (Fig. 1E). The oral end of the supravalvular segment (3 cm) was brought out to the abdominal skin. Finally an 18 F Foley

Fig. 1 **A** A 50 cm ileal segment is isolated; region *A* (3 cm supravalvular outlet segment) for cutaneous anastomosis, region *B* (6 cm valvular segment) for valve construction, and region *C* (41 cm) to be opened at the antimesenteric border. A 30 F catheter is inserted into the tubular ileal segment and the lumen of the valvular segment is reduced using continuous 3/0 polyglactin sutures. **B** The anterior surface of the valvular segment is wrapped by the most distal part of the detubularized ileal segment. **C** To create a valve, seromuscular layers of the valvular segment and the distal detubularized ileal segment are sutured together using interrupted 3/0 silk sutures. **D** Ligation of the interrupted sutures is completed (posterior view). **E** The posterior plate is completed by joining the limbs of the U with running absorbable sutures. Two medial borders of the detubularized ileal segment are sutured together. The reservoir is closed by a fold formed by upward reflection of the distal edge. Point *A* is anastomosed to point *A'* and point *B* is anastomosed to *B'*. **F** The oral end of the supravalvular outlet segment is anastomosed to the skin to create a continent cutaneous reservoir



catheter was placed through a stab incision in the anterior reservoir wall and brought out to the abdominal wall to allow daily irrigation (Fig. 1F). Parenteral antibiotics were given for 7 days. Intravenous fluids were given for 5 days in the form of 5% glucose and Ringer's solution. On the sixth postoperative day, oral fluids were given. To avoid mucus retention, the pouches were washed twice a week with saline.

The dogs were evaluated 18–20 weeks following surgery. The evaluation included a pouchogram of the reservoir (performed through the Foley catheter with 300 ml of diluted contrast medium) and video-urodynamics. Fluorourodynamic studies were performed under isoflurane induced general anesthesia using a diluted contrast medium. A multichannel urodynamic system (MMS 5000) was used for pressure studies. Urodynamic studies were done using a MMS 5000 urodynamic catheter with an infusion rate of 50 ml/min.

Results

All dogs survived for the duration of the experiment. All stomas could be easily catheterized with a 16 F catheter. On pouchograms of the reservoirs none of eight dogs showed leakage from the continent outlet (Fig. 2).

Video-urodynamic studies showed a mean reservoir capacity was 413 ± 51 ml (range 356–447). When the reservoir was filled to maximum capacity, mean total reservoir pressure was 29 ± 4.7 cm H_2O (range 21–45). There was no fluoroscopic evidence of leakage during filling and at maximum capacity in any dog. Simultaneous measurement of the pressure of the pouch was also done while the pouch was being manually compressed. Pressures of 80 cm H_2O were recorded during this treatment with no identifiable leakage in any dog.

Fig. 2 Pouchogram of the reservoir after 20 weeks revealed no leakage from the continent outlet

Discussion

Although a variety of continence mechanisms have been described for continent cutaneous diversion [3, 4, 10, 14, 16, 19, 22, 23], a reliable mechanism which is easy to construct and has universal applicability with low a complication rate is not yet available. The ideal outlet should be constructed from a readily available and surgically versatile intestinal segment without the need for synthetic materials. The continence in the Kock ileal reservoir, which is one of the most famous techniques, requires construction of an intussuscepted nipple valve constructed from an additional ileal segment [10]. Despite a great deal of experience with the ileal intussusception nipple [10, 11, 13, 17] and many technical modifications [18, 19], technical complexity, a relatively high complication rate, the use of an extra length of bowel, the need for metallic staples and the risk of stone formation are limiting factors. Our technique using only one isolated ileal segment has the advantage of technical simplicity and eliminates the need for metallic staples.

Continent valves made from plicated or tapered ileum with or without ileocecal reinforcement are used by many surgeons [14, 16], in part because of their technical simplicity. However, incontinence and catheterization difficulties were encountered in a quarter of patients [16]. Following modifications in the form of tapering and stapling the terminal ileum, the continence rate improved to greater than 90% [4, 14, 15]. In such procedures, the pouch continence was dependent mostly on the function of the ileocecal valve and passive tubular resistance. On the other hand, exclusion of the ileocecal segment may decrease intestinal transit time and permit the reflux of colonic contents into the terminal ileum with subsequent development of diarrhea and malabsorption syndrome [21]. In our technique, exclusion of the ileocecal segment was eliminated by using a single ileal segment and we had no leakage from the continent outlet in any dog.

Recently, an effective continent valve made from appendix or tapered ileum with the application of the flap valve principle has gained modest popularity [7, 8, 12, 22, 23]. However, embedding the appendix or tapered ileum into a submucosal tunnel of the pouch wall has inherent problems [6, 8] such as tightening of the tube or kinking at the outlet of the tunnel, which can lead to difficult catheterization. Following the guidelines of the Mitrofanoff procedure, Figueroa et al. [8], using a tapered ileal segment, reported that 40% of their patients required surgical manipulation to correct complications. Again, there was a trend to increased incidence of stomal stenosis of 21–50% [5, 24]. The principle of embedding a tubular structure within a serous lined, extramural tunnel was developed by Abol-Enein and

Ghoneim [1]. Although, it was initially used for reflux prevention in conjunction with orthotopic ileal bladder substitution with excellent clinical outcomes [9, 20], the technique was used subsequently for a continent cutaneous outlet [2]. However embedding a bulky mesentery of either tapered ileal segment or appendix within the tunnel is technically not easy.

In order to avoid embedding a bulky mesentery within the tunnel, Abol-Enein and Ghoneim recently developed a new continent urinary outlet [3]. They created 4–5 mesenteric windows between the mesenteric arcades which allows fixation of the outlet, either a tapered ileal segment or an appendix, within the trough and excludes the bulky and fatty mesentery. In that study, all but one of the 23 patients were continent day and night. Although the results of this procedure are excellent, the technique is not simple. Mesenteric windows need to be created between the arterial arcades and a separate ileal segment is used for the creation of the outlet valve. Our technique also relies on the construction of a serous lined extramural ileal valve. However, we used only one isolated ileal segment without creating mesenteric windows. Our technique is simple and we observed no leakage from the continent outlet in any dog.

In conclusion, the procedure of using a single ileal segment for the construction of the continent cutaneous urinary outlet is simple and safe. This new continent outlet seems to meet the prerequisites for a continent catheterizable outlet for urinary diversion, including easy catheterization, an uncomplicated surgical technique, complete continence without leakage and a low complication rate.

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