A New Type of Continent Ileostomy

Results of an Animal Study

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Kock's continent ileostomy is a well-established technique, however, it is technically difficult to construct and has a high incidence of complications. This study evaluates a new type of mucosal valve constructed in continuity with an intestinal reservoir. The valve is created along the antimesenteric border of the efferent limb 0.5 cm distal to the reservoir. The seromuscular layer is "stripped" from the mucosal layer for 50 per cent of the bowel circumference and then excised. The remaining seromuscular borders are then sutured to the apex of the pouch and along the antimesenteric border of the afferent limb. In this way the valve is created and, upon distention of the afferent limb and apex of the pouch, the valve closes. In seven dogs such a continent ileostomy was constructed and all were clinically continent. The reservoirs were intubated through the ileostomy two to three times a day. The mean volume aspirated was 143 ml/day. After eight weeks, radiographic and volume-pressure studies were performed. Prior to sacrifice, increasing volumes of barium were instilled into each pouch via the afferent limb and radiographs were taken: these studies confirmed the continence in all seven ileostomies. Following this the reservoirs were intubated and the instilled barium was aspirated. Then Ringer's solution was instilled into each pouch with continuous intrapouch pressure measurements. The pressure remained at 0 cm$H_2$0 until a mean volume of 243 ml was exceeded. The mean volume at which incontinence occurred was 415 ml.

[Key words: Kock reservoir; Mucosal valve; Continent ileostomy]

THE KOCK CONTINENT ILEOSTOMY has a definite place in ileostomy surgery. Due to its technical difficulty and high incidence of complications, surgeons have adopted this procedure cautiously. Complications are directly related to a surgeon's inexperience with the technique.[1-4] The major late complication, nipple valve dysfunction, may be attributed to the imperfections of the technique. There have been multiple modifications of the nipple valve, which may have achieved a slight decrease in its dysfunction.[3,5-8] The introduction of the myriad of synthetic valve devices, for example the aortic porcine valve,[9] the Maclet magnetic prosthesis,[10] the silastic indwelling ileostomy valve device,[11] and the balloon catheter,[12] all suggest dissatisfaction with the Kock continent ileostomy.

In China, a new type of valvular mechanism was developed which, to our knowledge, has not been published previously. Dr. Zhang Jin-Zhe,* the developer of the mucosal valve, utilized it in biliary-enteric anastomoses in order to prevent bacterial and gastrointestinal reflux into the biliary tract. We combined this mucosal valve with a terminal ileal reservoir in order to construct a continent ileostomy. The new mucosal valve prevents uncontrolled escape of gas and fecal material from the intestinal reservoir. It is easily intubated for evacuation of the reservoir. The aim of this study was to evaluate the new mucosal valve as an outlet valve in continuity with an intestinal reservoir.

Materials and Methods

Eight conditioned female mongrel dogs weighing 10 to 15 kg each were used. They were fasted overnight and were given 1.2 million units of penicillin intramuscularly. The operation was conducted under sterile conditions using intravenous pentobarbital anesthesia (25 mg/kg) and endotracheal intubation. The animals received Ringer's solution intravenously during this procedure.

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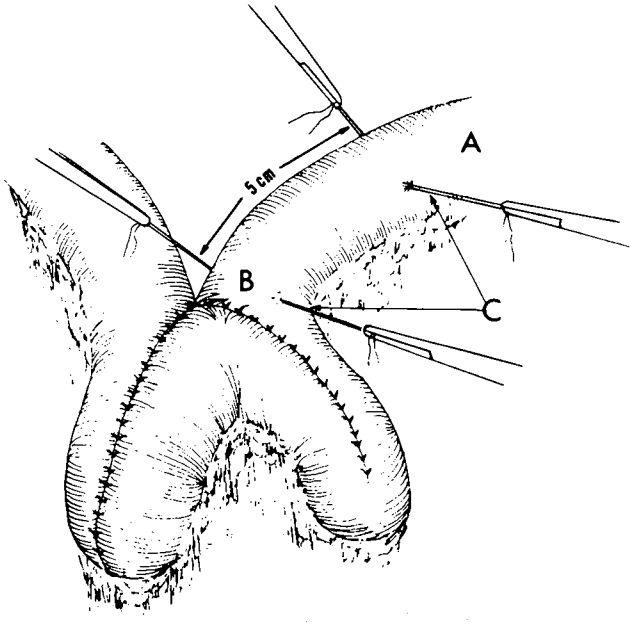

FIG. 1. In constructing the "mucosal valve," a 5 cm line is measured along the antimesenteric border of the efferent limb (A), beginning 0.5 cm distal to the reservoir (B). Four stay sutures (C) are inserted midway between the mesenteric and antimesenteric borders of the efferent limb, two on the anterior surface and two on the posterior surface of the intestine.

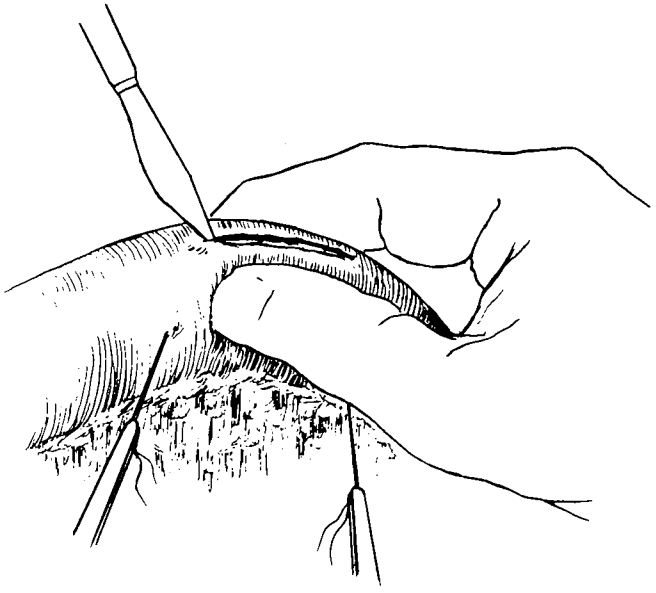

FIG. 2. Along the 5 cm line on the antimesenteric border of the efferent limb, an incision is made through the seromuscular layer up to, but not through, the mucosal layer. Then two parallel incisions were made along the 5 cm line; one of the incisions is made between the two stay sutures on the anterior surface and another incision is made between the two stay sutures on the posterior surface of the intestine.

The abdomen was entered through a midline incision. The technique of construction of the intestinal reservoir was as previously described by Kock.[7] The new mucosal valve was constructed in continuity with the intestinal reservoir as described below. At the end of the procedure a Foley catheter (#18-22 French) was passed through the ileostomy and left to gravity drainage for seven days. The animals were fasted until intestinal contents began to drain through the catheter. The animals were then started on a Sustacal liquid diet (500 calories/day) and then progressed to a diet of ALPO beef chunks (1000 calories/day). Every three days, the animals were weighed. During the second postoperative week, the catheter was occluded for 4-hour intervals for 24 hours, then for 12-hour intervals for 48 hours. Then the catheters were removed and the animals were observed for clinical continence. Each day, the animals were examined for fecal soilage, abdominal erythema, and excoriations. The reservoirs were intubated through the ileostomy two to three times per day, and the volume aspirated was recorded. During the eighth postoperative week, all animals underwent a second exploratory laparotomy. At that time, contrast radiography and pressure determinations on the reservoir were obtained. The abdomen was opened through the previous midline incision and the intestinal reservoir and its afferent limb were isolated. Twenty centimeters proximal to the reservoir, along the antimesenteric border of

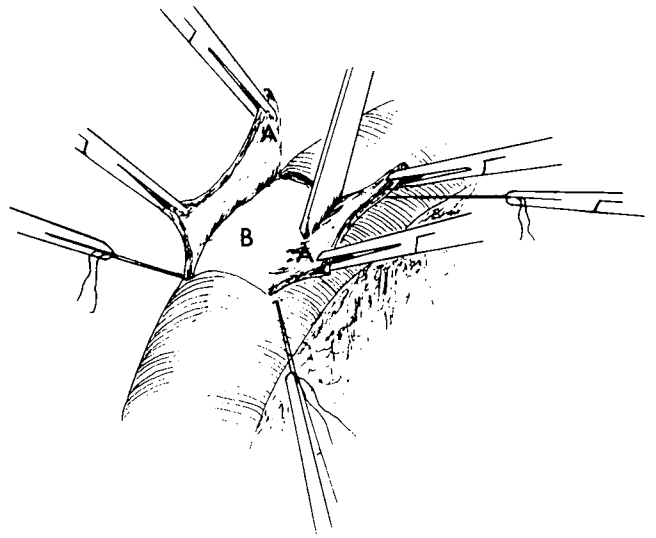

FIG. 3. The seromuscular layers are "peeled" from the antimesenteric border toward the mesenteric border up to the serosal incisions. The seromuscular flaps (A) are then excised. This will leave an area of denuded mucosa (B), which will act as the valvular mechanism. Care is taken to strip the seromuscular layer circumferentially, not longitudinally.

the afferent limb, a #20 French thoracostomy tube was inserted through an enterotomy and connected to a liter of lactated Ringer's solution. A #16 gauge catheter was inserted through the afferent limb into the reservoir and

connected to a pressure transducer. The sensed pressure was amplified and recorded on a Gould recorder. Then 50-ml aliquots of 50 per cent barium were instilled through the thoracostomy tube and radiographs were taken at 100 ml, and maximum volumes of the reservoir in order to determine continence. The barium was then aspirated from the reservoir and Ringer's solution was instilled into each pouch with continuous intrapouch pressure measurements. The reservoir and valves were stressed to maximum volume and pressure. The animals were then sacrificed.

Operative Procedure

Through a midline incision, the ileum and cecum were isolated. Two centimeters proximal to the ileocecal valve, the ileum was transected and the distal portion closed, leaving the colon as a blind loop. Forty centimeters of distal ileum were utilized for construction of the reservoir and mucosal valve. The distal 10 cm of terminal ileum was utilized for construction of the mucosal valve and ileostomy. Along the antimesenteric border of the efferent limb, 0.5 cm distal to the reservoir, a 5 cm line is measured. At a point midway between the antimesenteric and mesenteric borders of the bowel, parallel to the line, four 3-0 silk stay sutures are placed as shown in Figure 1. Two of these sutures are inserted on the anterior surface of the bowel and two on the posterior surface. Along the 5 cm line on the antimesenteric border, an incision is made through the seromuscular layers up to, but not through, the mucosal layer. Then two parallel incisions are made between the stay sutures as described in Figure 2. The seromuscular layers are "peeled" from the antimesenteric toward the mesenteric border to the serosal incisions and then excised. Care is taken to strip the seromuscular layer circumferentially and not longitudinally. This dissection is performed bluntly with the handle of the scalpel. The lateral walls of the bowel will have a seromuscular border remaining (Fig. 3).

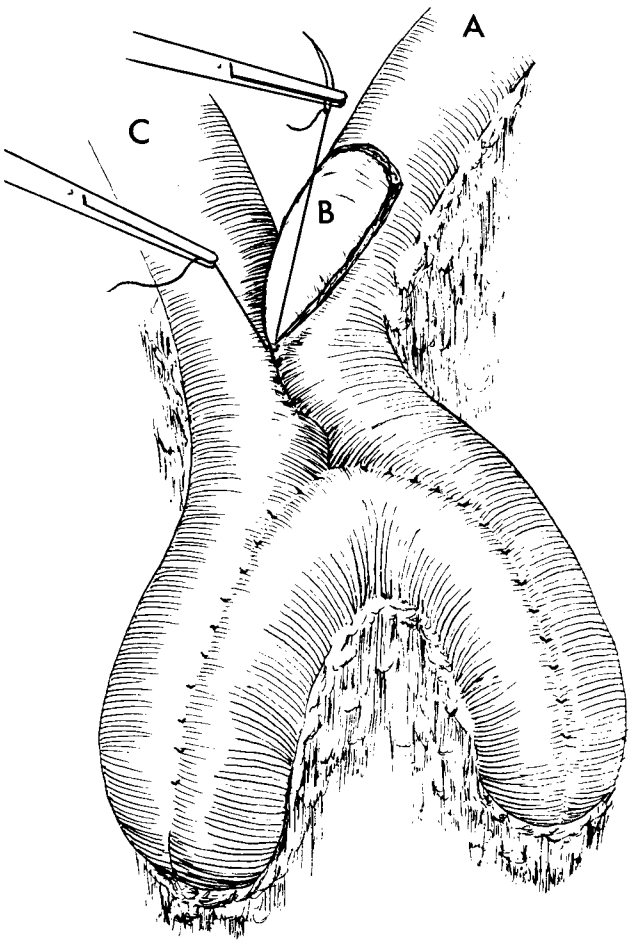

FIG. 4. The efferent limb (A), with the area of denuded mucosa (B), is apposed to the antimesenteric border of the afferent limb (C). This apposition will invaginate the mucosal surface of the efferent limb. The two seromuscular borders of the efferent limb are sutured to the afferent limb.

The efferent limb with the area of denuded mucosa is apposed to the antimesenteric border of the afferent limb. This denuded surface will act as the valvular mechanism. The two seromuscular borders of the efferent limb are sutured to the afferent limb, using two continuous 3-0 Dexon sutures. This step will invaginate the mucosal layer into the lumen of the efferent limb. This apposition should not obstruct the afferent limb (Fig. 4). At this point, the reservoir is intubated with a Foley catheter and 50 ml of Ringer's solution is injected and the catheter removed. There should be no loss of fluid through the valve. The reservoir is reintubated and the fluid aspirated. The terminal portion of the ileum is brought out through the abdominal wall as an end ileostomy. The reservoir is placed in the abdomen with its base cephalad and anchored to the anterior abdominal wall with one or two 3-0 silk sutures. The abdominal fascia is then closed with interrupted 0 Dexon sutures and the skin with 3-0 nylon subcuticular sutures.

Proposed Mechanism of Continence

The components involved in the function of the mucosal valve are illustrated in Figure 5. Two limbs of bowel are apposed. The efferent limb is made more pliable by removing half of its seromuscular layer. This apposition invaginates the mucosal surfaces of the outflow tract. As the inflow tract and reservoir distend, the mucosal surface is tightly apposed (Fig. 6). The mucosal surface acts as a valve, preventing uncontrolled escape of gas and feces from the reservoir. The outflow tract is easily intubated through the mucosal valve for evacuation of the reservoir.

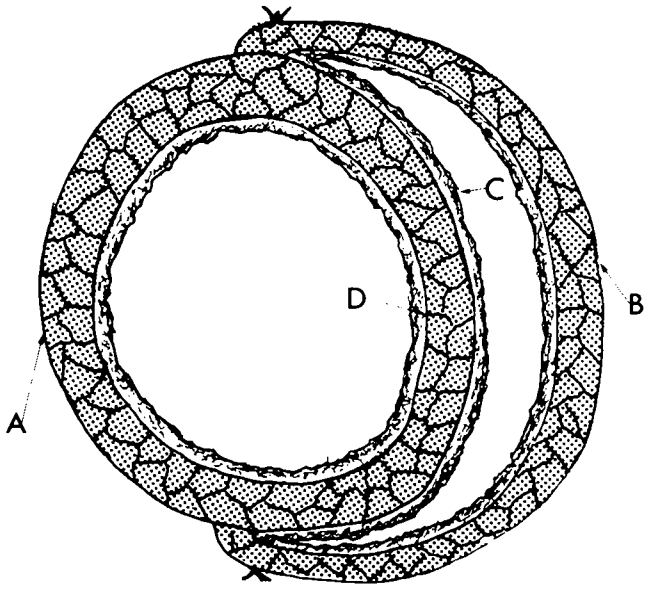

FIG. 5. Cross section of mucosal valve. Afferent limb (A), efferent limb (B), invagination of area of denuded mucosa of the efferent limb (C), normal thickness bowel wall (D).

Results

There was one mortality in the immediate postoperative period. This was attributed to anesthesia overdose. During the first two postoperative weeks, the animals lost from 10 to 15 per cent of their preoperative weights. Only two dogs continued to lose weight by the eighth postoperative week.

After removal of the catheters, the animals were examined daily for evidence of erythema or excoriations near the ileostomy. During the first week, after removal of the catheters, three of the ileostomies were found to be clinically incontinent. The animals developed fecal soilage and abdominal excoriations. The catheters were replaced and then reoccluded for six 12-hour periods. The catheters were again removed and the ileostomies were continent.

The reservoirs were intubated and their contents aspirated two to three times a day. The average daily volume ranged from 76 to 255 ml/day, with a mean of 143 ± 66.7 ml/day.

Radiographic and volume pressure relationships were performed after eight weeks. The radiographs with variable amounts of barium proved continence (Fig. 7). Following aspiration of the barium, Ringer's solution was infused, with continuous intrapouch pressure monitoring. The pressure in the reservoir remained at 0 cm H_2O until a mean volume of 243 ± 145 ml was instilled; then there was a gradual elevation of the intrapouch pressure. The Ringer's solution infusion continued until the valve became incontinent. The volume at which incontinence

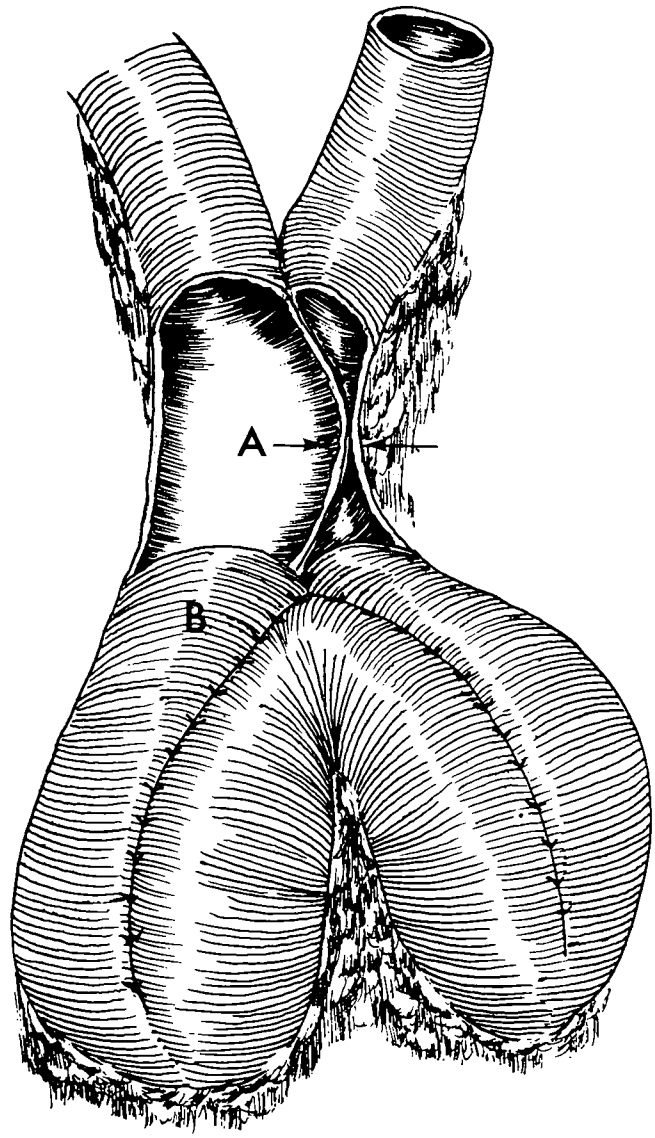

FIG. 6. As the afferent limb (A) and reservoir (B) distend, the mucosal surfaces of the efferent limb are tightly apposed (arrows).

was reached ranged from 230 to 680 ml, with a mean of 425 ± 140 ml. The corresponding pressure ranged from 3.2 to 16.5 cm H_2O, with a mean 7.0 ± 5.0 cm H_2O. With these excessive volumes, all ileostomies became incontinent. (Numbers = mean ± standard deviation).

Discussion

The continent ileostomy with reservoir offers an improved quality of life over the conventional ileostomy. Kock's continent ileostomy is a well-established technique; however, it is technically difficult to construct. We have described a valvular mechanism that is easier to construct; however, there are three important technical steps that must be followed: 1) The proximal portion of

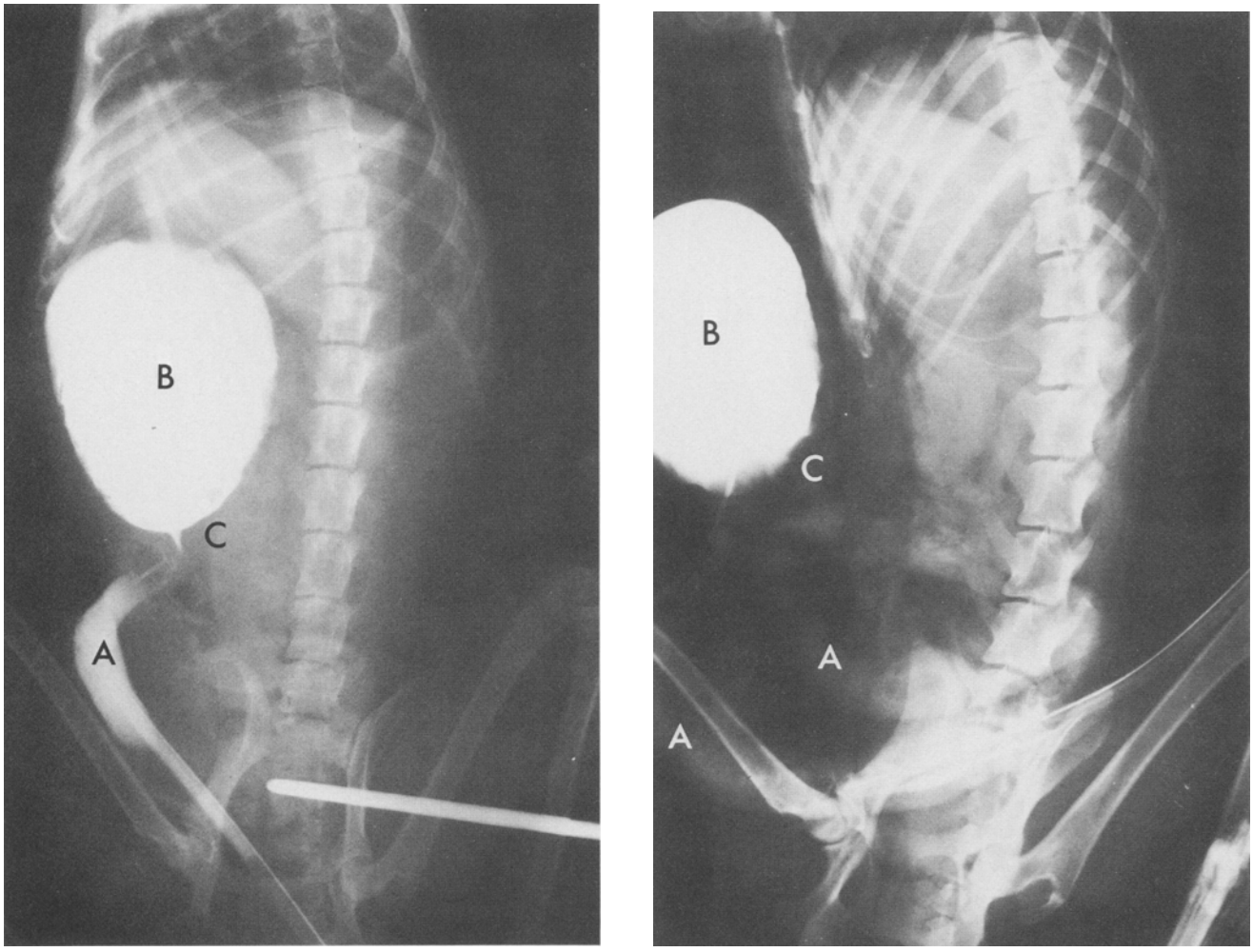

FIG. 7. Radiographs of the new continent ileostomy. Afferent limb (A), intestinal reservoir (B), area of outlet valve without extravasation of contrast (C).

the valve must be 0.5 cm from the intestinal reservoir, along the antimesenteric border of the efferent limb. 2) The incision along the antimesenteric border must be only through the seromuscular layers up to, but not through, the mucosal layer. 3) The critical step is when the efferent limb is apposed to the afferent limb. This apposition must not be greater than 50 per cent of the afferent limb circumference; however, it must not obstruct the afferent limb.

The significance of this apposition is exemplified by the pathophysiology of the valvular mechanism and by the early incontinence in three of the ileostomies. When the valve is apposed to the afferent limb, a partial bowel obstruction is created. When the afferent limb and reservoir dilate, this approximates the mucosal surface of the valvular mechanism, thereby creating complete bowel obstruction. The early incontinence in three ileostomies in this project responded to a reocclusion interval; this further allowed the reservoir and afferent limb to dilate.

We have demonstrated that all seven ileostomies were continent under physiologic conditions. At the termination of the project, all animals were without fecal soilage or abdominal excoriations. When the valve was stressed to maximal volume and pressure, which was significantly greater than the daily volume aspirated, overflow incontinence did occur. On occasion, some of the ileostomies developed overflow incontinence when the reservoirs were massively distended. This occurred only when the reservoirs were not aspirated for greater than 12 to 14 hours. When these reservoirs were intubated, there was a large residual volume noted, which implied an overflow mechanism.

In conclusion, we have demonstrated a new valvular mechanism which, in these animal experiments, was easy to construct and demonstrated a high incidence of clinical and radiographic continence. Overflow incontinence did occur, but at volumes that were significantly higher than the daily volume aspirated.

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Announcement

UNIVERSITY OF CALIFORNIA, SAN FRANCISCO SCHOOL OF MEDICINE GASTROENTEROLOGY PROGRAM

A program entitle, "Gastroenterology; Recent Developments in Theory and Practice," will be offered June 13-15, 1984 by the Division of Gastroenterology, Department of Medicine, University of California, San Francisco School of Medicine. This program will present a comprehensive overview of the most recent developments in the field of Gastroenterology and will offer an excellent opportunity for physicians to update their knowledge relating to both theory and practice. This program is intended for specialists in gastroenterology as well as physicians practicing internal medicine. The course will combine a series of lectures, presented didactically with ample time for discussion, and smaller-sized break-out sessions in order to explore topics of specific interest. Accommodations are being arranged at the Stanford Court Hotel, located atop Nob Hill, in San Francisco, California. Special conference rates will be available to participants in this program. Continuing education credit will be available. For further information, contact: Shelley A. Horwitz, Department of Medicine, Room M-997, University of California, San Francisco, California 94143.