



# Open vs laparoscopic repair of congenital duodenal obstructions: a concurrent series

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Received 28 January 2008; accepted 8 February 2008

## Key words:

Laparoscopic;  
Open repair duodenal  
obstructions;  
Duodenal atresia

## Abstract

**Objective:** The advantages of using laparoscopy for repair of congenital duodenal obstructions (CDO) are unclear because of scant data about complications and outcomes. Nitinol U-clips (Medtronic Surgical, Minneapolis, Minn) were developed to assist in the creation of vascular anastomoses in small vessels. Because of their ability to approximate tissue tightly with little tissue damage, we have begun to use these U-clips for laparoscopic repair of CDO. In this report, we investigate the impact of laparoscopic U-clip repair of CDO compared to the traditional open repair.

**Methods:** With institutional review board approval, a retrospective analysis of all patients undergoing repair of CDO from January 2003 to July 2007 was performed. During this study period, patients who underwent open repair of CDO (group 1) were compared with patients that underwent laparoscopic repair using the U-clip technique (group 2).

**Results:** Twenty-nine patients underwent repair of CDO. Fourteen patients (11 atresia, 3 stenosis) were in group 1 and 15 patients (11 atresia, 4 stenosis) in group 2. A female sex bias existed in group 1 (female-male [9:5]) compared to group 2 (female-male [7:8]). There was no difference in birth weight, age at operation, chromosomal anomalies, or congenital heart disease between the groups. There were no duodenal anastomotic leaks in either group. Operative times were similar between groups (96 vs 126 minutes;  $P = .06$ ). The length of postoperative hospitalization (20.1 vs 12.9 days;  $P = .01$ ), time to initial feeding (11.3 vs 5.4 days;  $P = .002$ ), and time to full oral intake (16.9 vs 9 days;  $P = .007$ ) were all statistically shorter in group 2.

**Conclusions:** The laparoscopic approach to CDO repair using U-clips is safe and efficacious. In addition, patients undergoing laparoscopic repair of CDO had a shorter length of hospitalization and more rapid advancement to full feeding compared to babies undergoing the open approach. We feel that in the hands of experienced laparoscopic surgeons, the preferred technique for correction of CDO will become the laparoscopic U-clip repair.

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Presented at the 59th Annual Meeting of the Section on Surgery, American Academy of Pediatrics, San Francisco, CA, October 25-27, 2007.

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Congenital obstruction of the duodenum (CDO) including duodenal atresia and stenosis occurs in approximately 1 in 6000 to 1 in 10,000 births [1,2]. Primarily because of associated congenital anomalies including Trisomy 21,

congenital heart disease, esophageal and other intestinal atresias, as well as anorectal and genitourinary anomalies, the early results after repair of CDO was poor with an expected survival of less than 40%. However, when the CDO is surgically repaired using an open approach and a diamond-shaped duodenoduodenostomy, the expected survival in these patients currently is greater than 95% [3-6].

Advances in minimally invasive surgical techniques for the last 20 years have led to attempts at the laparoscopic repair of CDO. A few of these repairs have been published with the authors reporting anecdotal success in single case reports and small case series [7-10]. These reports have used standard laparoscopic suturing and knot-tying techniques. Unfortunately, there has been an unacceptably high leak rate when compared to the traditional open operation.

Nitinol U-clips (Medtronic Surgical, Minneapolis, Minn) were initially designed for small vascular anastomoses. They have been shown to be easily and quickly placed, and their use has resulted in effective tissue approximation without significant tissue damage or stenosis [11,12]. In addition, these U-clips are approved for tissue approximation including esophageal, small intestinal, gastric, and mesenteric closures. With the potential advantages of U-clips, including expedient placement with minimal tissue manipulation, when compared to standard laparoscopic suturing and tying techniques, we began using U-clips for the anastomosis during laparoscopic repair of CDO. We reviewed our experience for the last 4 years to determine the efficacy and outcomes of laparoscopic repairs of CDO compared to traditional open techniques.

## 1. Methods

After obtaining approval from the Children's Mercy Hospital (Kansas City, Mo) institutional review board (06 08-135X), the charts of patients with CDO as identified through *International Classification of Disease, Ninth Revision* diagnostic and *Current Procedural Terminology* procedural codes from January 2003 to July 2007 were reviewed.

Patient variables collected included sex, age at operation, weight at operation, indications for duodenal surgery, and other congenital anomalies. Treatment data collected included operative approach, operative time, and operative technique. Outcome data included length of hospitalization

after operative repair, whether a nasogastric tube was used, time to initial enteral feeding, time to full oral enteral feeding, length of follow-up, and all postoperative complications and/or interventions. In addition, all radiologic examinations were reviewed.

Statistical evaluation performed between the 2 groups consisted of unpaired, 2-tailed Student *t* test for operative times, length of postoperative hospitalization, and time to initial and full oral feedings. Descriptive statistics are listed as mean  $\pm$  SEM.

## 2. Results

Twenty-nine patients underwent repair of a CDO at Children's Mercy Hospital from January 2003 to July 2007. Fourteen patients underwent a traditional open approach, and 15 patients underwent a laparoscopic operation using U-clips for the repair of their CDO. The operative approach was dictated by surgeon preference and experience. U-clip size used was surgeon and patient-weight dependent. In general, an S-60 was used for newborns and an S-70 for children out of the newborn period.

Demographic data between the 2 groups revealed a slight female predominance in the open technique (female-male [9:5]) compared to the laparoscopic group where the distribution was equal (female-male [7:8]). The mean age at the time of operation was similar between the groups with patients in the open group slightly older ( $41.8 \pm 25$  days) than those in the laparoscopic cohort ( $39.9 \pm 28$  days). Correspondingly, weight did not differ significantly between the 2 groups (laparoscopic group,  $3224 \pm 1540$  g vs open group,  $3332 \pm 1690$  g).

Regarding indications for duodenal surgery, there was a nearly identical distribution of duodenal atresias and stenosis/webs between the groups with 11/14 and 11/15 patients undergoing repair of duodenal atresia in open and laparoscopic groups, respectively. The remainder of patients in both groups underwent repair of duodenal stenosis/web. Congenital anomalies were similar between groups and are shown in Table 1.

There was no difference in the anastomotic technique between the groups as all patients with duodenal atresia underwent a standard diamond-shaped duodenoduodenostomy regardless of approach. Regarding the duodenal stenosis/web patients, 2/3 patients in the open group and 2/

**Table 1** Congenital anomalies in the babies undergoing repair of congenital duodenal obstruction

Associated congenital anomaly	Open approach (n = 14)	Laparoscopic approach (n = 15)
Trisomy 13	6	6
Congenital heart disease	4	3
Limb anomalies	1	1
Urinary anomalies	1	1

**Table 2** Mean outcome variables in the babies undergoing repair of congenital duodenal obstruction

Outcome variable	Open approach (n = 14)	Laparoscopic approach (n = 15)	P
Operative time	96.3 min	126.7 min	.06
Length of postoperative hospitalization	20.1 d	12.9 d	.01
Time to initial feeding	11.3 d	5.4 d	.002
Time to full oral intake	16.9 d	9.0 d	.007

4 patients in the laparoscopic group underwent a standard web excision with closure of the duodenum. Patients in both groups that did not undergo web excision underwent a diamond-shaped duodenoduodenostomy.

Outcome variables are listed in Table 2. Operative time was not significantly different between groups ( $P = .06$ ). The length of postoperative hospitalization, time to initial feeding, and time to full oral intake were all statistically shorter in patients undergoing a laparoscopic repair. One patient in each group developed a stenosis at the anastomosis. The patient in the open group underwent an open revision of the duodenoduodenostomy, whereas the patient in the laparoscopic group underwent a balloon dilation of the duodenoduodenostomy via endoscopic gastroduodenoscopy. All patients who underwent a laparoscopic repair of their CDO had an upper gastrointestinal (UGI) contrast evaluation between postoperative days 2 and 11, before initiating feeding. Four patients in the open group underwent UGI contrast studies between postoperative days 6 and 29. All patients had a nasogastric tube in place at the time of operation that was removed at the time of the UGI study (if performed) or at the time of initiating feeding if no UGI evaluation was performed. There were no duodenal leaks in either group.

### 3. Discussion

This report is the largest series describing the laparoscopic approach for repair of CDO. A unique finding of this study is that CDOs can be repaired safely via the laparoscopic approach using U-clips. We feel that the U-clip is especially advantageous in its application for the repair of CDO as it was developed for small anastomoses. U-clips are small circular clips that are delivered on a needle similar to a standard suture. They were initially designed for use in vascular anastomoses and later adapted for intestinal anastomoses [11-13]. We have previously described our operative technique for repair of CDOs using these U-clips [14]. The advantage that U-clips impart for the structure undergoing anastomosis is that there is very little tissue manipulation because of the mechanism by which they are deployed. Once the U-clip has been introduced into the tissue, there is a small deployment area that is squeezed with a forceps or needle driver. This leads to separation of the needle from the U-clip that is then

deployed into a circular configuration approximating the tissue. We believe that this action limiting the tissue damage is created by manipulating the duodenum during laparoscopic suturing and intracorporeal or extracorporeal knot tying of the sutures, thus limiting the risk for postoperative leakage. This seems evident as we did not have any duodenal leaks in the 15 patients undergoing laparoscopic repair. Moreover, U-clips have been shown to result in a patent anastomosis without stricture development [11-13]. In the current study, both the laparoscopic and open approaches had a low incidence of stricture formation (one in each group), suggesting that the use of U-clips is safe with regard to postoperative stricture formation. Finally, we believe that these U-clips may be helpful in performing a laparoscopic CDO repair for a surgeon who may not have performed many advanced laparoscopic operations that involve intracorporeal knot tying. In our current series, the laparoscopic procedures were performed by 4 staff surgeons and 2 pediatric surgical residents, all with varying levels of laparoscopic abilities.

Regarding patient outcomes, we found that the laparoscopic approach for CDO repair resulted in significantly shorter postoperative hospitalization, shorter time to initial feeding, and a shorter time to full oral intake. As has been suggested by multiple authors comparing laparoscopic and open operations, these reductions may be attributed to less inhibition of bowel function and an abbreviated ileus related to the laparoscopic approach when compared to the open operation [15-18]. However, we also suggest an alternative mechanism for these findings. Traditionally, we have used the volume and character of the fluid returned from the nasogastric (NG) tube as an adjunct indication for return of bowel function in patients with CDOs. Historically, it was our practice to remove the NG tube when the daily volumes decreased and were no longer bilious in nature. Often this took weeks to occur. With the development of the laparoscopic approach and the routine use of postoperative UGI contrast studies to evaluate for anastomotic leaks, the NG tubes were removed after the contrast study showed no leak and contrast passed through the anastomosis. In this report, the mean time to NG tube removal for the laparoscopic group was 5 days with initial feeding began, on average, 12 hours later. We were not concerned about the bilious nature of the gastric returns because we had radiologic evidence of an intact and patent anastomosis. In those patients undergoing the traditional open technique, the decision to advance diet was more based on the traditional method of determining

return of bowel function (ie, nasogastric returns). This led to a significant delay in removal of the nasogastric tube and initiation of feeds. This almost certainly contributes to the significant difference in time to initial feeds, full enteral diet, and hospital stay. However, even allowing for a day, difference in NG tube management between the groups does not change the highly statistical difference identified in this study.

As has been previously referenced, the laparoscopic approach almost certainly does offer an advantage over the open approach regarding the shorter hospitalization and return of bowel function [15-18]. However, the change in NG tube management based on the UGI studies also may have contributed to these clinical differences. On the basis of the data in this study, pediatric surgeons should reconsider the current clinical practice of waiting for a significant decrease in gastric output volumes and normalization of the gastric content color (ie, loss of bilious coloration) before removing the NG tube and initiating feeds. It is possible that the NG tube simply suctions material pooling the dilated duodenal bulb across and incompetent pylorus. Our thoughts are that this waiting period probably allows the duodenal dilatation to resolve, thus also resulting in a decrease in NG output, but likely intestinal function has already returned.

A concern may exist for missing a second intestinal atresia during the laparoscopic repair of duodenal atresia. The operating surgeon should not be concerned about the ability to evaluate the remainder of the bowel. Visualization of the distal intestine is outstanding during this operation, and technically evaluating the remaining intestine using the laparoscopic instruments is straightforward. The distal bowel is completely collapsed unless there is a second atresia. The markedly dilated segment between the duodenal atresia and intestinal atresia would be obvious during intestinal evaluation.

Although not statistically significant, the operative time during this study favored the open approach by 30 minutes (96 vs 126 minutes). Although this increase in operative time is probably not clinically relevant, we do feel that this difference will likely improve with more experience. Regardless, we feel that the benefits and superior cosmetic results noted with the laparoscopic approach outweigh the slightly longer operative time.

In summary, this is the largest series reporting the successful repair of CDOs using the laparoscopic approach. In this series, the use of U-clips to perform the anastomosis has been shown to be a simple, reproducible, and reliable technique that can be used by laparoscopic surgeons with a wide range of technical abilities. For this reason, we encourage their use for this condition. The benefits of the laparoscopic approach appear to include an abbreviated hospital stay and faster return to feeds, as well as the superior cosmetic results and avoidance of a painful muscle splitting incision. Finally, we would like to strongly emphasize that for pediatric surgeons not prepared to perform laparoscopic repairs of CDO, the decision to proceed with diet advancement based on the historical methods may

prolong hospitalization. Based on the data presented here, the presence of large volume NG tube output and/or bilious colored gastric return after repair of CDO may not serve as an accurate indicator of duodenal or jejunoileal paresis. On the other hand, if there is truly less duodenal ileus from the laparoscopic approach, this may further support the evidence to use this technique.

## References

- [1] Fonkalsrud EW, DeLorimier AA, Hays DM. Congenital atresia and stenosis of the duodenum: a review compiled from the members of the Surgical Section of the American Academy of Pediatrics. *Pediatrics* 1969;43:79-83.
- [2] Haeusler MC, Berghold A, Stoll C, et al. EUROSCAN Study Group. Prenatal ultrasonographic detection of gastrointestinal obstruction: results from 18 European congenital anomalies registries. *Prenat Diagn* 2002;22:616-23.
- [3] Girvan DP, Stephens CA. Congenital intrinsic duodenal obstruction: a twenty-year review of its surgical management and consequences. *J Pediatr Surg* 1974;9:833-9.
- [4] Webb CH, Wangenstein OH. Congenital intestinal atresia. *Am J Dis Child* 1931;41:262-4.
- [5] Grosfeld JL, Rescorla FJ. Duodenal atresia and stenosis: reassessment of treatment and outcome based on antenatal diagnosis, pathologic variance, and long-term follow-up. *World J Surg* 1993; 17:301-9.
- [6] Escobar MA, Ladd AP, Grosfeld JL, et al. Duodenal atresia and stenosis: long-term follow-up over 30 years. *J Pediatr Surg* 2004;39:867-71.
- [7] Rothenberg SS. Laparoscopic duodenoduodenostomy for duodenal obstruction in infants and children. *J Pediatr Surg* 2002;37:1088-9.
- [8] Bax NM, Ure BM, van der Zee DC, et al. Laparoscopic duodenoduodenostomy for duodenal atresia. *Surg Endosc* 2001;15:217.
- [9] Frantizides CT, Madan AK, Gupta PK, et al. Laparoscopic repair of congenital duodenal obstruction. *J Laparoendosc Adv Surg Tech A* 2006;16:48-50.
- [10] Holcomb III GW, Rothenberg SS, Bax KM, et al. Thoracoscopic repair of esophageal atresia and tracheoesophageal fistula: a multi-institutional analysis. *Ann Surg* 2005;242:422-8.
- [11] Lin PH, Bush RL, Nelson JC, et al. A prospective evaluation of interrupted nitinol surgical clips in arteriovenous fistula for hemodialysis. *Am J Surg* 2003;186:625-30.
- [12] Wolf PK, Alderman EL, Caskey MP, et al. Clinical and six-month angiographic evaluation of coronary arterial graft interrupted anastomoses by use of a self-closing clip device: a multicenter prospective clinical trial. *J Thorac Cardiovasc Surg* 2003;126:168-78.
- [13] Tirabassi MV, Banever GT, Moriarty KP, et al. Feasibility of thoracoscopic U-clip esophageal anastomosis: an alternative for esophageal atresia reconstruction. *J Pediatr Surg* 2004;39:851-4.
- [14] Valusek PA, Spilde TL, Tsao K, et al. Laparoscopic duodenal atresia repair using surgical U-clips—a novel technique. *Surg Endosc* 2007;21:1023-4.
- [15] Salimath J, Jones MW, Hunt DL, et al. Comparison of return of bowel function and length of stay in patients undergoing laparoscopic versus open colectomy. *J S L S* 2007;11:72-5.
- [16] Ostlie DJ, St Peter SD, Snyder CL, et al. A financial analysis of pediatric laparoscopic versus open fundoplication. *J Laparoendosc Adv Surg Tech A* 2007;17:493-6.
- [17] Yau KK, Tang CN, Yang GP, et al. Laparoscopic versus open appendectomy for complicated appendicitis. *J Am Coll Surg* 2007; 205:60-5.
- [18] Clinical Outcomes of Surgical Therapy Study Group. A comparison of laparoscopically assisted and open colectomy for colon cancer. *N Engl J Med* 2004;350:2050-9.