



Modified open technique for laparoscopic gastrostomy tube placement results in more leakage post operatively than Seldinger technique



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ABSTRACT

Background: Laparoscopic gastrostomy tube (GT) placement is a common procedure and frequent cause of morbidity. Some surgeons perform a Seldinger technique (ST), while others perform a modified open technique (MOT). We hypothesized that the modified open technique would result in more complications.

Methods: A prospective study of primary GT placed 12/2016–06/2018, ensuring at least 6 months follow up. We assessed any episode of granulation tissue, troublesome leaking, tube dislodgment, and infection requiring antibiotic or drainage.

Results: 92 GT were placed, with 56 were placed as modified open (60.9%). 34 children (37.0%) developed granulation tissue, 18 children (19.6%) experienced tube dislodgment, and 6 children (6.5%) developed a site infection, with no difference depending on technique ($P = 0.56$, 0.29 , and 0.76 , respectively). Following ST, 2 children developed leakage (5.6%), whereas 15 children (26.8%) had leakage following the MOT ($P = 0.01$).

Conclusion: MOT resulted in significantly more leaks. Other complications were similar between groups. Surgeons choosing MOT should be mindful of the size of gastrostomy at time of surgery, as this may result in increased complications.

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1. Introduction

Laparoscopic gastrostomy tube (GT) placement is a common procedure performed by pediatric surgeons.¹ Infants and children may require long-term feeding access for many indications, including failure to thrive and neurologic injuries.² Meanwhile, GT is also a frequent cause of morbidity, due to dislodgment, granulation tissue, leaking, and infection. Complications stemming from gastrostomy tube placement result in increased resource utilization, with a need for clinic, hospital, and emergency department visits. Given that GT placement is a high volume procedure with frequent complications, optimizing gastrostomy tube placement technique has the possibility of improving care delivery.^{3,4}

Laparoscopic gastrostomy tube placement can be performed in the majority of infants and children. It offers several advantages of percutaneous and open techniques, including improved visualization of the stomach and the ability to place a primary button, and small incisions allowing for improved postoperative pain control and cosmesis. The most common variations of technique for placement of a laparoscopic gastrostomy tube in children are a modified open technique (MOT) and a Seldinger technique (ST) with sequential dilation. The MOT allows for direct placement of the GT into the stomach, and includes suturing the stomach to the rectus sheath with semipermanent suture. With ST, the gastrostomy tract through the skin and stomach is enlarged over a wire, and generally stitches are placed through skin and stomach to temporarily secure the tube to the skin.

While several studies have examined this issue, they have generally included very heterogeneous groups, complicating any analysis.⁵ At our institution, each surgeon performs one of these two types of laparoscopic gastrostomy tube placement. Given the

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similarity of surgical technique between the two camps of surgeons within our institution, we wished to compare complications between procedures. We hypothesized that there would be a correlation between the two techniques utilized for laparoscopic GT placement and the common complications of gastrostomy tubes such as granulation tissue, dislodgement, infection, and leakage around the tube.

2. Methods

We retrospectively queried a billing database for gastrostomy tubes placed by surgeons from 12/2016–06/2018, as well as used a prospectively collected database of GT placed at our institution from 02/2017–06/2018. Inpatient, emergency department, and outpatient (both pediatric surgery and pediatric gastroenterology clinic) records were reviewed to assess any episode of granulation tissue requiring silver nitrate treatment, leaking around gastrostomy tube, tube dislodgment, and infection requiring antibiotic, antifungal or drainage. Leaking had to be specifically noted by a surgical advanced care practitioner, a surgical fellow or an attending surgeon. All patients had at least 6 months follow up at time of chart review.

The Seldinger technique has been described as the ‘intra-corporeal’ Seldinger technique,⁶ the push technique,⁵ or a U-stitch technique.^{7,8} The modified open/fascial stitch technique has been variously described as an “extracorporeal” Seldinger technique,⁶ subcutaneous suture technique,⁴ or the modified subcutaneous tunneled technique.⁷ Technique was choice of the surgeon; of 7 surgeons, 2 performed a modified Seldinger technique while 5 performed a modified open technique with fascial stitches. Outpatient elective GT were placed by providers during elective block time while inpatient gastrostomy tubes were placed on a rotating ‘surgeon of the week’ schedule.⁹ Each surgeon performed only 1 type of operation during the study period.

All surgeons place a low-profile primary gastrostomy tube, either a MIC-KEY[®] or Mini ONE[®], with both inpatient and outpatient follow up provided for all patients. For the purposes of this analysis, we included only primary laparoscopic GT placement, with or without antireflux procedure. We excluded cases with concomitant esophagectomy or gastrectomy and instances where the tube was not intended for feeding.

We assessed preoperative characteristics of children undergoing feeding tube placement, and noted all post-operative complications from tube placement. We compared complications across technique using chi-square and Student's t-test, as appropriate. Correlation between outcomes was assessed using Pearson correlation coefficients. To better assess risk factors for tube leakage we created a multivariate logistic model for the ‘event’ leakage, using biologically plausible preoperative risk factors as predictors. All analyses were performed in SAS 9.4 (SAS Institute, Inc., Cary, NC, USA). All tests were 2-sided, with $P < 0.05$ considered significant. The research was approved by the Feinstein Institute for Medical

Research Institutional Review Board as application #18–0808.

3. Results

Over the study period, 92 GT were placed, with no intra-operative or immediate post-operative complications. No patient required unplanned reoperation within 30 days of tube placement. 56 were placed as MOT (60.9%). Mean age 2.8 ± 4.0 years and was similar regardless of GT placement technique ($P = 0.55$, Table 1).

Patients were followed through in a variety of settings, both inpatient and outpatient. Mean outpatient visits (both clinic and ER) were similar between surgical techniques, with patients seen at an average of visits 3.6 ± 2.4 ($P = 0.16$) over an average of 10.4 ± 5.5 months after surgery (Table 2). There was no significant difference in duration of follow up in patients with and without a complication, or between patients with or without any individual complication. Children with any post-operative complication did require more post-operative visits, 4.7 ± 2.6 , as compared to 1.9 ± 1.4 visits for children without a complication ($P < 0.0001$).

A majority of children (55.4%) experienced at least one complication following surgery (Table 3). 34 children (37.0%) developed granulation tissue requiring treatment, 18 children (19.6%) presented following tube dislodgment, and 6 children (6.5%) developed a site infection, with no difference depending on technique ($P = 0.56$, 0.29, and 0.76, respectively). There was no significant correlation between these complications amongst patients.

Following ST, 2 children developed leakage (5.6%), whereas 15 children (26.8%) had leakage following the modified open technique ($P = 0.01$). Although we were limited in power, amongst individual surgeons performing each technique, there was no significant rate in difference in leakage rates in those surgeons performing ST ($P = 0.87$) and those performing MOT ($P = 0.88$). There was also no significant difference in leakage between children who were inpatients at the time of gastrostomy tube placement, and children who were hospitalized specifically for gastrostomy tube placement ($P = 0.51$). No patient needed an additional hospitalization to manage leaking, or a resiting of gastrostomy. All leakage was managed with local interventions during clinic and ED visits, or when children were hospitalized for other indications. No patient with leakage required admission specifically for the leakage during the study period. Patients with leakage were seen for leakage related issues a median of 1 outpatient visit (IQR 1–2). Three patients attended at least 5 clinic visits pertaining to leakage (2 placed by MOT, 1 by ST).

We created a multivariate logistic model to assess for risk factors for leakage, given the disparity between techniques. On univariate analysis, there were no other risk factors for leakage besides GT placement technique (Table 4). After adjusting for other risk factors, surgical technique remained the only predictor of post-operative leakage. Children undergoing MOT had 5.63 the odds of post-operative leakage (95% confidence interval 1.16–27.26, $P = 0.03$).

Table 1
Baseline characteristics of children undergoing laparoscopic gastrostomy tube placement.

	Modified open technique N = 56	Seldinger technique N = 36	Total N = 92	P value
Infant	37 (66.1)	17 (47.2)	54 (58.7)	0.07
Outpatient immediately prior to placement	36 (64.3)	19 (52.8)	55 (59.8)	0.27
Male	41 (73.2)	23 (63.9)	64 (69.6)	0.34
Age (mean \pm SD)	2.6 \pm 4.1	3.1 \pm 3.9	2.8 \pm 4.0	0.55
Follow-up time	10.0 \pm 5.2	11.0 \pm 6.0	10.4 \pm 5.5	0.40
Total outpatient and ER visits	3.9 \pm 2.3	3.2 \pm 2.5	3.6 \pm 2.4	0.16

Table 2
Average follow up of children with and without a complication following gastrostomy tube placement.

Complication	Duration follow up, in months			Total visits		
	No Complication	Complication present	P value	No complication	Complication present	P value
Infection	10.3 ± 5.5	12.1 ± 4.3	0.36	3.4 ± 2.2	7.2 ± 2.6	0.02
Granulation	10.5 ± 5.9	10.3 ± 4.8	0.86	2.5 ± 1.8	5.3 ± 2.2	<0.0001
Dislodged	10.1 ± 5.4	11.4 ± 5.8	0.35	3.4 ± 2.3	4.4 ± 2.6	0.12
Leakage	10.4 ± 5.9	10.5 ± 3.5	0.88	3.2 ± 2.2	5.3 ± 2.4	0.003
Any complication	9.8 ± 6.0	10.8 ± 5.1	0.42	1.9 ± 1.4	4.7 ± 2.63	<0.0001

Table 3
Complications following laparoscopic gastrostomy tube placement.

	Modified open technique (MOT)	Seldinger technique (ST)	Total	P value
	N = 56	N = 36	N = 92	
Any complication	34 (60.7)	17 (47.2)	51 (55.4)	0.20
Granulation tissue	22 (39.3)	12 (33.3)	34 (37.0)	0.56
Leakage	15 (26.8)	2 (5.6)	17 (18.5)	0.01
Infection	4 (7.1)	2 (5.6)	6 (6.5)	0.76
Dislodged	9 (16.1)	9 (25.0)	18 (19.6)	0.29

Table 4
Variables associated with gastrostomy tube leakage.

	Unadjusted OR (95% CI)	P value	Adjusted* OR (95% CI)	P value
Infant	2.70 (0.80–9.03)	0.11	2.25 (0.63–8.03)	0.21
Outpatient	1.29 (0.43–3.86)	0.65	1.26 (0.39–4.08)	0.70
Male	0.76 (0.25–2.31)	0.63	0.65 (0.20–2.13)	0.48
Utilizing MOT	6.22 (1.33–29.12)	0.02	5.63 (1.16–27.26)	0.03

*Adjusted for all other terms in the model.

4. Discussion

Multiple methods allowing for safe placement of gastrostomy tube have been described, with combinations of open, laparoscopic, fluoroscopic, and endoscopic techniques. Each method of tube placement has its own risks and benefits. The purpose of this study was to compare two methods of laparoscopic placement of gastrostomy tube: one with temporary transabdominal sutures and the other with semipermanent transfascial sutures.

In our experience, the modified open technique resulted in significantly more leakage around the gastrostomy tube, 26.8% vs 5.6% ($P = 0.01$). This is similar to results by Sutherland et al.,⁵ who found around double the rate of leakage with MOT as compared to ST, 29.0% vs 14.3% ($P = 0.0001$). However, they had two techniques for ST, utilizing either transabdominal sutures or T-fasteners, techniques which are similar but leave uncertainty as to which would be the ideal operation. A larger study by Mason and colleagues, however, of nearly 700 patients undergoing MOT vs ST saw no difference in minor complications, such as tube leakage.⁴ They did find significantly more major complications following MOT placed gastrostomy tubes.

We found that other complications were similar between groups. Previous work has shown up to twice the prevalence of granulation tissue following MOT, whereas we found no significant difference between the two techniques.⁵ Our rate of granulation tissue was consistent with other prior reports ranging from 45 to 70% of patients.^{10,11} We hypothesized that the leakage and granulation tissue would act synergistically, such that leakage would encourage the formation of granulation tissue while granulation tissue would allow for the persistence of leakage. However, granulation tissue was not related to leakage on either univariate or multivariate analysis ($P = 0.14$ and $P = 0.26$, respectively, data not shown). Indeed there was no correlation between any of the

complications.

The main limitations of this analysis stem from the retrospective nature of data collection at a single tertiary care center. We made several attempts to limit this bias. Firstly, we ensured that complications were documented by permanent members of the pediatric surgical service. Given that there was no significant difference in leakage rate amongst practitioners of each of the two techniques, we feel confident that the difference seen in leakage is not due to varying levels of vigilance in surgeons. This was confirmed in our finding that average duration of follow up was similar whether or not patients experienced a complication. Children who were inpatients would have been subject to more intensive examination during their hospitalizations, we found no difference in complications between these groups. We believe that in tracking inpatient, outpatient, and emergency department records, we were able to capture all complications that occurred. However, because of the relatively small number of surgeons and of complications, our findings should be contextualized with those from other centers.

A strength of this work is the standardization of procedure type, which allows us to appreciate the different complications associated with the two main variations on laparoscopic gastrostomy tube placement. While each surgeon has tailored the technique slightly (e.g. use of a pursestring in addition to fascial stitches, use of a MicKey vs MINI button), the two techniques are quite disparate. There were no immediate major complications following tube placement during the study period with either technique, but there was significantly more leakage seen following MOT. However, in the year prior to the collection of this dataset, one patient returned to the operating room emergently after a newly placed tube was accidentally dislodged at bedside. As the tube had been placed by the Seldinger technique, the stomach was not adherent to the abdominal wall, and the patient required a small laparotomy with placement of a Stamm gastrostomy tube. Within the study period,

this complication did not occur, but remains a feared possibility. In addition, there is some evidence that, given the disposable costs associated with dilators for the Seldinger technique, it has higher upfront costs.⁶ Given that we saw similar numbers between techniques for follow up visits and follow up duration, this could favor use of the MOT.

5. Conclusions

For a commonly performed procedure, there remains little consensus on optimal technique for gastrostomy tube placement. Surgeons choosing the modified open technique should be mindful of the potential increased rate of leakage around the GT, a complication that can be challenging for patients, their families, and health care professionals. Perhaps adjustments of the modified open technique such as limiting the size of skin incision and gastrostomy at time of tube placement may decrease the rate of leakage around the tube postoperatively. Future prospective studies may help better define the aspects of gastrostomy tube placement techniques that correlate directly with postoperative complications, this further optimizing care delivery for this common and morbid procedure.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at

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