Conversion to Gastrojejunostomy Tubes in Developmentally Disabled Children Intolerant to Gastrostomy Tube Feeding

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ABSTRACT

This study retrospectively evaluated the safety, impact on growth, and clinical outcomes of gastrojejunostomy tubes (GJTs) converted from surgically placed gastrostomy tubes (GTs) in 44 developmentally disabled children (median age: 28 months). The total duration of GJT follow-up was 31,378 device-days (median: 643 device-days). Three major complications (aspiration pneumonia) were identified in 3 patients (6.8%), 63 minor complications in 31 patients (70.5%), and 202 tube maintenance issues (TMIs) in 41 patients (93.2%). A significantly increased average change in weight-for-age *z*-scores was observed at each 6-month interval that continued past 25 months. Patients above the median rate of TMIs had marginally significant lower *z*-scores across the study period ($P = 0.06$), compared with those below the median rate. GJTs were removed in 6 patients (13.6%) because of adequate oral intake at last follow-up. Conversion from GTs to GJTs was a viable option to achieve sustained growth in developmentally disabled children. Frequency of TMIs may negatively impact their growth.

Key Words: complications, developmentally disabled, gastrojejunostomy tube, growth, intolerance

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What Is Known

- Gastrojejunostomy tubes are a viable postpyloric feeding option for developmentally disabled children intolerant to gastrostomy tube feedings, which can be an alternative to anti-reflux surgery.
- There are many complications and tube maintenance issues associated with gastrojejunostomy tubes.

What Is New

- Gastrojejunostomy feeding tubes offer continued significant growth past 25 months in developmentally disabled children intolerant to gastrostomy tube feedings.
- The rate of minor complications did not significantly impact the growth in this population.
- The rate of tube maintenance issues may negatively impact the growth in this population.

Gastrostomy tubes (GTs) are frequently used for nutritional support in developmentally disabled children who are unable to meet their dietary needs with oral intake. In some children with neurologic impairment, use of a GT is not indicated because of their underlying gastroesophageal reflux (GER) or gastrointestinal dysmotility leading to secondary reflux (1–5). The alternative to GTs has historically been a fundoplication with simultaneous gastrostomy. This approach, however, has been associated with a high rate of postoperative complications (6). Gastrojejunostomy tubes (GJTs) have been reported to be useful in children who require postpyloric feeding, such as those with severe GER, delayed gastric emptying, gastric outlet or duodenal stenosis, or altered upper gastrointestinal anatomy (7). No guidelines currently exist that provide specific recommendation regarding the use of fundoplication with gastrostomy versus GJTs (8). This is in part because of the limited long-term data on weight-for-age growth in children with use of GJTs. The aim of our study was to retrospectively investigate the safety of GJTs, their impact on growth, and long-term clinical outcomes in developmentally disabled children whose enteral nutrition was provided through GJTs.

METHODS

A total of 44 developmentally disabled children (median age: 28 months) who underwent successful conversion of a surgically placed GT to a GJT between January 1, 2009 and June 30, 2015 were included in the study. All conversion procedures were performed by interventional radiologists. Either a Mic-key low profile GJT (Kimberley-Clark, Roswell, GA) or a G-JET button (Applied Medical Technology, Brecksville, OH) varying in size (12–18 French, 14– 45 cm) was used. The most common indication for conversion of a GT to a GJT was GER (n = 21) and the most common clinical condition was neurologic (n = 28). (The detail of the patient's characteristics is available online as Supplemental Digital Content 1, *http://links.lww.com/MPG/B652*.) Their GJ tube feeding regimens were determined by a nutritionist based upon their target growth velocities between follow-up appointments. The

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patients' weight-for-age *z*-scores based on the 2000 Centers for Disease Control and Prevention (CDC) Growth Charts (9) were recorded at each appointment.

The patients' electronic medical records and imaging studies were reviewed to record GJT-related complications and tube maintenance issues (TMIs), weight-for-age *z*-scores and clinical outcomes. GJT-related complications were classified as minor or major according to the Society of Interventional Radiology clinical practice guidelines (10). TMIs included retraction, blockage of any lumen of the tube, dislodgment, leakage, balloon malfunction, damage to the outer part of the tube, and cracking of the tube. The duration of GJT follow-up was defined as time from the date of GJT placement to the date of GJT removal, the date of the patient's death while the GJT was in place, or the date of the most recent follow-up visit with GJT in place. This was recorded as device-days. A repeated-measures regression model was used to evaluate the average change in weight-for-age *z*-scores from the time of GJT insertion to each 6-month interval. If a patient had multiple follow-up visits during a particular 6-month interval, only the *z*-score at the last visit in the interval was used for the calculation. SPSS Version 22 (IBM Corporation, Armonk, NY) was used for statistical analysis. P values of <0.05 were considered statistically significant.

RESULTS

The total duration of GJT follow-up was 31,378 device-days (median: 643 device-days).

Safety of Gastrojejunostomy Tubes

Major and Minor Complications

There were no conversion procedure-related complications and the 30-day mortality rate was zero. Major and minor complications are summarized in Table 1. The major complications of aspiration pneumonia, 1 early and 2 late, occurred in 3 patients (6.8%). One patient who had aspiration pneumonia 7 days after GJT placement was found to have the tube retracted into the stomach. The tube location was normal in the remaining 2 patients. There were 63 minor complications, 14 early and 49 late, which occurred in 31 patients (70.5%). The median rate of minor complications was 0.20/100 device-days. The most frequent early minor complication was vomiting related to GJT feeding (n = 6) followed by feeding intolerance (n = 4) and peristomal infection (n = 4). The most frequent late minor complication was site erythema (n = 18), which usually required adjustment of the stoma length of the tube, followed by vomiting related to GJT feeding (n = 12), feeding intolerance (n = 9), and abdominal pain (n = 9).

TABLE 1. Major/minor complications and tube maintenance issues

Type	Early (n = 50)	Late (n = 218)
Major complication		
Aspiration pneumonia	1 (2.0)	2 (0.9)
Minor Complication	14 (28.0)	49 (22.5)
Site erythema	3 (6.0)	18 (8.3)
Vomiting	6 (12.0)	12 (5.5)
Abdominal pain	3 (6.0)	9 (4.1)
Feeding intolerance	4 (8.0)	9 (4.1)
Bleeding	1 (2.0)	7 (3.2)
Peristomal infection	4 (8.0)	6 (2.8)
Granulation	0 (0.0)	4 (1.8)
Other issues*	0 (0.0)	3 (1.4)
Tube maintenance issue	35 (70.0)	167 (76.6)
Dislodgement	19 (38.0)	58 (26.6)
Leakage	1 (2.0)	40 (18.3)
Balloon malfunction	4 (8.0)	26 (11.9)
Blockage of any lumen	9 (18.0)	24 (11.0)
Retraction	9 (18.0)	23 (10.6)
Stomach (coiling)	7 (14.0)	11 (5.0)
Duodenum	2 (4.0)	11 (5.0)
Esophagus	0 (0.0)	1 (0.5)
Damage to outer tube	0 (0.0)	15 (6.9)
Other issue†	0 (0.0)	8 (3.7)
Cracked tube	1 (2.0)	1 (0.5)

Values are presented as number (percent column total).
*Dehydration, prolapsed around tube site, and blistering around tube site.
†Three with unspecified, 3 tube size too small, 1 trichobezoar, 1 formula backflows.

Tube Maintenance Issues

TMIs are summarized in Table 1. There were 202 TMIs, 35 early and 167 late, which occurred in 41 patients (93.2%). The median rate of TMIs was 0.64/100 device-days. The most frequent early TMI was dislodgment (n = 19) followed by retraction into the stomach or duodenum (n = 9) and blockage of either jejunal or gastric lumen (n = 9). The most frequent late TMI was dislodgment (n = 58) followed by leakage (n = 40) and balloon malfunction (n = 26). Almost all TMIs required a tube exchange or replacement by interventional radiologists.

Impact on Growth

At the time of conversion from a GT to a GJT, the average weight-for-age *z*-score of all patients was −3.18, which reflected severe malnutrition (11). The average changes in weight-for-age *z*-scores at 6-month intervals compared with patients' baseline at time of GJT insertion are summarized in Table 2. A significantly increased average change in weight-for-age z-scores at each 6-month interval was observed; +0.81 at 1 to 6 months ($P < 0.001$), +1.28 at 7 to 12 months ($P < 0.001$), +1.22 at 13 to 18 months ($P = 0.001$), +1.16 at 19 to 24 months ($P = 0.01$), and +1.39 past 25 months ($P = 0.01$). The average weight-for-age *z*-score of all patients at last follow-up was −1.91. Patients whose rate of minor complications were above the median rate of minor complications (0.20/100 device-days) did not show a significantly lower average change in weight-for-age *z*-scores (+0.60, 95% confidence interval (CI): −0.94 to 2.15, $P = 0.44$) across the study period, compared with those below the median rate. However, patients whose rate of TMIs was above the median rate of TMIs (0.64/100 device-days) showed a marginally lower average change in weight-for-age *z*-scores (−1.50, 95% CI: −3.06 to 0.05 $P = 0.06$) across the study period, compared with those below the median rate.

Clinical Outcomes

Of all 44 patients, 16 (36.4%) were switched back to GTs; 6 patients (13.6%) because of regaining tolerance to oral intake and 10 patients (22.7%) because of GJT issues. All the 6 patients who regained tolerance to oral intake eventually removed their GTs. The GJT issues in the 10 patients included guardian's request for discontinuing the GJT (n = 2), GJT intolerance (n = 1), and frequent TMIs (n = 7). Of the 7 patients converted back to GTs because of frequent TMIs, 3 patients had a GT at the end of the study period and 4 patients were eventually reconverted back to a GJT because of intolerance to GT feedings. At last follow-up, 32 patients (72.7%) were still using their GJTs for feeding. Two patients were deceased because of their underlying disease.

TABLE 2. Impact on growth

Variable		Change in average weight-for-age *z*-score	*P*-value	95% CI*
Time†	Number of individuals			
Insertion	43	Reference	–	–
1–6 months	33	0.81	<0.001	0.38–1.25
7–12 months	31	1.28	<0.001	0.68–1.87
13–18 months	26	1.22	0.001	0.49–1.96
19–24 months	16	1.16	0.01	0.25–2.07
25+ months	18	1.39	0.01	0.38–2.40
Minor complications/100 days				
Below median		Reference	–	–
Above median		0.60	0.44	−0.94–2.15
TMIs/100 days				
Below median		Reference	–	–
Above median		−1.50	0.06	−3.06–0.05

*CI = confidence interval; TMIs = tube maintenance issues.
†Last measure in time period was used for each participant.

DISCUSSION

One issue when reporting complications related to GJTs is that there is no universal reporting guidelines or definitions of the major or minor complications that researchers can follow. Aspiration pneumonia observed in 3 patients was classified as a major complication as it required prolonged hospitalization (>48 hours) (10). However, this could be classified as a TMI in another study when aspiration pneumonia occurred secondary to tube retraction to the stomach (which was seen in 1 patient). Likewise, aspiration pneumonia in patients with an appropriately positioned GJT (which was seen in 2 patients) may be reported separately from major complications as it is less likely related to a GJT. In addition, even if complications, such as tube site bleeding or feeding intolerance were classified as minor in this study (as they do not require hospitalization), these complications may not be minor to the patients or families. Despite this issue, our study has shown the safety of conversion of a GT to a GJT and GJT feedings as evidenced by no procedure-related complications and zero mortality related to GJT feedings. No other major complications other than aspiration pneumonia were observed. This significantly contrasts with other studies that reported a variety of major compilations, such as peritonitis or deep wound infection (8), which is likely related to the use of an established gastrostomy tract for GJT placement in our study. Notably, minor complications occurred in 70.5% of our patients at a rate of 0.20 events/100 device-days. Reported incidences of minor complications significantly vary (3,5,6,12). This is mainly because of difference in definition of minor complications as some authors classified TMIs as minor complications.

In accordance with previous reports (1,2,6,13–15), TMIs were quite common in our study and occurred in 93.2% of our study population. On average, 2.34 GJT manipulations were required per year in our study, which is within the reported range from 1.68 to 4.6 manipulations per year (6,15,16). Most TMIs required an exchange or replacement of GJTs by interventional radiologists. TMIs are quite onerous on patients and their caregivers as they necessitate frequent hospital visits or admissions. Because of the high frequency of TMIs, several authors have concluded that GJTs are not suitable for long-term use and should be used as a temporary measure until children gain tolerance to gastric feeding or surgical intervention is undertaken (2,13). However, some patients in our study had no alternatives to long-term GJT feedings because of their high surgical risk. The most frequent TMI was tube dislodgement constituting 38% of all TMIs in our study, which is also similar to other reports (2,6,13). Some events of dislodgement may be preventable with proper instructions for use to the caregivers and routine check of the anchoring balloon at each clinical visit. A better and more reliable system to secure GJTs is awaited as such a system could significantly decrease hospital visits.

Studies investigating growth outcomes from long-term GJT feedings are scarce (2,13). Our study has shown a significantly increased average change in weight-for-age *z*-scores ranging from +0.81 to +1.39 at each 6-month interval that continued past 25 months. Michaud et al (13) reported that 15 of 29 patients (51.7%) with GJTs had growth improvement with a mean weight-for-age *z*-score changing from −1.49 at GJT insertion to −0.07 at last follow-up. Although their average change in weight-for-age *z*-score was significant, their duration of follow-up was not reported. Notably, there was a marginal negative impact of frequency of TMIs on an average change in weight-for-age *z*-scores across the study period. This observation would underscore importance in prevention of TMIs.

In our study, 12 patients (27.2%) had their GJTs switched back to GTs at last follow-up, 6 of whom (13.6%) were able to remove GTs because of their regained tolerance to oral intake. A subset of patients who spontaneously regained tolerance to gastric feeding and eventually had their feeding tubes removed has been reported with the incidence ranging from 7.3% to 30% (6,14,15). Given the drawbacks of GJTs causing frequent minor complications and TMIs, GJTs would be best utilized for this subset of patients who eventually regain tolerance to gastric feeding.

Our study limitations stem from its retrospective nature at a single academic medical center and the relatively small sample size. Patients' feeding regimens were not standardized across the patient population as they were based upon the patients' own caloric needs between visits. The weight-for-age *z*-scores were not recorded at set intervals as patients did not have a predetermined follow-up schedule with their pediatrician or pediatric gastroenterologist. It is also important to mention that the underlying developmental disability in our population was diverse, which may have impacted their growth outcomes.

In summary, conversion from GTs to GJTs in developmentally disabled children intolerant to GT feedings was safe and a viable option to achieve their sustained growth. The drawbacks of GJTs are their high rates of minor complications and TMIs, which could be the limitation for the long-term use. Given the possible negative impact of frequent TMIs on their growth, proper instructions for use of GJTs

to patients' caregivers is crucial and more durable GJTs associated with less TMIs are awaited.

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REFERENCES

1. Fortunato JE, Darbari A, Mitchell SE, et al. The limitations of gastrojejunal (G-J) feeding tubes in children: a 9-year pediatric hospital database analysis. *Am J Gastroenterol* 2005;100:186–9.
2. Godbole P, Margabanthu G, Crabbe DC, et al. Limitations and uses of gastrojejunal feeding tubes. *Arch Dis Child* 2002;86:134–7.
3. Mathus-Vliegen EM, Koning H, Taminiau JA, et al. Percutaneous endoscopic gastrostomy and gastrojejunostomy in psychomotor retarded subjects: a follow-up covering 106 children years. *J Pediatr Gastroenterol Nutr* 2001;33:488–94.
4. Doede T, Faiss S, Schier F. Jejunal feeding tube via gastrostomy in children. *Endoscopy* 2002;34:539–42.
5. Friedman JN, Ahmed S, Connolly B, et al. Complications associated with image-guided gastrostomy and gastrojejunostomy tubes in children. *Pediatr* 2004;114:458–61.
6. Wales PW, Diamond IR, Dutta S, et al. Fundoplication and gastrostomy versus image-guided gastrojejunal tube for enteral feeding in neurologically impaired children with gastroesophageal reflux. *J Pediatr Surg* 2002;37:407–12.
7. Crowley J, Hogan M, Towbin R, et al., Society of Interventional Radiology Standards of Practice Committee; Society for Pediatric Radiology Interventional Radiology Committee. Quality improvement guidelines for pediatric gastrostomy and gastrojejunostomy tube placement. *J Vasc Interv Radiol* 2014;25:1983–91.
8. Livingston MH, Shawyer AC, Rosenbaum PT, et al. Fundoplication and gastrostomy versus percutaneous gastrojejunostomy for gastroesophageal reflux in children with neurologic impairment: a systematic review and meta-analysis. *J Pediatr Surg* 2015;50:707–14.
9. Flegal KM, Cole TJ. Construction of LMS parameters for the Centers for Disease Control and Prevention 2000 growth charts. *National Health Statistics Report* 2013;63:1–3.
10. Sacks D, McClenny TE, Cardella JF, et al. Society of Interventional Radiology Clinical Practice Guidelines. *J Vasc Interv Radiol* 2003;14 (9 Pt 2):S199–202.
11. Becker P, Carney LN, Corkins MR, et al. Consensus statement of the Academy of Nutrition and Dietetics/American Society for Parenteral and Enteral Nutrition: indicators recommended for the identification and documentation of pediatric malnutrition (undernutrition). *Nutr Clin Pract* 2015;30:147–61.
12. Greenberg SB. Placement of a gastrojejunal tube system with a weighted distal end in children with surgical gastrostomies. *Ped Radil* 1994;24:173–4.
13. Michaud L, Coopman S, Guimber D, et al. Percutaneous gastrojejunostomy in children: Efficacy and safety. *Arch Dis Child* 2012;97:733–4.
14. Al-Zubeidi D, Demir H, Bishop WP, et al. Gastrojejunal feeding tube use by gastroenterologist in a pediatric academic center. *J Pediatr Gastroenterol Nutr* 2013;56:523–7.
15. Campwala I, Perrone E, Yanni G, et al. Complications of gastrojejunal feeding tubes in children. *J Surg Res* 2015;199:67–71.
16. Raval MV, Phillips JD. Optimal enteral feeding in children with gastric dysfunction: surgical jejunostomy vs image-guided gastrojejunal tube placement. *J Pediatr Surg* 2006;41:1679–82.