Original Article

Single-Incision Open versus Laparoscopic Gastrostomy in Infants: A Comparative Study

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Abstract

Background: Gastrostomy tube can be inserted through a single incision without laparoscopic or endoscopic guidance. The superiority of this approach over the laparoscopic technique is still debated. Therefore, we aimed to compare single-incision open and laparoscopic gastrostomy in infants. **Materials and Methods:** We retrospectively reviewed paediatric patients aged 12 months or less who required enteral feeding between 2006 and 2019. Patients were grouped according to the technique into two groups. Group 1 ($n = 42$) included patients who had a single incision open gastrostomy, and Group 2 ($n = 45$) included patients who underwent laparoscopic gastrostomy. **Results:** The median age was 2 months (Q1-Q3: 1–4 months) in Group 1 and 5 months (3–6 months) in Group 2 ($P < 0.001$). Male presented 52.38% in Group 1 and 37.78% in Group 2 ($P = 0.17$). There were no differences in cardiac and neurological comorbidities between the groups. Operative time was significantly shorter in Group 1 (23 [20–25] vs. 40 [35–45] min; $P < 0.001$). There were no differences in the post-operative leak around the tube ($P > 0.99$), granulation tissue formation ($P = 0.36$), wound dehiscence ($P = 0.61$), surgical site infection ($P > 0.99$) and pneumonia ($P = 0.10$) between the groups. **Conclusion:** Single-incision open and laparoscopic gastrostomy could be effective and safe techniques in infants. The minimal anaesthesia without gas insufflation and short time for the open gastrostomy make it not inferior to laparoscopic gastrostomy and should be considered in small infants.

Keywords: Gastrostomy, laparoscopy, single-incision gastrostomy

Introduction

Several gastrostomy tube insertion techniques were described, and minimally invasive approaches have become more popular recently.[1-3] Gastrostomy tube feeding is a common surgical procedure in children,[4] and it is indicated if supplementary enteral feeding is required for more than 2 or 3 weeks.[5] Several clinical conditions require prolonged enteral feeding and subsequently gastrostomy tube insertion, such as renal, cardiac, neurological, metabolic and pulmonary disorders, in addition to oesophageal obstruction.[6]

Percutaneous endoscopic, image-guided, laparoscopic or open surgical techniques may all be used to place a gastrostomy tube in paediatric patients. Before Gauderer and colleagues introduced percutaneous endoscopic gastrostomy (PEG) in 1980, the open technique was standard.[7] However, several complications for PEG were reported, such as blind puncture of the stomach and the possibility of damaging the colon or small intestine.[8,9] These complications are infrequent with laparoscopic insertion. Moreover, PEG has restrictions related to age and weight and is not possible in oesophageal obstruction.[10]

A single-incision gastrostomy under local anaesthesia with sedation can be performed without laparoscopic or endoscopic guidance. The superiority of this approach over the laparoscopic technique is a subject of ongoing debate. Therefore, we aimed to compare single-incision open and laparoscopic gastrostomy in neonates and infants.

Materials and Methods

Design and patients

We retrospectively reviewed 194 paediatric patients aged 12 months or less who required enteral feeding between

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January 2006 and December 2019. Infants who underwent PEG insertion were excluded (n = 107). Forty-two patients underwent a single-incision gastrostomy, and 45 patients had laparoscopic gastrostomy. The local Institutional Review Board approved the data collection for this study, and the consent to participate was waived because of the retrospective design.

Data and endpoints

We collected the patients' gender, age and weight at the time of the procedure and the associated comorbidities. The primary outcome was the operative time. Secondary outcomes were major complications (perforation, intestinal leak or obstruction and peritonitis) and minor complications (wound infection, tube dislodgment, stenosis, incidental removal or pulling out, leak and granulation tissue formation around the tube). The median duration of follow-up was 27 months (11–49 months) in Group 1 and 24 months (9–46 months) in Group 2.

Operative techniques

Laparoscopic gastrostomy

Under general anaesthesia, the optimal location for gastrostomy tube insertion was marked in the left paramedian plan 2 cm below the costal margin. We insufflated carbon dioxide in the abdomen through a small umbilical incision; then inserted a 5-mm trocar and laparoscope. An orogastric tube was inserted to decompress the stomach. We made an incision in the left upper quadrant as previously demarcated, through which a 5-mm trocar was introduced. The gastrostomy tube was placed near the greater curvature in the dependent portion of the stomach and away from the pylorus.

We pulled the stomach with an atraumatic grasper and brought it toward the anterior abdominal wall under direct vision. We used absorbable sutures to fix the stomach to the fascia in four quadrants. Sharp dissection or cautery was used to perform a gastrostomy inside an absorbable purse-string suture. Then, the gastrostomy tube was introduced into the stomach, and the balloon was inflated. The laparoscope was used to confirm the position of the tube. At the end of the procedure, the umbilical incision was closed, and dressings were applied.

Single-incision open gastrostomy

Local anaesthesia with sedation or general anaesthesia was used for this approach. We used the muscle splitting technique to make a mini-transverse incision (1–2 cm) in the left upper quadrant through the rectus muscle. The greater curvature of the stomach was taken to the anterior abdominal wall by pulling the great omentum. We injected 20 cc air into a nasogastric catheter to make the stomach clear in case we had trouble bringing the greater curvature to the anterior abdominal wall. The gastrostomy tube was inserted through an incision in the middle of a purse-string suture. We fixed the stomach around the gastrostomy tube to the posterior rectus sheet at four quadrants. Then, the wound was closed in layers.

Statistical analysis

Binary and ordinal data were described as frequencies (percentages) and compared with Chi-square or Fisher's exact test when appropriate. A normality test was performed for continuous data, and non-normal data were presented as median (Q1-Q3) and compared using the Mann–Whitney test. Time-to-event variables were compared using the log-rank test. Statistical significance was described as $P < 0.05$. All of the analyses were carried out using STATA 16 (STATA Corp., College Station-TX-USA).

Results

Baseline data

We grouped the patients into two groups. Group 1 included patients who had open gastrostomy (n = 42), and Group 2 included patients who had a laparoscopic gastrostomy (n = 45). Patients in Group 1 were younger ($P < 0.001$) and had lower body weight ($P < 0.001$). Five patients (11.9%) in Group 1 had oesophageal atresia. Pre-operative demographics and clinical data are compared in Table 1.

Table 1: Pre-operative demographics and clinical data

	Group 1 (n=42), n (%)	Group 2 (n=45), n (%)	P
Male	22 (52.38)	17 (37.78)	0.17
Age (months)	2 (1-4)	5 (3-6)	<0.001
Weight (kg)	2.89 (2.5-3.8)	5 (4.5-5.3)	<0.001
Saudi nationality	40 (95.24)	43 (95.56)	>0.99
ASA physical class			
I	1 (2.38)	0	0.56
II	19 (45.24)	16 (35.56)	
III	17 (40.48)	23 (51.11)	
IV	5 (11.9)	6 (13.33)	
Oesophageal atresia	5 (11.9)	0	0.02
Neurological disease	17 (40.48)	24 (53.33)	0.23
Cardiac disease	10 (23.81)	5 (11.11)	0.16

Binary and ordinal data were presented as number and percentage and continuous data as median (Q1–Q3). ASA: American Society of Anesthesiologists

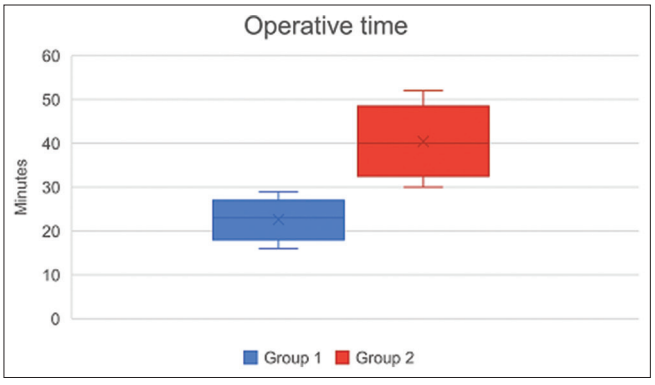


Figure 1: Box plot of the operative time

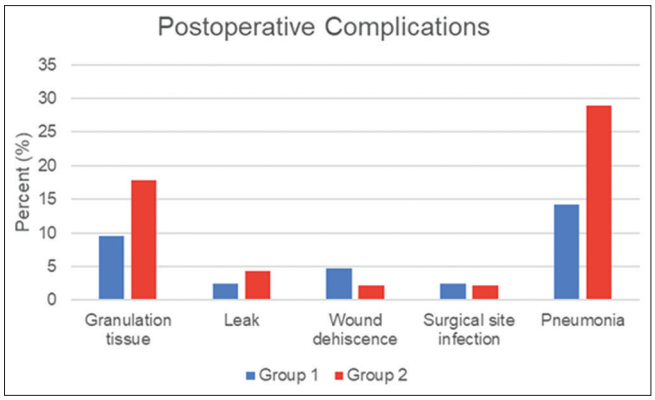


Figure 2: Post-operative complications

Table 2: Operative and post-operative data

	Group 1 ($n=42$), n (%)	Group 2 ($n=45$), n (%)	P
Operative time (min)	23 (20-25)	40 (35-45)	<0.001
Granulation tissue formation	4 (9.52)	8 (17.78)	0.36
Leak around the tube	1 (2.38)	2 (4.44)	>0.99
Wound dehiscence	2 (4.76)	1 (2.22)	0.61
Surgical site infection	1 (2.38)	1 (2.22)	>0.99
Pneumonia	6 (14.29)	13 (28.89)	0.10

Binary and ordinal data were presented as number and percentage and continuous data as median (Q1-Q3)

Table 3: Comparison between the single-incision and the laparoscopic gastrostomies

	Single-incision gastrostomy	Laparoscopic gastrostomy
The need of general anaesthesia to perform the procedure	Can be done under local anaesthesia with sedation	Yes
Cost (USD)	700-1334	2131
Suture the stomach to posterior abdominal wall	Yes	Yes
Invasiveness, number and size of the abdominal incisions	1 incision (1-2 cm)	2 incision (0.5-1 cm)
Need to create pneumoperitoneum	No	Yes
Number of wounds (possibility of surgical site infection)	1	2
Number of scars (cosmesis)	1	2
The need for OR and general anaesthesia to change the gastrostomy tube	No	No
Procedure done under direct vision, no blind puncture	Yes	Yes

Operative outcomes

The primary endpoint was the operative time. Operative time was significantly shorter in Group 1 ($P < 0.001$) [Figure 1]. Enteral feeding was resumed within 5 days in both the groups (median 5 Q1-Q3 percentiles: 3–7 in Group 1 and 5 [3–9] in Group 2; log-rank $P = 0.73$). Secondary endpoints were the post-operative complications. There were no differences in the post-operative complications between the groups [Table 2]. We did not report major complications in both the groups [Figure 2].

Discussion

Tube gastrostomy is a common surgical procedure in paediatric patients.[11] There is no consensus on the optimal approach for its insertion, the devices used or methods of gastropexy. PEG has a short operative time and small incision; however, it is associated with major complications. In addition, it cannot be performed in small babies and those with oesophageal obstruction. Therefore, single-incision gastrostomy has replaced PEG with shorter operative time, lower post-operative pain and a smaller incision.[12]

The PEG tube has an internal retention bumper rather than a balloon with a minimum available size in Saudi Arabia of 14 Fr. These characteristics limit its use in neonates and paediatric patients with a body weight of <5 Kg.[13] In addition, there are limited data on its use in patients under 1 year old; therefore, it is not the preferred method of gastrostomy tube insertion in this age group.[14,15] Moreover, oesophageal perforation during PEG insertion was reported in infants.[16] The single-incision and laparoscopic gastrostomies combined the simplicity of PEG in addition to the higher safety profile.

In a meta-analysis by Suksamanapun and colleagues, laparoscopic gastrostomy was found to have a lower risk profile than PEG. The better surgical visualisation, which helps avoid intestinal perforation and enables early identification and treatment of other complications, was the cause of the fewer complications identified with laparoscopic gastrostomy.[17] Furthermore, laparoscopic gastrostomy was associated with shorter surgery and lower post-operative pain.[18,19]

It is assumed that gastrostomy is associated with an increased rate of post-operative gastro-oesophageal reflux, and subsequent Nissen fundoplication may be required. In a report by Aprahamian *et al*.,[20] 24% needed fundoplication after gastrostomy. Another advantage of laparoscopic gastrostomy is the feasibility to perform concomitant fundoplication in some patients if required, and it can be performed later without taking down the gastrostomy tube.[21,22] Despite these benefits of laparoscopic gastrostomy, the procedure has disadvantages such as lack of triangulation and instrument crowding.[23-25]

We did not report major complications such as colonic perforation or organ injury in our patients. The overall reported complication rate is comparable to the literature, ranging from 3% to 60%.[6] The wide variability of the complication rate could be attributed to the use of different gastrostomy techniques. On the other hand, Kim and colleagues compared the outcomes of endoscopic, laparoscopic and open gastrostomies and found no major differences.[26]

Single-incision open gastrostomy can be performed in the intensive care unit under local anaesthesia and sedation with short operative time. The technique has the advantage of

direct visualisation, the use of simple equipment and avoiding the use of endoscopy. Furthermore, fixation of the stomach to the anterior abdominal wall permits early adherence and prevents leakage around the tube. Other advantages include avoiding radiological control and the low learning curve. The technique could be cost-effective by reducing the cost of using laparoscopic equipment and the operating room with the potential to start feeding within 24 h of the procedure. Comparison of the single-incision gastrostomy versus laparoscopic gastrostomy is presented in Table 3.

Dehiscence can occur after any gastrostomy, and we found no difference in wound dehiscence rates between groups. The risk of gastric content leakage and peritonitis is low with single-incision gastrostomy. This low risk is attributed to the fixation of the stomach to the inner layer of the rectus sheath, and it does not require adhesion formation as with other approaches.[27-29] In our cohort, there were no cases of intestinal leakage or peritonitis.

Strength and limitations

The retrospective nature of this study and the small sample size restricted the interpretation of the results. A lack of a structured patient recruitment procedure was also present. However, the study found that single-incision open gastrostomy is a simple procedure that eliminates the need for endoscopy or laparoscopy, especially in very small neonates. Future research with a larger sample size and better selection criteria is warranted.

Conclusion

Single-incision open and laparoscopic gastrostomy could be effective and safe techniques in infants. The minimal anaesthesia without gas insufflation and short time for the open gastrostomy make it not inferior to laparoscopic gastrostomy and should be considered in small infants.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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