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A systematic review and meta-analysis of gastrostomy insertion techniques in children

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ABSTRACT

Background: Gastrostomy tubes are inserted via multiple techniques to provide a route for enteral feeding in the pediatric population. This review compares the rate of major complications and resource utilization associated with the various insertion techniques.

Methods: Major electronic databases were queried for comparative studies of two or more insertion techniques, including open, laparoscopic, percutaneous endoscopic, or fluoroscopic guided. Major complications were defined as reoperation within 1 year or death. Screening of eligible studies, data extraction, and assessment of methodological quality were conducted independently by two reviewers. Forest and funnel plots were generated for outcomes using Revman 5.1, with $p < 0.05$ considered significant.

Results: Twenty-two studies with a total of 5438 patients met inclusion criteria. No differences in major complications were noted in studies comparing open versus laparoscopic approaches or open versus PEG. Studies comparing laparoscopic gastrostomy and PEG revealed a significantly increased risk in major complications with PEG ($n = 10$ studies, OR 0.29, 95% CI: 0.17–0.51, $p < 0.0001$). The number needed to treat to reduce one major complication by abandoning PEG is 45.

Conclusions: PEG is associated with an increased risk of major complications when compared to the laparoscopic approach. Advantages in operative time appear outweighed by the increased safety profile of laparoscopic gastrostomy insertion.

The placement of a gastrostomy feeding tube (GT) is one of the most commonly performed operative procedures for children. These feeding tubes are offered to a wide spectrum of pediatric patients that cannot meet their long-term nutritional needs without supplementation, including patients with neurodevelopmental delay (NDD), intractable gastroesophageal reflux disease (GERD), or other cases of failure to thrive (FTT). Gastrostomy tubes are typically well tolerated and provide improved quality of life compared to parenteral and nasogastric feeding for patients unable to maintain adequate oral nutrition [1].

The GT device can be positioned using one of four different technical approaches: surgically using the Stamm or open technique (OPEN), using the percutaneous-endoscopic approach (PEG), guided by interventional-radiology (IRG) or by laparoscopic (LAP) minimally invasive surgery. The original description of the surgical technique of placing a GT was provided in 1984 by Stamm [2]. While this approach continues to be employed in certain circumstances, the original technique mandated a considerable operative incision affiliated with significant postoperative pain [3]. Evolving technology gave rise to a less invasive approach described by Gauderer et al. [4] involving an endoscopic technique to place the feeding tube: the percutaneous-endoscopic gastrostomy (PEG). Shortly after its introduction, PEG gained popularity owing to its minimally invasive nature, speed, low cost, high patient tolerability and early postoperative feeding. However, lack of direct visualization of the intraabdominal cavity and inadvertent injury to surrounding structures have tempered initial enthusiasm with the technique [5,6]. Shortly following the introduction of PEG, Ho [7] described a percutaneous image-guided alternative to surgical and endoscopic gastrostomy placement. In contrast to the OPEN and PEG approaches, it obviates a laparotomy incision or gastroscope, respectively, and is therefore considered the least invasive gastrostomy insertion technique [8]. Despite being less invasive, this relatively blind approach has been associated with unique complications including placement of the catheter through a lobe of the liver and fistulation into the small bowel [9,10]. In 1990, laparoscopic gastrostomy placement was introduced, combining the minimally invasive advantages of PEG with the safety of the OPEN procedure allowing for tube placement under direct visualization. Two laparoscopic variations have been reported and studied, including both a laparoscopic (LAP) and a laparoscopic-assisted percutaneous endoscopic approach (LA-PEG) [11,12].

The approach to gastrostomy placement has undergone considerable evolution since first described. However, the literature

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reporting the supremacy of one technique to another is conflicting and there are no reports comparing all four techniques. An early meta-analysis evaluating effectiveness and safety of IRG, PEG and OPEN gastrostomy, inclusive of pediatric and adult populations, documented the superiority of IRG (major complications 5.9% versus 9.4% for PEG and 19.9% for surgery, $p < 0.05$; thirty-day procedure-related mortality 0.3% versus 0.53% for PEG and 2.5% for surgery) [13]. However, 6 years later, a single-center retrospective review investigating the same 3 techniques reported no significant difference between complication rates ($n = 147$) [14]. Following the introduction of laparoscopy GT insertion, 3 single-center retrospective reviews have been conducted comparing various outcomes following OPEN, PEG and LAP gastrostomy in a pediatric population, reporting varying results [15–17].

There is currently no consensus as to the optimal technique of gastrostomy insertion in the pediatric population, and there remains a paucity of well-designed trials to answer the question. The PEG, IRG and LAP techniques are the most commonly preformed and widely accepted approaches today but there has yet to be a systemic review of the literature critically comparing these approaches. This report evaluates the available literature summarizing complication rates and resource utilization for gastrostomy techniques in children. Given that gastrostomy tube placement remains one of the most commonly preformed elective procedures, summary recommendations on relative advantages and disadvantages of each technique should inform future practice for many children with nutritional deficiencies in need of long-term enteral access.

1. Materials & methods

1.1. Guideline

The PRISMA statement, checklist and flowchart were referenced to achieve the highest standard in reporting items for a systematic review and meta-analysis [18,19].

1.2. Literature search

A systematic search of electronic databases was performed to identify all relevant studies comparing two or more gastrostomy insertion techniques in children reporting procedural-related complication rates. A reference librarian was consulted to assist with the development of database-specific search strategies. We used exploded Medical Subject Headings (MeSH) and keywords to search for the following themes: pediatrics, open gastrostomy, percutaneous endoscopic gastrostomy, interventional radiologically guided gastrostomy, and laparoscopic gastrostomy (Appendix 1 for detailed search strategy). We applied the search strategy to the following databases: MEDLINE (PubMed, PubMEd in Process and Ovid), EMBASE, Cumulative Index of Nursing and Allied Health Literature (CINAHL), Scopus and Cochrane Library. The search was restricted temporally from 1993 to 2013, with no linguistic restriction. Reference lists from the retrieved articles were then hand searched to identify additional potentially relevant articles.

Table 1
Studies that met inclusion criteria, segregated by procedure. Complication rates and MINORS score are displayed.

Study	Intervention A		Intervention B		MINORS score
	n	Incidence of major complication (%)	n	Incidence of major complication	
LAP versus open	LAP		Open		
Collins et al. (1995)	46	0	52	0	14
Ruangtrakool and Ong (2000)	18	NA[b]	51	NA[b]	16
Wadie and Lobe (2002)	56	3 (5.36%)	74	5 (6.76%)	16
Conlon et al. (2004)	247	10 (4.05%)	754	36 (4.78%)	13
Fraser et al. (2009)	695	1 (0.15%)	557	5 (0.90%)	11
Naiditch et al. (2010)	65	NA[a]	94	NA[a]	16
Thatch et al. (2010)	25	0	32	0	16
Liu et al. (2013)	260	1 (0.38%)	23	0	14
Total	1412	15 (1.13%)	1637	46 (2.81%)	
LAP versus PEG	LAP		PEG		
Lee et al. (2002)	51	0	8	0	10
Steyaert et al. (2003)	14	0	19	5 (26.32%)	13
Conlon et al. (2004)	247	10 (4.05%)	41	7 (17.08%)	13
Zamakhshary et al. (2005)	26	1 (3.85%)	93	8 (8.61%)	16
Fraser et al. (2009)	695	1 (0.15%)	282	6 (2.13%)	11
Vervloessem et al. (2009)	19	0	448	9 (2.01%)	14
Akay et al. (2010)	104	9 (8.66%)	134	26 (19.41%)	15
Peters et al. (2010)	98	0	16	2 (12.5%)	14
Villalona et al. (2011)	85	2 (2.36%)	34	3 (8.82%)	14
Liu et al. (2013)	260	0	86	1 (1.17%)	14
Total	1599	23 (1.44%)	1161	67 (5.77%)	
OPEN versus PEG	OPEN		PEG		
Cameron et al. (1995)	33	3 (9.09%)	30	0	16
Stylianos and Flanigan (1995)	17	0	15	0	12
Day et al. (2001)	18	0	34	0	10
Conlon et al. (2004)	754	36 (4.77%)	41	3 (7.32%)	13
Lindmayer et al. (2006)	30	NA[c]	2	NA[c]	
Fraser et al. (2009)	557	5 (0.90%)	282	6 (2.13%)	11
Ackroyd et al. (2011)	75	0 (0%)	85	2 (2.36%)	15
Lintula et al. (2012)	13	1 (7.69%)	56	4 (7.15%)	16
Liu et al. (2013)	23	0	86	4 (4.66%)	14
Total	1520	45 (2.96%)	631	19 (3.01%)	
PEG versus IR	PEG		IR		
Nah et al. (2010)	136	6 (4.42%)	195	1 (0.51%)	16

[a] Complications not segregated by procedure, total of 3 major complications reported.
[b] Total of 2 major complications.
[c] Results uninterpretable as presented.