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GASTROCYSTOPLASTY USING THE LINEAR CUTTER STAPLER TO HARVEST THE SEGMENT WITHOUT OPENING THE STOMACH

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ABSTRACT

Objectives: We evaluate a modification of gastrocystoplasty using the Linear Cutter stapler to harvest the segment for augmentation without opening the stomach.

Patients and Methods: Ten patients (6 children and 4 adults) underwent gastrocystoplasty. Indications for surgery included urinary incontinence and upper tract deterioration. The use of intestinal segments was precluded because of either young age or impaired renal function. Preoperative renal function, radionuclide renal scan and urodynamic evaluations were done in all patients.

Results: There were no complaints of early satiety or weight loss. Mean time to feeding was 5 days postoperatively. None of the patients had clinical evidence of gastric leakage. Of the 10 patients, 8 void spontaneously and 2 require intermittent catheterization. Bladder capacity and compliance and urinary flow rates were significantly improved in all patients. At a mean follow-up period of 9.4 months clinically significant hypochloremic, hypokalemic metabolic alkalosis was not noted in any patient.**Conclusion:** This simplification reduces operative time and blood loss without introducing complications, and has been successfully used in our first 10 patients.

Key Words: Bladder augmentation, Linear Cutter stapler, stomach.

INTRODUCTION

Various segments of small and large bowel have been used extensively for bladder augmentation or replacement, despite fundamental differences in inherent functions of the bladder and intestine. While the bladder is involved in urine storage and evacuation with no absorption or diffusion through its mucosa, the intestine has the power of absorption, secretion and propulsion, with no storage function. When the bladder is augmented or replaced by bowel segments, the inherent intestinal contractions increase pressure inside the reservoir and undermine storage capacity[1]. Although largely circumvented by detubularization and reconfiguration of segments, these processes have further decreased the already weak force of evacuation of intestinal bladders[2]. Also enterocystoplasty may be complicated by hyperchloremic acidosis, especially in patients with impaired renal function[3].

More recently, stomach has been proposed as a viable alternative for bladder augmentation and substitution[4–7]. A wedge-shaped segment of stomach has been used to enlarge or replace the bladder reliably and provides adequate compliance[7]. Also, gastric tissue is impermeable to most ions, particularly chloride which is transported in urine and, thus, offers a protective mechanism against acidosis in patients with impaired renal function[8]. In addition, the thick wall of the stomach easily accommodates submucosal tunnels for ureteric reimplantation. Finally, in cases of congenitally short gut or irradiation of the lower abdomen the stomach is the only source of material for bladder augmentation or replacement.

The standard technique of gastrocystoplasty was described by Adams et al.[9] It involves a wedge resection of the gastric fundus and antrum along the greater curvature. This segment is transferred to the pelvis with a pedicle based on the right gastroepiploic vessels and is used for the bladder augmentation. Stomach continuity is then reestablished with a 2-layer closure of the remaining proximal and distal segments. Based on the experience of Raz et al.[10], we describe a technique of harvesting the gastric segment using the Linear Cutter stapler without opening the stomach. We have found that this approach simplifies the operation by reducing operative time and blood loss.

PATIENTS AND METHODS

Ten patients (6 children and 4 adults underwent gastrocystoplasty. The diagnosis was neurogenic voiding dysfunction in 5 patients (secondary to myelomeningocele in 4 and secondary to spinal injury in 1), posterior urethral valve and reflux uropathy in 1, contracted bladder in 4 (after multiple suprapubic operations and vesical schistosomiasis). Indications for surgery included urinary incontinence and upper tract deterioration. The use of intestinal segments was precluded because of either young age or impaired renal function. The use of stomach in pediatric patients was preferred because of the decreased mucus production, the resultant acid urine that decreases the incidence of bacteriuria and the suppleness of the stomach and the well-defined submucosal plane that makes it ideal for reimplantation of the ureters.

Also the inherent musculature of the gastric segment more often allows for spontaneous voiding that can result in more efficient emptying, less residual urine, and decreased need for intermittent catheterization.

Renal function was determined via serum electrolytes, blood urea nitrogen, creatinine and/or creatinine clearance. Radionuclide renal scan and urodynamic evaluations were done in all patients preoperatively. The aim of surgery was either to preserve the upper urinary tracts and/or attain urinary continence.

The modified gastrocystoplasty is done through a midline transperitoneal incision. The greater omentum is taken down between hemostats leaving a 2 - 3 cm. strip intact along the gastroepiploic vessels. Omental vessels are ligated and the right gastroepiploic artery is selected to supply the chosen segment. Short branches to the stomach are ligated and divided proximal and distal to the portion of stomach selected for augmentation, and the left gastroepiploic artery is divided.

Instead of excising a wedge-shaped segment, a Linear Cutter stapler is placed across the greater curvature, isolating the selected crescent-shaped segment, and fired. At this point the staple line on the remaining stomach is reinforced with interrupted 3-zero silk sutures, eliminating the time-consuming two-layer closure required with the typical wedge resection technique, and lessening the risk of gastric content spillage and blood loss.

The pedicle and gastric segment are passed through a small window in the transverse mesocolon and then back through the ileal mesentery to the pelvis. The bladder is opened using an inverted U-shaped flap, and a 2-layer anastomosis between the bladder and the gastric segment is performed after excising the staple line. Before closure of the anterior wall a ureteral reimplantation is performed, if necessary. Follow-up consists of cystogram at two weeks postoperatively. Renal ultrasound is obtained at 2 to 4 months and electrolytes are obtained on a routine basis. Follow-up ranged from 3 to 18 month (mean 9.4).

RESULTS

There were no intraoperative complications. The gastric segment reached the pelvis easily in all cases and minimal bowel manip-

Fig. 1: The right gastroepiploic artery is used as a vascular pedicle to this segment. Short branches to the stomach are ligated and divided proximal and distal to the portion of stomach selected for augmentation, and the left gastroepiploic artery is divided.

Fig.2: A long, narrow segment of stomach based along the greater curvature, which includes both body and antrum, is isolated with the use of a gastrointestinal stapler so that the stomach is never open.

Fig.3: The pedicle and gastric segment are passed through a small window in the transverse mesocolon and the staple line is excised. The bladder is opened using an inverted U-shaped flap.

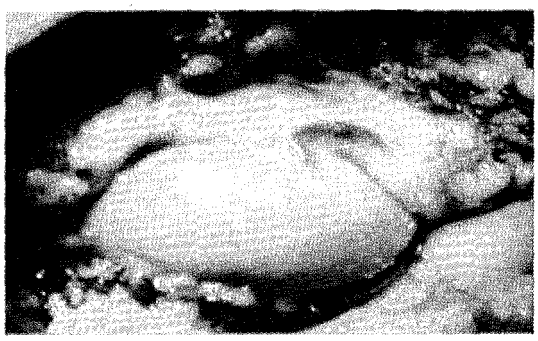

Fig. 4: The gastric segment is sutured to the native bladder with two layers of absorbable sutures.

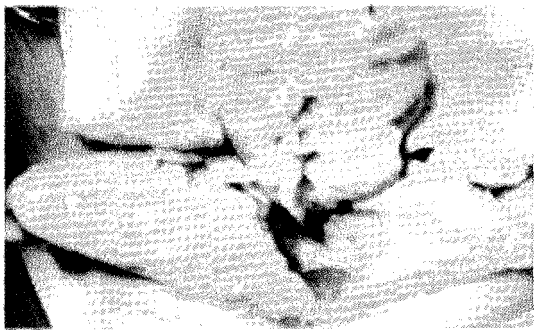

Fig. 5: The gastric segment after excision of the staple line fitting well with the bivalved bladder without tension.

Fig. 6: Lateral view showing the 2-layer anastomosis between bladder and gastric segment in a female child.

Fig. 8: Left: Preoperative cystogram demonstrating markedly reduced bladder capacity and vesicoureteral reflux on left side. Right: Postoperative cystogram revealing improved capacity and configuration of bladder, and absence of left ureteral reflux.

ulation was needed. All patients are currently on histamine receptor 2 blocking agents, and 9 are doing well with no complications or additional procedures. One patient complains of persistent dysuria unresponsive to proton pump blockers. No patient has demonstrated radiological or serological evidence of further renal deterioration. Clinically significant hypochloremic, hypokalemic metabolic alkalosis was not noted in any patient. Reviewing postoperative gastrointestinal function, the patients had no complaints of early satiety or weight loss. Mean time to feeding was 5 days postoperatively. None of the patients had clinical evidence of gastric content leakage.

Of the 10 patients who have undergone gastrocystoplasty by the aforementioned technique 8 void spontaneously (4 adults and 4 children) and 2 children require intermittent catheterization. No patient has to empty the bladder more frequently then every 3 to 4 hours, all are continent and none requires anticholinergic agents. However, patients had to be awakened at least 2 times to remain continent at night.

Mean maximum flow rate increased from 8.8 ml/sec (range 6.9 to 14.2) to 17.7 ml/sec (range 11 to 26.4) after gastrocystoplasty. Mean bladder capacity increased from 120 ml (range 60 to 160) preoperatively to 460 (range 420 to 480) ml postoperatively. While involuntary detrusor contractions were noted throughout vesical filling in patients with neurogenic bladder, they appeared only near the end of bladder filling after gastrocystoplasty. Bladder capacity and compliance were significantly improved in all patients. Patients with a gastric neobladder who voided spontaneously demonstrated an interrupted biphasic flow pattern. Urine was evacuated mainly by contraction of the gastric bladder (70%) in stage 1 and by abdominal straining (80%) in stage 2 of voiding. Post-void residual urine volume in patients with spontaneous voiding ranged from 0 to 50 ml. We attributed the ability of spontaneous voiding to the generous excision of the scarred dome of the bladder before bivalving and to the musculo-elastic properties of the stomach.

DISCUSSION

Surgically, the stomach is relatively thick-walled and easy to work with. It is readily accessible and has a rich, reliable vascular supply. The suppleness of the stomach and the well-defined submucosal plane makes it ideal for reimplantation of ureters and continent catheterizable stomas. Use of stomach for bladder augmentation has clear advantages in patients with renal insufficiency due to its ability to secrete acid. This allows for buffering of systemic acidosis and lessens the

need for bicarbonate supplementation. The resultant acid urine also appears to decrease the incidence of bacteriuria. In comparison to other intestinal segments, there is also decreased mucus production and stone formation. The inherent musculature of the gastric segment may also offer an additional advantage over small and large bowel in more often allowing for spontaneous voiding that can result in more efficient emptying, less residual urine, and decreased need for intermittent catheterization [11,12].

Use of stomach in bladder augmentation is gaining popularity because of ease of performance, availability of donor segment and limitation of postoperative morbidity. Harvesting the intestinal segment is only part of what is usually a complex operation in a patient requiring bladder augmentation and often complete urinary reconstruction. We believe that using the Linear Cutter stapler without opening the stomach will further simplify the procedure. While it is not possible to make a direct comparison based on the published literature, we are confident that eliminating the two-layer gastric reanastomosis as required in the wedge resection technique[13] reduces operative time. Furthermore, this technique may reduce operative blood loss since the gastric staple line is not removed, eliminating the oozing from the cut edges during reanastomosis of the proximal and distal portion of the stomach. Finally, eliminating the gastric reanastomosis may allow for earlier feeding, although no comparison to the standard technique is possible since no similar data are available. However, since the development of the hematuria-dysuria syndrome is fairly common following gastrocystoplasty, this type of augmentation is most appropriate in patients who have minimal or no perineal and urethral sensation. If gastrocystoplasty is performed in patients who are sensate, it is important to ensure that they are completely continent[14]. In the experience of Nguyen and coworkers, 36% of patients developed signs or symptoms of the hematuria-dysuria syndrome after gastrocystoplasty; 14% required treatment with medication, 9% on a regular basis. The symptoms of the hematuria-dysuria syndrome respond well to administration of H2 blockers and hydrogen ion pump blockers[15].

Although there is a theoretical possibility of creating gastric outlet obstruction or insufficient stomach capacity, this has not occurred in our patients. Indeed, the experience of general surgeons performing gastroplasty for morbid obesity has demonstrated almost universal dilation of the gastric stoma and pouch created by single staple line. Furthermore, in an early description of gastrocystoplasty. Sinaiko used a similar technique of clamping across the greater curvature and creating a crescent-shaped segment. Rather than stapling, he closed the stomach in two suture layers. In this original trial on dogs the remaining stomach eventually regained its original size, shape and function. In two patients treated by creation of a gastric pouch no functional or radiological evidence of reduced capacity or obstruction was noted[16,17]. None of our patients complained of early satiety or weight loss. Experience with gastroplasty has shown that obstruction tends to occur early in the postoperative period or within the first 3 months. Thus, follow-up is adequate in our 10 patients to exclude obstruction of the native stomach.

Another concern may involve the size of the gastric segment to be used for bladder augmentation. Sinaiko was able to obtain a large enough segment to create a gastric pouch in dogs, whose "large" capacity was demonstrated on excretory urography[16]. In this study the segment obtained in this fashion has proved to be adequate in all instances.

A final concern may involve the inclusion of a segment of antrum in the harvested segment leading to elevated gastrin levels and increased gastric acid secretion. Leong studied this phenomenon in humans on whom he performed antral gastrocystoplasty and antral gastric conduits and he found decreased serum gastrin levels, decreased total gastric acid production and no evidence of ulcer formation[18].Lim et al and Raz et al have reported similar results[10,19].

The ultimate goal of augmentation cystoplasty, besides preservation of the upper urinary tract, is to obtain a high capacity, low pressure reservoir for urine so that the patient can void every 3 to 4 hours and maintain continence. Mean bladder capacity increased from 120 ml (range 60 to 160) preoperatively to 460 (range 420 to 480) ml. The pressure inside these high capacity reservoirs did not exceed 30 cm water during most of the filling period, which may be explained by the nature of the involuntary contractions elicited by gastric segments. These low frequency, small amplitude contractions started after the augmented gastric bladder had been filled to most (70 to 90%) of its ultimate new capacity. Similar observations after gastrocystoplasty were reported by Atala et al, who demonstrated uninhibited contractions only when the bladder was filled 50% of its volume[6]. These observations should impact favorably on the storage capacity of the gastric reservoir.

The increased maximum flow rate after gastrocystoplasty shown in this study is probably the result of a stronger driving force for urination achieved by supplementation of the gastric musculature to the denervated or fibrotic detrusor muscle. This process is best exemplified by vesical schistosomiasis, when the end result of massive and repeated pancystitis with extensive muscle destruction and fibrosis is a contracted bladder. In these cases the structure and function of the bladder as a reservoir and driving force of urine are limited.

In conclusion, the use of a Linear Cutter stapler in harvesting a long and narrow segment of the stomach, based along the greater curvature, simplifies gastrocystoplasty and does not require opening of the gastric remnant thus reducing operative time and blood loss.

No complications specific to this modification have occurred and segments of adequate size for bladder augmentation have been obtained in all instances. However a long-term follow up is required to report the incidence of hematuria-dysuria syndrome and metabolic abnormalities.

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RESUME

Objectifs: Nous évaluons une modification de la gastrocystoplastie utilisant un bistouri linéaire et des agrafes pour isoler un segment pour l'augmentation sans ouvrir l'estomac.

Patients et méthodes: Dix patients (6 enfants et 4 adultes) ont subi une gastrocystoplastie. Les indications pour la chirurgie ont inclus l'incontinence urinaire et les altérations du haut appareil urinaire. L'utilisation des segments intestinaux a été exclue en raison du jeune âge ou de l'altération de la fonction rénale. La fonction rénale préopératoire, le balayage rénal de radionucléide et les évaluations urodynamiques ont été réalisés chez tous les patients en préopératoire.

Résultats: Il n'y avait aucune plainte précoce de perte de satiété ou de poids. Le temps moyen pour la reprise de l'alimentation était de 5 jours en postopératoire. Aucun patient n'a eu de signes cliniques de fuite gastrique. Des 10 patients, 8 vident spontanément la néovessie et 2 nécessitent le sondage intermittent. La capacité, la compliance et les débits ont été sensiblement améliorés chez tous les patients. Pendant une période moyenne de suivi de 9.4 mois l'alcalose métabolique hypochloremique et hypokaliemique cliniquement significative n'a été notée chez aucun patient.

Conclusion: Cette simplification réduit la perte effective de temps et de sang sans présenter des complications spécifiques à elle et a été utilisée avec succès chez nos 10 premiers patients

Editorial Comment

The paper is a well written experience with gastrocystoplasty in 10 patients. The follow up is short. The mean follow up is only 9.4 months however the authors feel this is adequate to assess major complications of their technique. Actually the technique described is not new. The authors have appropriately referenced a previous experience of the same technique. I have used the proposed technique, but felt it was too limiting as to the amount of gastric flap tissue I could take without damaging gastric function. Apparently this should not have been a major concern. I would support the publishing of this paper because it may facilitate the use of gastric tissue in bladder augmentation by streamlining the technique. It will be interesting to see how these patients do in the long term.

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