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Endoscopic blind limb reduction with septotomy for the treatment of candy cane syndrome after Roux-en-Y gastric bypass: Pilot feasibility study

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ABSTRACT

Background and study aims Candy cane syndrome (CCS) refers to patients with a long and symptomatic blind afferent roux limb (BARL) after Roux-en-Y gastric bypass (RYGB). Revisional surgery is efficacious but can be cost prohibitive.

Patients and methods We describe endoscopic blind limb reduction (EBLR), that converts the BARL into a "common channel" and eliminates food pooling, thereby improving symptoms. Patients that did not have a complete symptomatic response underwent a repeat EBLR or EBLR with septotomy (EBLR-S) based on residual BARL length.

Results Five patients with CCS underwent the EBLR procedure. Mean age was 60.4 years, average BARL length 5.8 cm, and median Charlson comorbidity index was 3. Technical success was achieved in all five patients (100%). Symptom resolution was achieved in all five patients (100%). Two patients required a second procedure.

Conclusions EBLR may be a potentially safe, efficacious, and cost-effective alternative to surgery in patients with CCS. Further prospective studies are needed.

Introduction

Candy Cane Syndrome (CCS) was first described in 2007 and refers to a constellation of postprandial abdominal pain, nausea, and vomiting that is caused by preferential flow of enteral contents into an excessively long blind afferent Roux limb (BARL) after Roux-en-Y gastric bypass (RYGB) [1]. Symptoms are frequently debilitating and in extreme cases, may lead to food aversion, cachexia, and rupture of the BARL [2]. Diagnosis of CCS is frequently challenging due to symptom overlap with other disorders such as dumping syndrome and ulcer disease and requires a high index of suspicion. Radiographic or endoscopic appearance of a long or dilated BARL that preferentially fills with radio-contrast, should prompt a diagnostic workup.

The true prevalence of CCS may be higher than is currently estimated and expected to rise with the increasing number of RYGBs being performed worldwide.

Surgical resection of the BARL has been considered standard of care. Although highly efficacious, surgery can be cost-prohibitive and is frequently associated with a high risk (up to 25%) of adverse events (AEs). Patients with complex medical problems, extensive surgical histories, and those who are not nutritionally optimized are not considered surgical candidates [3]. Such patients may go untreated, sometimes for several years following RYGB. Given the increasing prevalence of CCS and the high cost and morbidity associated with surgery, there is a need to develop a minimally invasive, efficacious, and cost-effective treatment for patients with CCS.

Patients and methods

Study design

This was a prospective series of five patients who underwent endoscopic blind limb reduction (EBLR) for management of CCS. The study was conducted at a large tertiary referral center under a prospective registry and approved by our Institutional Review Board. All patients were followed in clinic 1 month after the EBLR procedure and underwent follow-up upper endoscopy to ensure healing. Patients with residual symptoms or inability to progress to solid food underwent a repeat endoscopic procedure. Patients with a residual BARL length < 2 cm underwent EBLR and patients with a BARL length > 2 cm underwent endoscopic blind limb reduction with septotomy (EBLR-S). Patients were monitored for immediate AEs after procedure and followed for delayed adverse events after procedure via phone or clinic visits.

Outcome definitions

The main aim of our study was clinical success, which was defined as resolution of postprandial symptoms and the ability to restart a solid diet. Technical success was defined as the ability to complete all intended procedure steps.

Patient characteristics

A total of five patients with a diagnosis of CCS were enrolled after a detailed evaluation that included history, diagnostic testing, and/or prior endoscopic evaluation. All five patients were referred by our bariatric surgical service and were deemed high risk for surgical intervention. Prior to the procedure, all patients were seen in a clinic to discuss the risks and benefits of this novel technique and verified informed consent was obtained. All procedures were performed under general anesthesia in the left lateral position by an endoscopist with experience in endoscopic suturing and bariatric endoscopy (KK) (▶ **Table 1**).

Procedure description

Endoscopic blind limb reduction

Using a gastroscope and an endoscopic suturing device (Appolo OverStitch, Boston Scientific, Marlborough, Massachusetts, United States), a single suture was applied at each end of the inter-jejunal septum (IJS) (▶ **Fig. 1a**). With each suture, multiple passes or bites were taken while applying constant outward suture traction and after the desired BARL length was achieved, a cinch was applied (▶ **Fig. 1b**). Use of the described technique results in shortening of both the BARL and IJS and creation of a common channel or pouch that extends from the gastro-jejunal anastomosis above to the afferent limb below (▶ **Fig. 1c**). All patients were started on a liquid diet the same day and advanced to a solid diet as tolerated.

Endoscopic blind limb reduction with septotomy

Using a linear echoendoscope, the IJS was thoroughly evaluated to exclude major blood vessels and adjacent organs. Following this, a repeat EBLR was performed, and two sutures were applied at either end of the IJS, using the technique described above. A scissor-type electrosurgical knife (Clutch Cutter, Fujifilm Medical, Tokyo, Japan) was then used to dissect the IJS along a horizontal plane that is equidistant from the sutures (▶ **Fig. 1d**). A hemostatic clip was applied at the apex of the septal dissection. Water-soluble radiocontrast was subsequently injected into the gastric pouch to exclude leaks or perforations. Both procedure techniques have been previously described in video format (4).

Results

Patient and procedure characteristics

Five patients (4 females and 1 male) were included, mean age 60.4 years, average BARL length 5.8 cm (range, 5–7 cm), median Charlson comorbidity index 3. All patients were deemed unsuitable for surgical management. Three patients had RYGB within the last year. One patient had RYGB 1.5 years ago and one patient had it 6 years ago. Follow-up ranged from 3 months to a year (▶ **Table 1**).

Study outcomes and adverse events

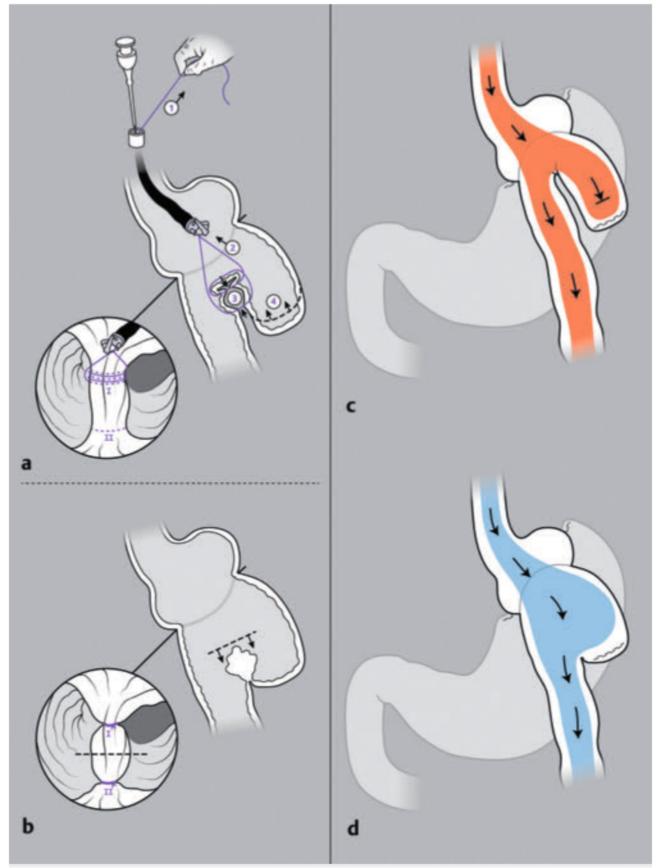
Technical success was achieved in all five patients (100%). Clinical success was achieved in three of five patients after the first procedure. Two patients with incomplete symptom resolution underwent a repeat intervention. Following this, both patients experienced complete resolution of symptoms (100%). Among the two patients with an incomplete clinical response, the first patient underwent a repeat EBLR procedure (▶ **Fig. 2**) and the second patient underwent a repeat EBLR procedure with septotomy (▶ **Fig. 3**). Following the second procedure, both patients had resolution of their symptoms and were able to restart a solid diet.

There were no major early or delayed AEs in any of the procedures. Mild self-limited bleeding was encountered in one patient and stopped spontaneously after cinching. The most common minor AE was mild nausea and abdominal pain that responded well to medical management and lasted for 2 to 3 hours post procedure.

▶ Table 1 Candy cane syndrome patient characteristics and results.

Patient no.	Age	Gender	Time since RYGB	Charlson Comorbidity index	BARL length prior to intervention	EBLR	Symptomatic response	BARL length on repeat EGD	Repeat intervention	Time between first and second procedure	Follow-up period	Symptomatic response during follow-up
1	51	F	11 months	3	6 cm	Yes	Incomplete	4 cm	Yes*	6 weeks	1 year	Complete
2	72	F	12 months	3	5 cm	Yes	Complete	2 cm	No	NA	8 months	Complete
3	56	F	9 months	2	6 cm	Yes	Complete	2 cm	No	NA	3 months	Complete
4	52	F	6 years	2	7 cm	Yes	Complete	3 cm	No	NA	3 months	Complete
5	71	M	18 months	4	5 cm	Yes	Incomplete	2 cm	Yes†	8 weeks	6 months	Complete

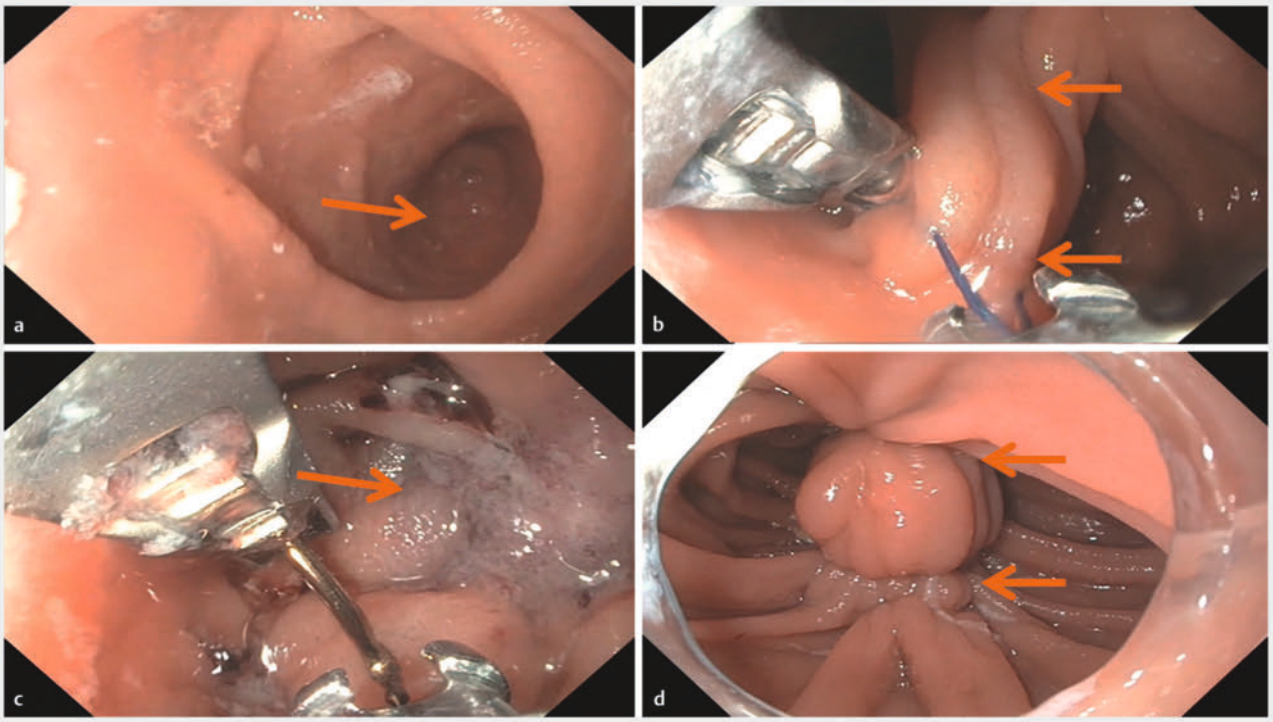
BARL, blind afferent Roux limb; EGD, esophagogastroduodenoscopy; EBLR, endoscopic blind limb reduction; EBLR-S, endoscopic blind limb reduction with septotomy RYGB, Roux-en-Y gastric bypass.
*Patient underwent EBLR-S.
†Patient underwent repeat EBLR.



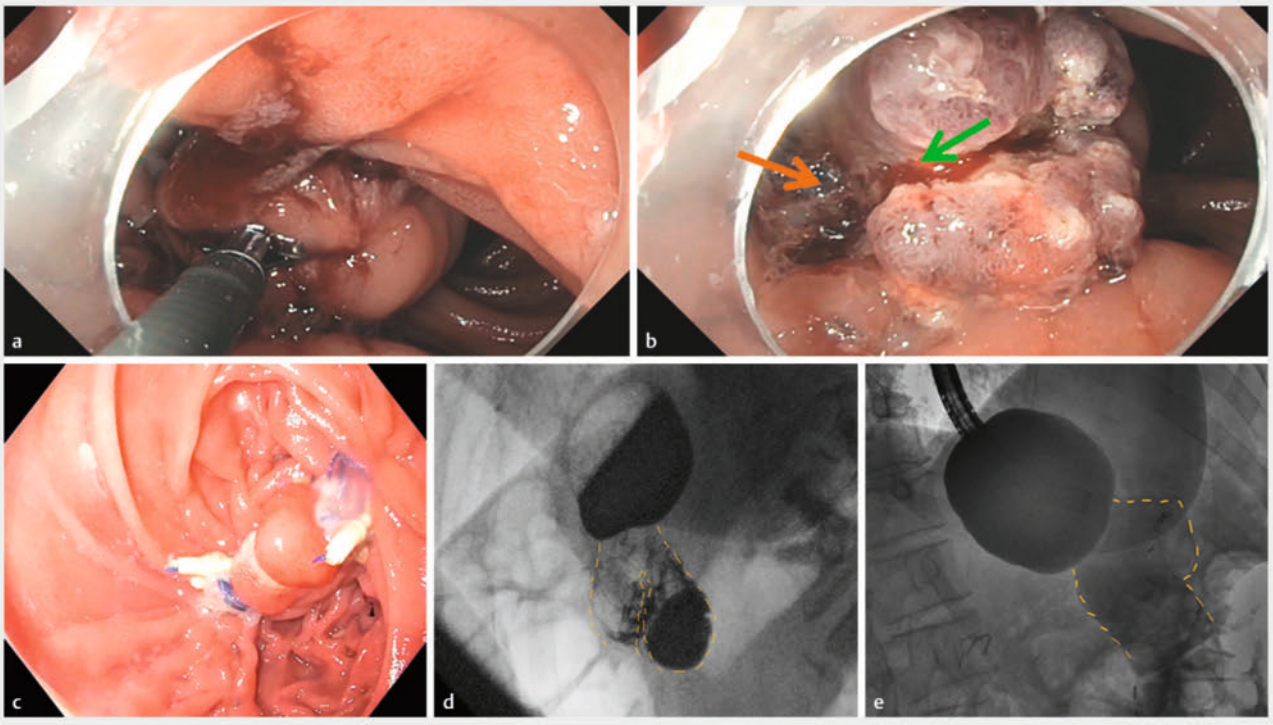
▶ Fig. 1 **a** Illustration depicting the EBLR procedure. Using a single suture at one end of the IJS (I), multiple passes or bites are taken using the following technique. After every throw of the needle, constant outward tension is applied (1). This results in tightening of the IJS between bites (2) and progressive shortening of the blind limb (3) until a desired blind limb length is achieved (4). Following this, a cinch is applied. Using the same technique, a separate suture is applied at the other end of the inter-jejunal septum (II). **b** Illustration depicting a septotomy. A scissor type electrosurgical knife is used to dissect the inter-jejunal septum along a horizontal plane (dotted line) that is equidistant from the previously placed sutures. **c** Illustration of typical candy cane post-RYGB anatomy. **d** Illustration depicting post-EBLR anatomy. Note that the IJS and BARL are replaced by a large common channel that empties directly into the afferent limb. (Courtesy Kadkhodayan.et al [4])

Discussion

Abdominal pain and nausea in post-RYGB patients present clinicians with a diagnostic challenge due to the wide range of potential causes. Diagnosis of CCS requires a high index of suspicion and is likely under-reported. If left untreated, patients can experience severe morbidity, a persistent aversion to solid food, and poor quality of life. Surgical revision remains the gold standard for management of such patients. Although highly efficacious in carefully selected patients, revision surgery can be associated with a high complication rate, particularly in patients who have poor nutritional status, multiple comorbidities, or a prior history of open surgery. With an increase in the obesity epidemic and the number of patients un-



▶ **Fig. 2** Endoscopic images demonstrating different steps of Endoscopic Blind Limb Reduction (EBLR). **a** Long, blind afferent roux limb (BARL) is seen prior to endoscopic reduction (arrow). **b** Endoscopic suturing of both ends (arrows) of the Inter Jejunal Septum (IJS). **c** Shortening of the BARL and IJS (arrow) after application of sutures. d Follow-up endoscopy revealing significant shortening of the BARL and IJS, resulting in re-modeling and formation of a common chamber beyond the GJ-anastomosis that leads directly into the afferent limb.



▶ **Fig. 3** Endoscopic images demonstrating a septotomy procedure (EBLR-S). **a** After application of sutures at either end of IJS, a scissor type knife is used to dissect the IJS along a place that is equidistant from both the sutures. **b** Dissection is completed when the base of the BARL is reached. **c** Follow-up endoscopy revealing a healed septotomy site and complete reduction of the IJS and BARL. **d** Fluoroscopic image of the BARL and IJS before EBLR-S. **e** Fluoroscopic image of the common chamber emptying into the BARL after the EBLR-S procedure.

dergoing RYGB, there is an urgent need to develop a more cost-effective, safe, and efficacious treatment for patients with CCS.

In recent years, several endoscopic techniques have been developed. Examples of such techniques include endoscopic closure of the blind pouch, endoscopic revision of the gastrojejunostomy to redirect food to the Roux limb, use of a lumen-apposing metal stent (LAMS) to connect the blind end to the efferent limb, and a magnetic compression wire-cutting septotome [4, 5, 6, 7, 8, 9]. Although initially encouraging and minimally invasive, the described techniques are mostly single patient case descriptions without long-term follow-up. In addition, there are concerns around AEs, LAMS migration, LAMS indwelling time, septotome migration etc. Most currently described techniques are viewed as a bridge to more definitive surgical re-intervention after patient nutritional status is optimized [10].

Pros of the described EBLR and EBLR-S techniques include: 1) minimally invasiveness and ability to discharge most patients the same day; 2) lower cost than surgery and most of the currently described endoscopic techniques; 3) in patients with long BARL lengths, ability to repeat EBLR with or without septotomy as many times as needed to achieve the desired BARL length or until symptom resolution; 4) no need for in-dwelling devices such as a LAMS; 5) no potential complications from migration or retention of devices such as magnet and wire devices; and 6) re-modeling of the BARL and IJS into a common chamber, which is permanent, and the procedure may be considered destination therapy and an alternative to surgical reintervention as opposed to a temporary bridge to more definitive surgery.

Drawbacks of our study are: 1) low number of patients and limited assessment of efficacy and safety; 2) possible need for repeat intervention in patients with long BARLs due to the limited length of BARL and IJS that can be captured within the jaws of the suturing device during each session, which can be adjusted for, using multiple sessions/procedures. In patients with BARL lengths < 2 cm a repeat EBRL is usually adequate. Longer BARL lengths may require a septotomy to dissect the previously contracted IJS and allow the suturing device to access deeper levels of the IJS; and 3) patients without an IJS or who have an abnormally thick IJS may not be optimally suited for this procedure. This is due to the inability to efficiently capture IJS length with currently available suturing devices in such patients.

Conclusions

Surgical resection of the BARL remains the gold standard for treatment of CCS but can be cost-prohibitive and highly morbid. Our study demonstrates that EBLR with or without septotomy provides a safe, effective, and minimally invasive alternative to surgery and potentially paves the way for nonsurgical destination therapy for carefully selected patients with CCS. Despite promising outcomes, further multicenter studies on larger patient cohorts with long-term follow up are warranted to establish procedure efficacy and safety.

Conflict of Interest

Shayan Irani, MD is a consultant for Boston Scientific, Gore, and Conmed. Dennis Yang, MD is a consultant for Microtech, Medtronic, Olympus, FujiFlim, and Apollo Endosurgery. Mustafa Arain is a consultant for Cook, Boston Scientific, and Olympus. Muhammad Hasan, MD is a consultant for Boston Scientific and Olympus. Bello Vincentelli Gustavo, MD is a consultant for Teleflex Medical Device Company. The remaining authors have no conflict of interest to declare.

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