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A Retrospective Comparison of Pediatric Gastrostomy Insertion Techniques

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Abstract

Aim of the Study: Gastrostomy tube insertion is frequently performed in children with feeding difficulties. Short-term complications are known, but long-term results are less evaluated. This retrospective study aims to compare percutaneous endoscopic gastrostomy (PEG) with laparoscopic and open placement of gastrostomy tubes in a pediatric population.

Methods: A retrospective analysis of all gastrostomy placements between 2011 and 2016 was performed. Demographics, indication for gastrostomy, prior and simultaneous surgery, short and long-term complications were recorded and compared between the techniques. Short-term complications (< 30 days) included: infection, peristomal leakage and excess granulation tissue. Long-term complications included: infection, peristomal leakage, excess granulation tissue, mucosal prolapse and unintentional dislodgement.

Main Results: A total of 238 patients were included, of which 188 received a PEG, 28 laparoscopic and 22 open gastrostomy. Most tubes were inserted for feeding difficulties in general (48%), unsafe swallowing (19%) and psychomotor retardation (15%). Minor complications were common in all groups. A significant difference was seen between the laparoscopic (n = 0) and open group (n = 3; 14%) in short-term superficial infections (p = 0.044). Long-term infections occurred most frequently after the open (45%) and PEG (36%) respectively laparoscopic (18%) technique (p = 0.091), with a significant difference between the laparoscopic and open group (p = 0.035). Major complications were rare, however three PEG children showed signs of sepsis and were admitted to the intensive care unit.

Conclusions: In all gastrostomy placements minor complications occurred frequently. Moreover PEG was associated with an increased risk of major complications when compared to the laparoscopic and open approach. Also PEG requires a second anesthesia for replacement with a low-profile 'button', which can be a disadvantage for patients with severe comorbidity.

Keywords: *Gastrostomy; PEG; Laparoscopic; Peristomal Leakage*

Abbreviations

GT: Gastrostomy Tube; PEG: Percutaneous Endoscopic Gastrostomy; NND: Neurodevelopmental Delay; FTT: Failure to Thrive; GERD: Gastroesophageal Reflux Disease

Introduction

Children who cannot be fed orally need a nasogastric tube for feeding. However, when this is a long-term problem there is an indication for a gastrostomy. The placement of a gastrostomy feeding tube (GT) is a commonly performed operative procedures in children. These feeding tubes are offered to a wide spectrum of pediatric patients that cannot meet their long-term nutritional needs without supplemen-

tation, including patients with neurodevelopmental delay (NDD), feeding disorders or other cases of failure to thrive (FTT) [1]. Impaired feeding is very common, with a reported prevalence of 25% in all children and 80% in children with developmental disabilities. Severe feeding problems are noted in 3% to 10% of children and occur with greater prevalence in children with physical disabilities, medical illness, or a history of prematurity [2]. Gastrostomy tube placement is a long-term solution for supporting nutrition in these children.

There are several techniques to perform a gastrostomy. For over a century, the primary approach was an open gastrostomy, by suturing the anterior stomach to the anterior abdominal wall to secure the gastrostomy tract [3]. The original description of this surgical technique of placing a GT was provided in 1894 by Stamm [4]. While this approach continues to be employed in certain circumstances, the original technique mandated a considerable operative incision affiliated with significant postoperative pain [5]. In the past 30 years, endoscopic and laparoscopic methods were also introduced. Percutaneous endoscopic gastrostomy (PEG) tube placement was originally developed in 1980 as an alternative to open gastrostomy tube placement in medically complex children [6]. 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 intra-abdominal cavity and inadvertent injury to surrounding structures have tempered initial enthusiasm with the technique [7,8]. 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 [9,10]. Laparoscopic gastrostomy tubes provide an alternative to PEG placement and have been compared in the pediatric population with lower rates of major complications owing primarily to improve visualization of abdominal anatomy and ability to place a surgical pexy of the stomach to the anterior abdominal wall [11].

However, there is still no consensus about which technique should be preferred. The literature show different results in the preferences of gastrostomy techniques, with advantages and disadvantages for all techniques. For this reason a retrospective evaluation of the gastrostomy patients of the last six years in the Radboudumc-Amalia Children's Hospital was conducted, to answer the question regarding short-term and long-term morbidity and mortality of percutaneous endoscopic gastrostomy (PEG) and the other surgical techniques (laparoscopic and open methods) for placement of gastrostomy tubes in a pediatric population.

Methods

Study Design and Outcomes

In the Radboudumc-Amalia Children's Hospital there are 40-60 gastrostomy placements yearly. A retrospective analysis was performed of all gastrostomy placements in the Radboudumc-Amalia Children's Hospital for patients under the age of 18 years between January 2011 and December 2016. When patients had multiple gastrostomy tube placements between these dates, the first operation date during the study period was recorded primary and subsequent procedures were considered reoperations. Pediatric surgeons at this institution performed percutaneous endoscopic gastrostomy (PEG), laparoscopic gastrostomy and open gastrostomy procedures for placement of the gastrostomy tubes. Pediatric gastroenterologists assisted in the PEG placements by performing the gastroscopy during the placement. Criteria for the conversion of a PEG to a laparoscopic or open method and exclusion criteria for PEG placement include weighing less than 8 kg, severe comorbidity or simultaneous abdominal procedures (such as fundoplication or jejunostomy). Other perioperative reasons for conversion from PEG to laparoscopic approach were the inability to safely place the trans-abdominal needle in the stomach. Medical records were reviewed for patient age and weight at the time of tube placement. Other demographics included gender, indication for gastrostomy placement, comorbidities, prior abdominal surgery and simultaneous surgery. The outcome parameters were deceased after tube placement and cause of death, short and long-term complications. The short-term complications (< 30 days) included: infection (superficial, deep, abscess, fasciitis and sepsis), peristomal leakage and excess granulation tissue. The long-term complications included: infection (superficial, deep, abscess and sepsis), peristomal leakage, excess granulation tissue, mucosal prolaps and unintentional dislodgement. These data were recorded and compared between the different placement techniques. The infection grading is based on the type of medication used in the patient. The grading superficial is used if only local antibiotic is applied. The grading deep is used when systemic antibiotics are administered to the patient. A follow-up of at least 6 months was required for inclusion.

Statistical Analysis

The statistical analyzes were performed with the Statistical Package for the Social Sciences version 22.0 (SPSS 22). Continuous data are represented as medians and ranges and categorical data as frequencies and percentages. Pearson's Chi-square test was used for the comparison of categorical data. A p-value of < 0.05 was considered statistically significant for all analyses.

Results

Patient Demographics and Treatment Groups

Table 1 contains patient demographics for the cohort overall and by gastrostomy procedure type. A total of 238 patients under the age of 18 years who underwent gastrostomy tube placement were included. The most common technique used for gastrostomy placement was the percutaneous endoscopic gastrostomy (PEG) (n = 188; 79%). The laparoscopic technique was performed in 28 patients (12%) and the open technique in 22 (9%). The ages of the patients ranged from 1 day to 17 years, with a median of 25 months and a range of 204 months in the total cohort. The open group contained the youngest patients with a total of six patients under the age of one month with a median of 2,5 days and a range of three. The children in the PEG and laparoscopic groups were all older than one month. There were multiple indications in the patient cohort for the placement of a gastrostomy tube. Most common was a feeding disorder in general, which was the indication in 115 (48%) patients of a total of 238 patients. The inability to swallow or unsafe swallowing in 45 (19%) patients, psychomotor retardation in 36 (15%) patients and failure to thrive in twelve (5%) patients. Significant differences between the three different gastrostomy tube placement techniques, as shown in table 1, were seen in a feeding disorder in general ($p = 0.025$), cystic fibrosis ($p = 0.010$) and esophageal atresia ($p < 0.001$). The most common comorbidity was a mental retardation, with 129 of 238 (54%) patients of the total cohort and 85 (36%) patients had epilepsy. Seventy-eight (33%) patients had gastro-esophageal reflux disease (GERD) and gastroparesis was found in 48 (20%) patients. There were only significantly different comorbidities between the different groups in GERD (30% PEG, 54% laparoscopic, 32% open, $p = 0.044$), cardiac anomaly (10% PEG, 25% laparoscopic, 27% open, $p = 0.009$) and esophageal atresia (1% PEG, 4% laparoscopic, 27% open, $p < 0.001$).

Demographics	Total group N = 238	PEG n = 188	Laparoscopic n = 28	Open n = 22	P-value PEG vs LAP vs OPEN
Gender, n (%)					
Male	113 (47%)	86 (46%)	16 (57%)	11 (50%)	0.514
Female	125 (53%)	102 (54%)	12 (43%)	11 (50%)	0.514
Age at surgery (months), median (range)	25 (204)	24 (199)	54 (189)	7 (204)	
Weight surgery (kg), median (range)	12 (51,9)	12 (46,5)	14 (29,8)	5,8 (51,9)	
Indication gastrostomy, n (%)					
Feeding disorder general	115 (48%)	91 (48%)	18 (64%)	6 (27%)	0.025
Unsafe swallowing	45 (19%)	35 (19%)	6 (21%)	4 (18%)	0.761
Excessive fluid intake	10 (4%)	10 (5%)	0 (0%)	0 (0%)	0.232
Cystic fibrosis	7 (3%)	4 (21%)	0 (0%)	3 (14%)	0.010
Failure to thrive	12 (5%)	11 (6%)	1 (4%)	0 (0%)	0.430
Psychomotor retardation	36 (15%)	32 (17%)	2 (7%)	2 (9%)	0.235
Esophageal atresia	9 (4%)	2 (1%)	1 (4%)	6 (27%)	0.000
Cleft palate	4 (2%)	3 (2%)	0 (0%)	1 (5%)	0.790

Table 1

Prior abdominal surgery occurred in 56 (24%) patients of the total cohort. Eight (3%) patients of the total cohort had a congenital diaphragmatic hernia repaired, which was neonatal (four (2%) in the PEG group, three (11%) in the laparoscopic and one (5%) in the open group (p = 0.060)). A Nissen fundoplication prior to the GT placement, due to gastroesophageal reflux disease (GERD) was conducted in eight (3%) patients, of which six (3%) in the PEG, one (4%) in the laparoscopic and one (5%) in the open group (p = 0.944). *Twenty-five (11%) patients received prior other abdominal surgery, which was significantly different between the groups (13 (7%) in the PEG group versus one (4%) laparoscopic and 11 (55%) in the open group (p < 0.001)*.

Seventy-one patients (30%) of the total cohort had a simultaneous procedure at the time of tube insertion. Nissen fundoplication was performed simultaneously significantly more in the surgically placed gastrostomies, with six (21%) in the laparoscopic and three (14%) in the open group versus none in the PEG group (p < 0.001). Simultaneously closing an old gastrostomy site, which was placed prior to the study period, was performed in three (2%) patients in the PEG group, none in de laparoscopic group and two (9%) in the open group (p = 0.064). Other simultaneous abdominal surgery, was performed in nine (5%) patients in the PEG group, three (11%) in the laparoscopic group and eight (36%) in the open group (p < 0.001).

Complications

Twenty-two (9%) of 238 patients died after gastrostomy insertion, of which 18 (10%) in the PEG group, none in the laparoscopic group and four (18%) in the open group (p = 0.083). Medical records detailing each patient death were examined to determine any association to gastrostomy placement. Except for one case in the PEG group, they were all attributed to causes other than the placement. The other patients died of underlying diseases, as shown in table 2.

Surgical complications after gastrostomy placement	Total group N = 238	PEG n = 188	Laparoscopic n = 28	Open n = 22	P-value PEG vs LAP vs OPEN
Deceased, median (range)	22 (9)	18 (10)	0 (0)	4 (18)	0.083
Reason death					
Disease specific	21 (9%)	17 (9%)	0 (0%)	4 (18%)	0.250
Gastrostomy related	1 (1%)	1 (1%)	0 (0%)	0 (0%)	
Short-term complications	137 (58%)	106 (56%)	17 (61%)	14 (64%)	0.758
Infections	58 (24%)	45 (24%)	6 (21%)	7 (32%)	0.666
Infections > 1 time	13 (5%)	11 (6%)	2 (7%)	0 (0%)	0.477
Peristomal leakage	21 (9%)	12 (6%)	5 (18%)	4 (18%)	0.036
Peristomal leakage > 1 time	4 (2%)	3 (2%)	1 (4%)	0 (0%)	0.610
Excess granulation tissue	72 (30%)	55 (29%)	9 (32%)	8 (36%)	0.769
Excess granulation tissue > 1 time	24 (10%)	19 (10%)	4 (14%)	1 (5%)	0.525
Long-term complications	163 (68%)	119 (63%)	22 (79%)	22 (100%)	0.001
Infections	83 (35%)	68 (36%)	5 (18%)	10 (45%)	0.091
Infection > 1 time	31 (13%)	29 (15%)	1 (4%)	1 (5%)	0.102
Peristomal leakage	55 (23%)	35 (19%)	9 (32%)	11 (50%)	0.002
Peristomal leakage > 1 time	25 (11%)	18 (10%)	2 (7%)	5 (23%)	0.135
Excess granulation tissue	124 (52%)	95 (51%)	16 (57%)	13 (59%)	0.637
Excess granulation tissue > 1 time	92 (39%)	71 (38%)	10 (36%)	11 (50%)	0.507
Mucosal prolapse	13 (5%)	6 (3%)	5 (18%)	2 (9%)	0.005
Unintentional dislodgement	35 (15%)	24 (13%)	5 (18%)	6 (27%)	0.013

Table 2

Complications were divided into short-term (<30 days) and long-term complications, which are shown in table 2 and figures 1 and 2. Overall, there were short-term complications in 137 of 238 (58%) patients, of which 106 of 188 (56%) patients in the PEG group compared with 17 of 28 (61%) in the laparoscopic group and 14 of 22 (64%) in the open group (p = 0.758). Short-term gastrostomy-related infections occurred in 58 (24%) patients. Forty-five (78%) of these 58 patients experienced a single infection. Recurrent infections were noted in 13 (22%) of them. As shown in table 2, there were no statistically significant differences in infection frequencies between the different groups of gastrostomy tube placement techniques. Grading of the infections included superficial, deep, sepsis, abscess and fasciitis, which was different between the groups, as visualized in figure 1. Superficial infections occurred more frequently in the open group (14%) and deep infections occurred slightly more frequently in the laparoscopic group (21%). A significant difference was seen between the laparoscopic (n = 0) and open group (n = 3; 14%) in superficial infections (p = 0.044). The only patients with severe infections, sepsis (1%), abscess (2%) and fasciitis (1%) occurred in the PEG group, although this was not a significant difference. Peristomal leakage significantly was most common following open gastrostomy tube placements (18,2%) compared to laparoscopic (17,9%) and PEG (6%) (p = 0.036). However recurrent peristomal leakage was not significantly different. Granulation tissue occurred equal in all patients.

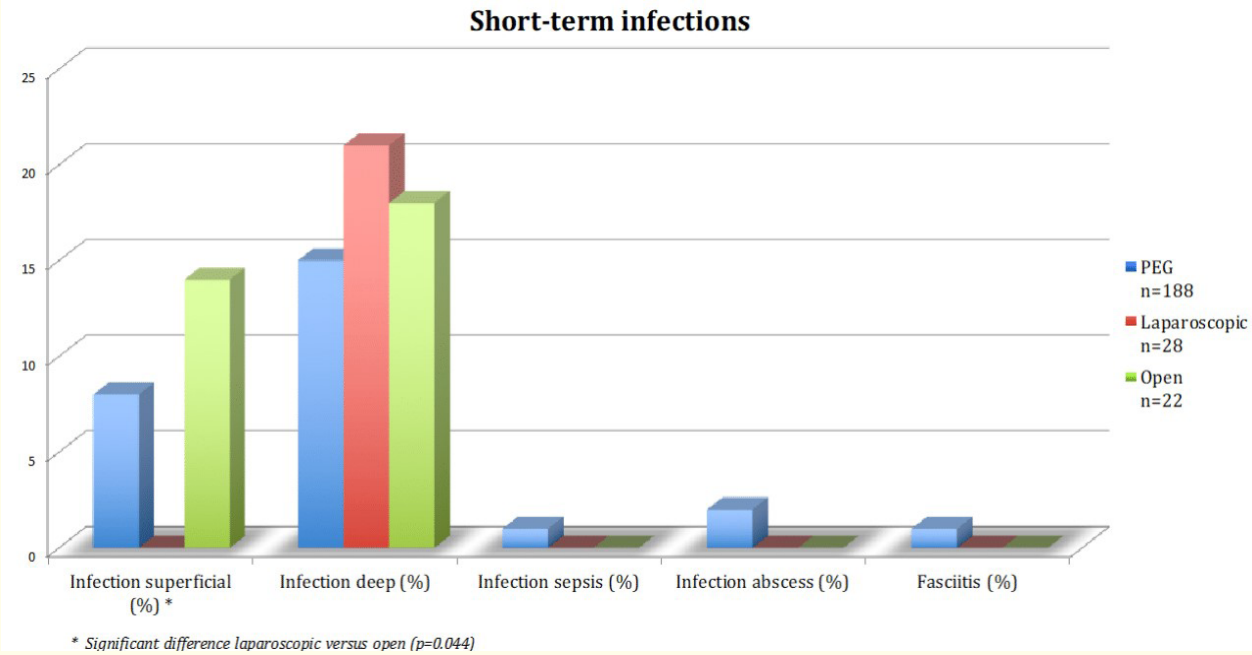

Figure 1

The majority of patients encountered some form of long-term complication (n = 163; 68%). Infections during long-term follow-up occurred most frequently after the open placement technique (45%) and PEG (36%) respectively laparoscopic (18%) technique (p = 0.091), with a significant difference between the laparoscopic and open group (p = 0.035). Recurrent infections occurred more frequently in the PEG group (15%) compared to the open (5%) and laparoscopic (4%) group (p = 0.102). Figure 2 shows the different grading of infection between the groups during long-term follow-up. There were no significant differences in grading of infections between the groups. However, the severe infections, abscess and sepsis, only occurred in the PEG group (p-values respectively 0.875 and 0.064). In total 55 (23%) patients experienced leaking around their gastrostomy tube, of which 35 (19%) in the PEG group, nine (32%) in the laparoscopic

group and eleven (50%) in the open group, which was a significant difference (p = 0.002). Recurrent peristomal leakage occurred most frequently in the open group (23%) compared to the PEG (10%) and laparoscopic group (7%) (p = 0.135). The occurrence of excess granulation tissue was approximately equal in all groups (open (59%) versus laparoscopic (57%) versus PEG (51%) (p = 0.637)). A significant difference was seen in the prevalence of mucosal prolapse (p = 0.005), occurring in five (18%) patients in the laparoscopic, two (9%) in the open and six (3%) in the PEG group. A buried bumper syndrome only occurred in two patients in the PEG group (p = 0.765). During the follow-up period, 24 (13%) patients in the PEG, five (18%) in the laparoscopic and six (27%) in the open group experienced gastrostomy tube dislodgement (p = 0.013). Recurrent tube dislodgement occurred most frequently in the laparoscopic group (n = 3; 11%) versus two patients (9%) in the open group and 4 (2%) in the PEG group (p = 0.033).

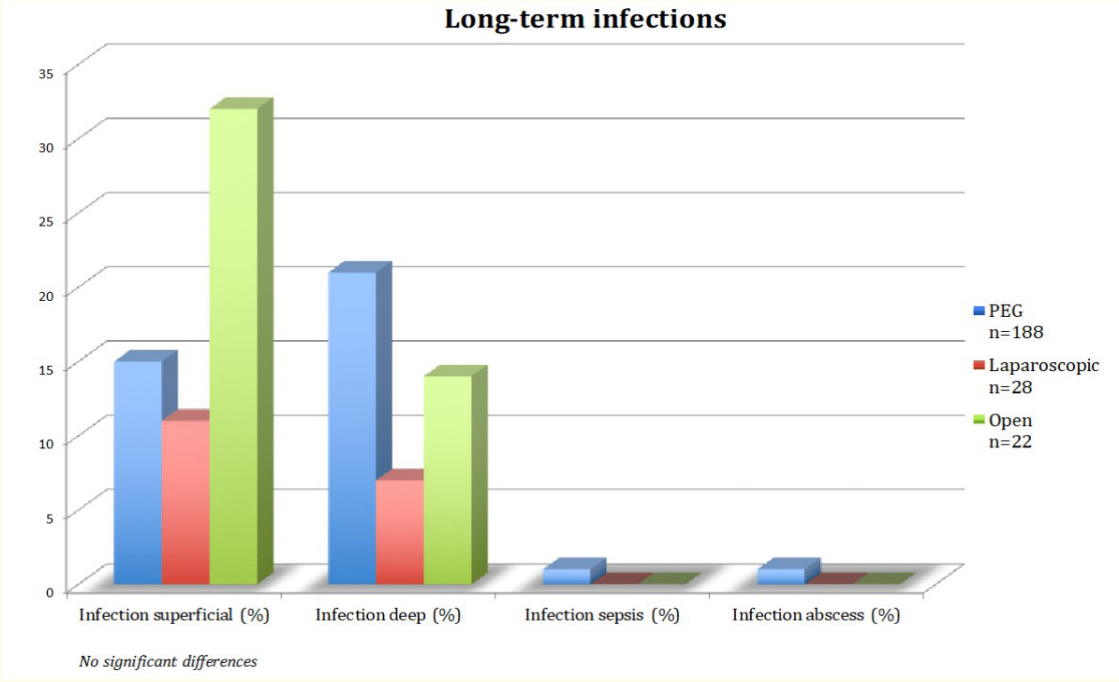

Figure 2

In this patient cohort there were no misplaced gastrostomies. Conversion during surgery from PEG to a laparoscopic method occurred in four patients and from PEG to an open method in three patients. These conversions were all successful.

Discussion

Outcomes following gastrostomy tube (GT) placement have been reported in the literature, however only a few prior studies have examined more than two different GT placement techniques at a single institution. Many studies have been single-center reviews of a single technique or a comparison between two different techniques, most commonly laparoscopic and PEG techniques. This study aimed to compare percutaneous endoscopic gastrostomy (PEG) and the other surgical techniques (laparoscopic and open methods) for placement of gastrostomy tubes in a pediatric population to answer the question regarding the differences between short-term and long-term morbidity and mortality. Previous studies have favored different techniques, depending on the particular study. Some favored the laparoscopic technique due to its association with fewer serious complications, a shorter post-operative length of stay, and a shorter duration

of time under anesthesia [12-14]. There were significant and more serious postoperative complications requiring a second operation in the PEG group when compared with the laparoscopic group, which is enhanced by the results of our study [12]. Moreover, a systematic review and meta-analysis of gastrostomy insertion techniques in children showed the following: 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 [15]. On the other hand, one study comparing PEG, laparoscopic and open methods found that the laparoscopic technique had the highest morbidity of all three techniques. The open procedure significantly delays feeding start day, which may impact length of hospital stay. Because the PEG technique is associated with shorter insertion times, reduced overall complications, and decreased costs, they found that it should be considered the procedure of choice. If PEG is contraindicated, then the open technique may be the best method due to fewer complications [16]. Our study showed that in all gastrostomy placements minor complications occurred frequently. Moreover PEG was associated with an increased risk of major complications when compared to the laparoscopic and open approach. Also PEG requires a second anesthesia for replacement with a low-profile 'button', which can be a disadvantage for patients with severe comorbidity. The choice of insertion technique should not only be based on the preference of the surgeon, but more importantly the comorbidity of the patients.

As mentioned above, gastrostomy-related complications were common in all groups and included infection, peristomal leakage and excess granulation tissue. The complication rate was high, but most complications were minor and easy to treat using local medication. In previous literature, the percentages of complication rates vary from 8 - 48% in the PEG group, compared to 5 - 73% in de laparoscopic group [9,12,17,18]. Our study showed an overall short-term complication rate of 58% and long-term of 68% (Table 2). Of which 56% for PEG, 61% for laparoscopic and 64% for open gastrostomy tube placements for short-term complications and 63% versus 79% and 100% for long-term complications. When focusing on serious complications, a difference was seen between the groups, because they only occurred in the PEG group. Minor complications are common in all groups and many pediatric surgeons do not even consider these as complications anymore, but rather part of having a gastrostomy. However, these minor complications can also have a major impact on the quality of life of the patient. Therefore, this must also be taken into account when deciding on the need for a gastrostomy.

Our results also demonstrate that infants and children who undergo gastrostomy tube placement are a medically complex group of patients, because many had multiple comorbidities. Twenty-two (9%) of the 238 patients died after gastrostomy insertion during the follow-up period, of which only one due to the gastrostomy placement and the other patients because of non-gastrostomy-related issues. This also shows that it is a medically complex patient population.

This study has several limitations. First, it is a retrospective study with limitations inherent to this study design. For this study data about PEG, laparoscopic and open placement is used from a single center, therefore the results may not be generalized to all surgeons or to all hospitals. Furthermore, the decision for a PEG, laparoscopic or open placement is partly based on the surgeon's preference and comfort with the chosen type of procedure. Hence, there may be inherent bias or differences in technique, which cannot be accounted for.

Conclusions

In all gastrostomy placements minor complications occurred frequently. Moreover PEG was associated with an increased risk of major complications when compared to the laparoscopic and open approach. Also PEG requires a second anesthesia for replacement with a low-profile 'button', which can be a disadvantage for patients with severe comorbidity. The choice of insertion technique should not only be based on the preference of the surgeon, but more importantly the comorbidity of the patients.

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