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CASE REPORT

Collis–Nissen fundoplication using a computer-powered right angle linear cutting stapler in children

Tsubasa Takahashi · Tadaharu Okazaki · Akihiro Shimotakahara · Geoffrey J. Lane · Atsuyuki Yamataka

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Abstract We reviewed our clinical experience of using a computer-powered right angle linear cutter (CPRALC) for Collis–Nissen fundoplication (CNF) in three children with gastroesophageal reflux (GER) or failed Nissen associated with short esophagus. Case 1 was a 13-month-old female with persistent GER after type-C esophageal atresia repair. Case 2 was a 2-year-old female with dysphagia secondary to fundic wrap migration after laparoscopic Nissen. Case 3 was a 3-year-old male with post type-C esophageal atresia repair, dysphagia secondary to fundic wrap migration after open Nissen. All had short esophagus confirmed pre- or intra-operatively. After the esophagus was mobilized, Collis vertical gastroplasty was performed using CPRALC parallel to the lesser curve to elongate the esophagus. Nissen fundoplication was performed loosely around the neo-esophagus. There were no intra- or post-operative complications, although case 3 still has mild dysphagia, requiring dilatation. This is the first report of CNF performed using CPRALC in children. It would appear to be safe and effective for treating children with GER or failed Nissen associated with short esophagus.

T. Takahashi · T. Okazaki · A. Shimotakahara · G. J. Lane · A. Yamataka (✉)
Department of Pediatric General and Urogenital Surgery, Juntendo University School of Medicine,
2-1-1 Hongo, Bunkyo-ku, Tokyo 113-8421, Japan
e-mail: yama@juntendo.ac.jp

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Introduction

Gastroesophageal reflux (GER) is a commonly occurring disorder in infants and children. Antireflux surgery is one of the most frequent operations performed by pediatric surgeons. However, the incidence of wrap breakdown and recurrence of GER requiring reoperation has been noted in up to 12% of children after an initial open/laparoscopic Nissen fundoplication [1–3].

The computer-powered right angle linear cutter (CPRALC) (Fig. 1) is a computerized digital stapler, developed by Power Medical Interventions® based in Langhorne, PA, USA. CPRALC operates at an optimal pressure modulated by tissue density providing only the necessary force required for stapling and selects the optimal staple depth in situ. Because of the computer-powered control, stapling and transection are initiated simultaneously by the touch of a single button, with no undesirable mechanical force on the staple site during activation.

The Collis–Nissen fundoplication (CNF) is a combination of Collis gastroplasty [4] and Nissen fundoplication [5]. Collis gastroplasty, which creates a gastric tubular segment from the lesser curve of the stomach, is an option for lengthening the esophagus to allow an intraabdominal fundoplication [4]. CNF is used specifically for patients with short esophagus to decrease post-antireflux surgery complications such as breakdown or wrap migration.

Here, we review our experience of CNF using CPRALC in children with GER or failed Nissen fundoplication with short esophagus.

Fig. 1 The computer-powered right angle linear cutter is a computerized digital stapler, developed by Power Medical Interventions®

Materials and methods

Subjects

Case 1

A female born at 36 weeks' gestation weighing 2,462 g at birth was diagnosed with Gross type C esophageal atresia with a three-vertebral body length gap and underwent primary repair at 4 months of age elsewhere after esophageal elongation with bouginage. At 12 months of age, she was referred to our institute for refractory anastomotic stenosis. An esophagram demonstrated anastomotic stenosis and GER, indicating that the esophagus was too short to conduct Nissen fundoplication without esophageal lengthening. At 13 months of age, she underwent synechotomy of the stenotic esophageal anastomosis through a right thoracotomy, resulting in release of the esophageal stenosis and expansion of the lumen, and CNF with 2.5 cm neo-esophagus created by CPRALC. Pyloromyotomy was performed concurrently because of possible injury to the vagus nerve during synechotomy.

Case 2

Case 2 was a female born by cesarean section for growth retardation at 29 weeks' gestation; birth weight, 601 g. Postprandial emesis and poor weight gain became significant at 2 months of age. An esophagram showed GER into the upper esophagus and the laparoscopic Nissen fundoplication was performed elsewhere at 11 months of age when she weighed 4.5 kg. She complained of dysphagia after 13 months of age and an esophagram demonstrated a narrow distal esophagus due to wrap migration to the mediastinum. She was referred to our institute for further management. CNF was performed using CPRALC when she was 2 years old. Short esophagus was noted intraoperatively. The neo-esophagus was 1.5 cm long.

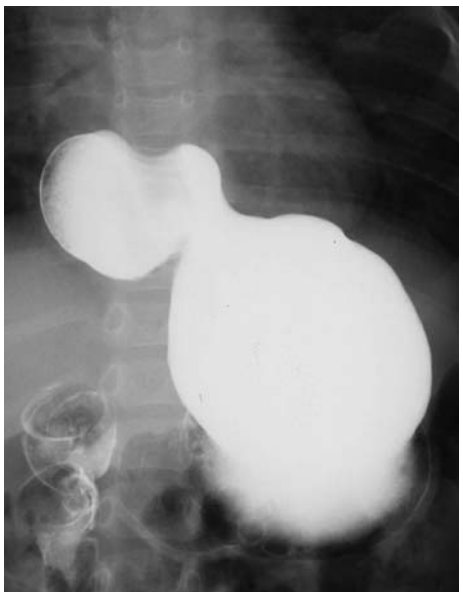

Fig. 2 Case 3: esophagram shows wrap migration to the mediastinum

Case 3

A male born at 38 weeks' gestation weighing 2,392 g at birth was diagnosed with Gross type C esophageal atresia and underwent primary repair elsewhere at 1 day of age. He was referred to our institute for severe anastomotic stenosis at 3 months of age. An esophagram demonstrated anastomotic stenosis and GER into the upper esophagus. Open Nissen fundoplication was performed at 12 months of age after esophageal balloon dilatation was repeated over a period 3 months. However, 3 months later, he suffered from dysphagia and an esophagram showed wrap migration to the mediastinum (Fig. 2). The same procedure as in case 2 was performed to create a 2 cm neo-esophagus.

Collis–Nissen fundoplication

This procedure is performed through an upper midline incision (Fig. 3). The esophagus is encircled and adequately mobilized at the hiatus. Short gastric vessels are divided if needed, and the fundus of the stomach is well mobilized. The vagus nerve is identified whenever possible and care taken not to injure it. The right and left crus are approximated with interrupted nonabsorbable sutures. Collis vertical gastroplasty is performed using CPRALC parallel to the lesser curve to elongate the esophagus, while large-bore nasogastric tube is in place. Nissen

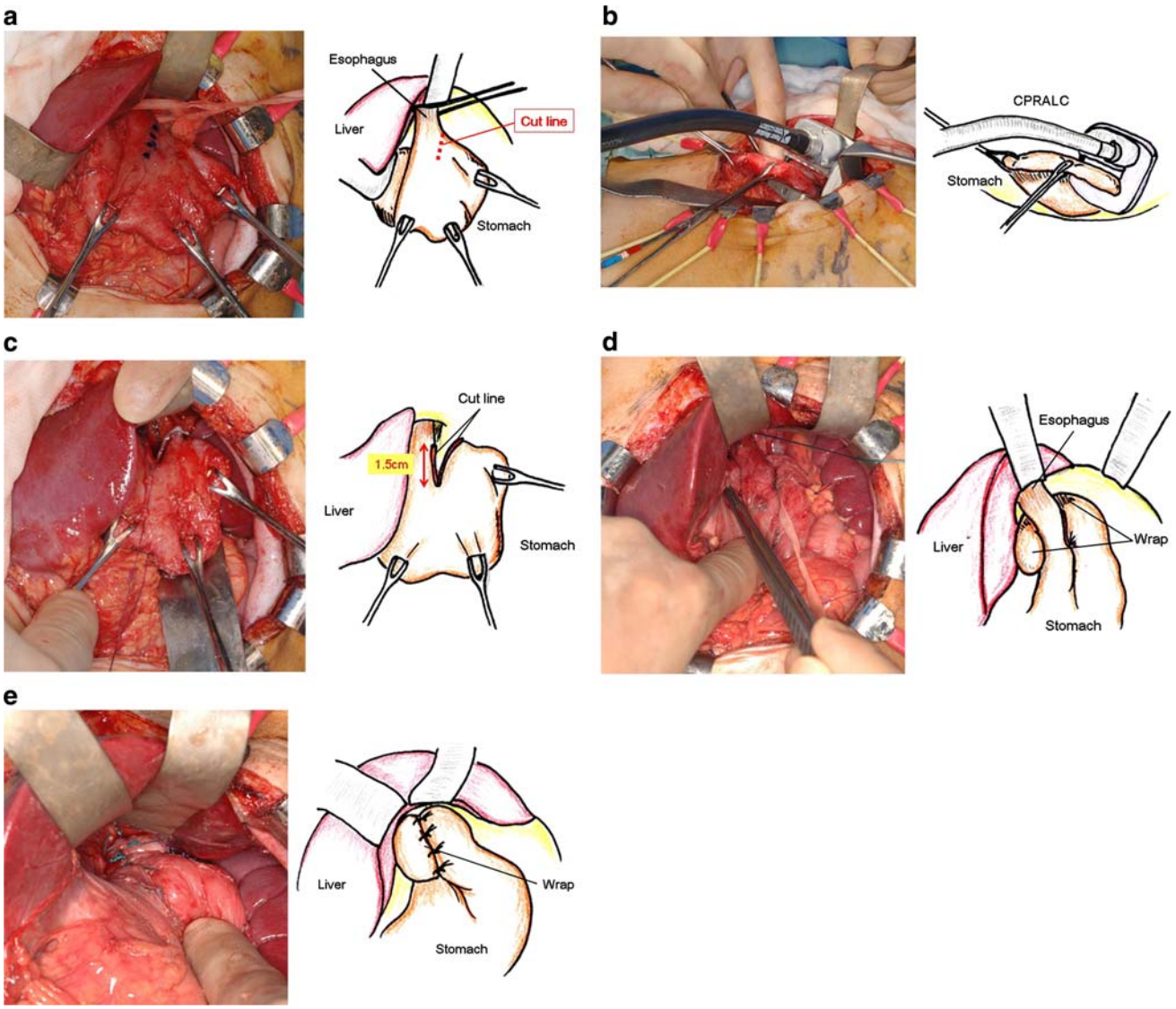

Fig. 3 **a** The esophagus is encircled and adequately mobilized at the hiatus and the fundus of the stomach is also well mobilized. **b** Collis vertical gastroplasty is performed using CPRALC parallel to the lesser curve to elongate the esophagus. **c** The neo-esophagus. **d** Nissen fundoplication is wrapped loosely 360° around the neo-esophagus with four nonabsorbable sutures. **e** Fundoplication lying below the diaphragm under no tension. *CPRALC* computer-powered right angle linear cutter

fundoplication is then performed loosely around the neo-esophagus with four nonabsorbable sutures.

Results

All three recovered from surgery uneventfully and there have been no esophageal or gastric leakages. None have had recurrence of GER secondary to wrap migration or disruption, and there have been no complications in this series except for mild dysphagia in case 3 requiring esophageal balloon dilatation for a narrowing wrap once, after which the mild dysphagia disappeared. Duration of regular follow-up assessments to date has been 18, 13, and 11 months, respectively.

Discussion

A number of reports in the adult and pediatric surgical literature have shown that laparoscopic fundoplication can be performed safely with excellent results [6]. However, antireflux surgery sometimes fails and redo fundoplication may be required. One of the causes of failure, short esophagus, increases the difficulty and potentially limits the effectiveness of laparoscopic fundoplication. A

fundoplication performed around an intrinsically shortened esophagus will have a high failure rate because of mediastinal wrap herniation, disruption, or misplacement [7]. Pacilli et al. and others have reported a recurrence rate following redo Nissen fundoplication of between 28 and 42% [3, 8, 9]. It is postulated that the high rate of wrap herniation after laparoscopic Nissen fundoplication can be prevented by ensuring the intraabdominal esophagus is of adequate length [10, 11].

Collis gastroplasty has been used for several decades [4]. Collis gastroplasty, which creates a gastric tubular segment from the lesser curve of the stomach, is an option for lengthening the esophagus. Unfortunately, Collis gastroplasty alone, without fundoplication, cannot control reflux [12]. Then, in 1961, Nissen reported his fundoplication procedure for reflux control [5]. After a few years of follow-up, it became clear that fundoplication alone was associated with unacceptably high recurrence rates in patients with short esophagus [13]. Orringer et al. described Collis gastroplasty combined with Nissen fundoplication, with excellent results [14, 15]. CNF may be a superior procedure for antireflux surgery in patients with short esophagus, because it lengthens the intraabdominal esophagus and prevents wrap migration.

Cameron et al. [16] reported two concerns about using staplers; namely, the possibility of early leakage related to the staple line. Baker et al. [17] reported that most leaks were due to mechanical/tissue issues. In stapling, too little pressure may cause poor hemostasis. On the contrary, if there is too much pressure, blood flow is reduced, tissue can shear, and adversely affect wound healing. Therefore, first, appropriate pressure is very important for good tissue apposition and hemostasis. Second, staple depth is critical for correct staple-line formation and achieving optimal strength and compression to facilitate hemostasis and adequate wound healing [17]. CPRALC allows all of the above, ensuring accurate atraumatic stapling. In other words, CPRALC creates optimal stapling conditions for every tissue based on abundant stored data provided by Power Medical Interventions®, in contrast to manual stapling which is subjective.

When conventional reusable stapler is used for Collis gastroplasty, a pin to prevent dislodgement of the stapler devise is not used, because the pin created the hole in the stomach [16]. However, if a pin is not used in stapling, inadequate stapling could occur, especially when the gastric tissue is thick. While CNF is a technical improvement, it is not without complications. There can be leakage from the gastroplasty line and fistulization, occurring in 10% or less of open cases [18, 19], and is most likely due to inadequate stapling. On the contrary, in CPRALC there is no need to pin tissues to prevent dislodgment, because mechanically CPRALC has firmer jaws and a better grip to allow more accurate stapling. Thus, CPRALC could minimize the above-mentioned complications, although we need to expand our patient numbers in order to clarify this point.

The unit cost of a CPRALC device is US$7,500 and that of a conventional stapler is US$220. While CPRALC is more expensive than a conventional stapler, CPRALC is reusable and can be used up to 1,500 times. The unit cost of a cartridge for the CPRALC device is US$450 and for a conventional stapler is US$330. So, the cost per usage for CPRALC is US$455 versus US$550 for a conventional stapler. Thus, if CPRALC is used more than 80 times, the total cost of CPRALC is lower, and in the long-term, CPRALC is more cost-effective than a conventional stapler.

This is the first report of CNF performed using CPRALC in children. CPRALC is a readily available device that is safe and easy to use that can be applied effectively during CNF for treating GER or failed Nissen in children with short esophagus.

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