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Operative Complications Following Gastrostomy Tube Placement After Cardiac Surgery During Infancy

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ABSTRACT

Introduction: Gastrostomy tube (GT) placement is common in infants following repair of congenital heart defects. We aimed to determine rate of operative complications and predictors of short-term GT use to counsel parents regarding the risks and benefits of GT placement.
Methods: We reviewed infants aged <1 y with congenital heart disease who underwent GT placement after cardiac surgery between 2018 and 2021. Demographics and clinical data were collected and analyzed. Comparisons were made between infants who required the GT for more than 1 y and those who required the GT for less than 1 y.
Results: One hundred thirty three infants were included; 35 (26%) suffered one or more complication including wound infection (4, 3%), granulation tissue (3, 2%), tube dislodgement (10), leakage from the tube (9), unplanned emergency department visit (15), and unplanned readmission (1). Thirty-four infants used the GT for feeds for 1 y or less (26%) including 17 (13%) who used it for 3 mo or less. Fifty-six infants had their GT removed during the study period (42%), 20 of whom required gastrocutaneous fistula closure (36%). Thirty-three infants had a GT placed on or before day of life 30, 17 (52%) used the GT for less than 1 y, and 10 (31%) used it for 3 mo or less.
Conclusions: GT placement is associated with a relatively high complication and reoperation rate. GT placement in infants aged less than 30 d is associated with shorter duration of use. Risks, benefits, and alternatives such as nasogastric tube feeds should be discussed in the shared decision-making process for selected infants.

Introduction

Congenital heart disease (CHD) occurs in about two in every 1000 live births and is associated with a wide range of defects, many of which require operative intervention in infancy.[1] Many infants struggle to take in adequate calories following open cardiac surgery due to either inadequate oral intake or aspiration that can occur following transient injury to the recurrent laryngeal nerve during cardiac repair.[2-5] In these cases, it is common for infants to undergo placement of

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permanent enteral feeding access in the form of gastrostomy tube (GT). However, recent data suggest that many of these infants will quickly recover their ability to consume all calories orally once discharged home.[6,7] Traditional teaching recommends that permanent enteral access be obtained if the child is expected to require supplemental nutrition for 6 mo or more;[7] however, this is not based on empiric evidence. However, pediatric surgeons and cardiologists lack clear criteria to determine which patients will need their GT for 6 mo and which children will use the tube for only a few weeks or months. The literature lacks data documenting rates of complications related to GT placement. In general, GT surgery is thought to be fairly low risk compared to the open sternotomy these infants have already undergone. But a recent survey of caretakers found that more than 50% of children with GTs developed a complication requiring intervention.[7] Additionally, there is a growing body of literature documenting the increased risks associated with surgical GT placement compared to discharge home with nasogastric (NG) feeds for selected infants follows neonatal intensive care unit stay. These risks include increased rates of tube-related complications leading to emergency department (ED) visits, lower cognitive communication and motor composite scores at 1 y following discharge, and even GT-related deaths.[8-13] In addition to the risks of the tube placement itself, general anesthesia poses its own risk in this population including the risk of cardiac arrest.[14] The true impact of GT placement in this patient population is not well described. To address these gaps in the literature, we aimed to quantify gastrostomy-related complications among infants with congenital heart disease (CHD) and to identify factors that predict short-term GT use to inform parental counseling discussions regarding the true risks and benefits of GT placement.

Materials and Methods

Following approval of the Colorado Multiple Institutional Review Board with waiver of consent (#22-0819), a retrospective cohort review was performed of infants who underwent GT placement at Children's Hospital Colorado from 2018 to 2021. Inclusion criteria were age less than 1 y with a diagnosis of CHD, who underwent GT placement at Children's Hospital Colorado following an initial cardiac operation. A minimum of 1-y follow-up data were included for each patient. Records of all children who underwent GT surgery during this 4-y period with a diagnosis of CHD were reviewed and eligible patients included. Patients who underwent a cardiac interventional procedure without a sternotomy were excluded as were patients who underwent GT prior to cardiac repair.

Collected data included demographic information, details of the cardiac diagnosis and prior cardiac operation including complications, as well as indications for GT surgery, associated complications, and follow-up details. Cardiac defects were categorized into single ventricle physiology (SVP) and biventricular physiology, based on our prior work.[15] Diagnoses associated with SVP included hypoplastic left heart syndrome (HLHS), double outlet right ventricle, tricuspid atresia, complete unbalanced atrioventricular canal defect, and dysfunctional left ventricle. Diagnoses categorized as biventricular physiology included balanced atrioventricular canal defect, isolated ventricular septal defect, truncus arteriosus, tetralogy of Fallot, aortic coarctation, interrupted aortic arch, transposition of the great vessels, isolated atrial septal defect, total anomalous pulmonary venous return, and patent ductus arteriosus. Cardiac operations were also categorized as either definitive operations, the first in a planned series (such as in a child with HLHS), or cardiac transplant. Details of each patient's clinical course were recorded including whether they required extracorporeal membrane oxygenation (ECMO) prior to GT, medical comorbidities prior to GT, and the indication for GT surgery.

Outcome variables collected included postoperative GT complications. Complications were defined as those occurring within 30 d of surgery unless otherwise noted. These were categorized as infectious, granulation tissue within two weeks of surgery requiring intervention, tube dislodgement, leakage, unplanned ED visit, or unplanned readmission. For the analysis, complications were grouped as a single outcome variable. Events were recorded as complications if the family or primary team (if the child remained hospitalized at 30 d postoperatively) contacted the pediatric surgery clinic or pediatric surgery inpatient team outside of normal scheduled follow-up or if the issue was noted during a routine follow-up visit. Granulation tissue was noted as a complication if it required intervention in the form of either silver nitrate or steroid cream. Only ED visits or readmissions specifically related to GT complaints were recorded with the current series. ED visits or readmission related to the primary cardiac diagnosis were not included here. Secondary outcomes included the need for gastrocutaneous (GC) fistula closure following GT removal. GC fistula closure is recommended if leakage from the site persists 1 mo follow GT removal. No other interventions are offered to attempt to close the fistula prior to operative intervention. Comparisons were made between infants who required GT for more than 1 y and those who used it for less than 1 y to identify preoperative factors which could identify infants who only require enteral feeds for a short time period. One year was chosen in the current series given the increased risk of general anesthesia in this patient population.

During the study period, 13 different pediatric surgeons placed GTs at our hospital. Preferred operative technique was at the discretion of the attending surgeon. Most cases were performed laparoscopically with either temporary transabdominal sutures (preferred technique of three surgeons) or dissolvable sutures securing the stomach to the posterior fascia via direct visualization of this fascial layer (preferred technique of 10 surgeons). We did not evaluate the relationship between surgical technique and outcomes in the current series.

Statistical analysis

Continuous variables are reported as median and interquartile range given their non-normal distribution based on visual interpretation of histograms. Categorical variables are reported as counts and percentages. Continuous variables were analyzed with a Mann–Whitney U test, and categorical variables were analyzed with a Chi-square test or Fisher's

exact test. A P value of <0.05 was considered statistically significant. All statistical analyses were performed with PRISM version 9.4.1 (1994-2022 GraphPad Software, LLC).

Results

During the 4-y period, 133 infants met inclusion criteria and were included in the analysis. Most infants were male ($n = 78$, 59%), White race ($N = 93$, 70%), and did not identify as Hispanic or Latino ($N = 76$, 57%). The most common indication for GT placement included inadequate oral intake (77, 58%), aspiration (45, 34%), and as part of planned therapy for reflux (10, 8%); one infant underwent GT following tracheostomy. Complications occurred in 35 infants (26%) and included wound infection (4, 3%), granulation tissue within 2 wk (3, 2%), tube dislodgement (10, 8%), leakage from the tube (9, 7%), unplanned ED visit (15, 11%), unplanned readmission (1, 1%), and other complications (6, 5%) (Fig. 1). No infants suffered anesthetic-related complications. Fourteen GTs (11%) were converted to gastrojejunostomy tubes within 1 y of placement none of which were placed to treat GT leakage. Indications for gastrojejunostomy were related to reflux, vomiting, aspiration, and intolerance of gastric feeds in all cases.

Thirty-four infants used the GT for feeds for 1 y or less (26%) including 17 infants (13%) who used the tube for 3 mo or less. Fifty-six infants had their gastrostomy button removed during the study evaluation period (42%), 20 of whom required GC fistula closure (36%). Thirty-three infants had a GT placed on or before day of life 30, 17 (52%) used the GT for less than 1 y, and 10 (31%) used it for 3 mo or less.

When comparing infants who used the GT for more or less than 1 y, the two groups did not differ in terms of sex, race, ethnicity, distance to hospital, or home address in a rural location. There was no difference in the percentage of patients who underwent the first in a series of staged cardiac operations (as opposed to definitive repair). There was no difference in the rate of complication from the initial cardiac operation including unplanned reoperation, unplanned recannulation to ECMO, sternal wound infection, or other complications. Day of life at the time of GT placement was lower in the group who used the tube for less than 1 y than those who used it for more than 1 y (median 31 d *versus* 61 d; $P < 0.0001$). The number of days from the index cardiac operation to GT placement was lower in the <1 y group (median 24.5 *versus* 33 d, $P = 0.06$) but did not reach statistical significance (Table 1).

When comparing infants who required their GT for more or less than 1 y, no differences were noted in the hospital course prior to GT surgery or the presence of a variety of medical comorbidities (Table 2). Notably, rate of ECMO cannulation during the course of cardiac repair did not differ between groups, nor did the presence of a neurologic deficit such as prior intraventricular hemorrhage or stroke. The number of infants who required oxygen support at the time of GT surgery or hospital discharge also did not differ. The percentage of feeds infants were taking by mouth at either the time of GT surgery or hospital discharge did not differ between groups.

Discussion

GT placement among infants with CHD is associated with any complication about one-fourth of cases and the same number of infants using the tube for 1 y or less. Need for repeat operation to close the GC fistula occurs in about one-third of children who have their tube removed. We found that younger age at time of GT placement was related to shorter duration of GT use with more than half of infants in whom GT was placed prior to 30 d of life required the tube for less than 1 y. Based on these data, we recommend careful consideration prior to GT surgery in infants before 30 d of age to avoid unnecessary anesthesia events and exposure.

Fortunately, no infants in our series suffered anesthetic-related complications; however, we know that general anesthesia is high risk in this population including risks of cardiovascular and respiratory complications as well as the impact of multiple anesthetic exposures on neurocognitive development.[16,17] Anecdotally, part of the motivation to conduct this review stemmed from a case at our institution where an infant acutely decompensated during GT surgery requiring emergent ECMO cannulation. Although events such as these are rare with none in the current series, the possibility has motivated us to consider the true risks of this

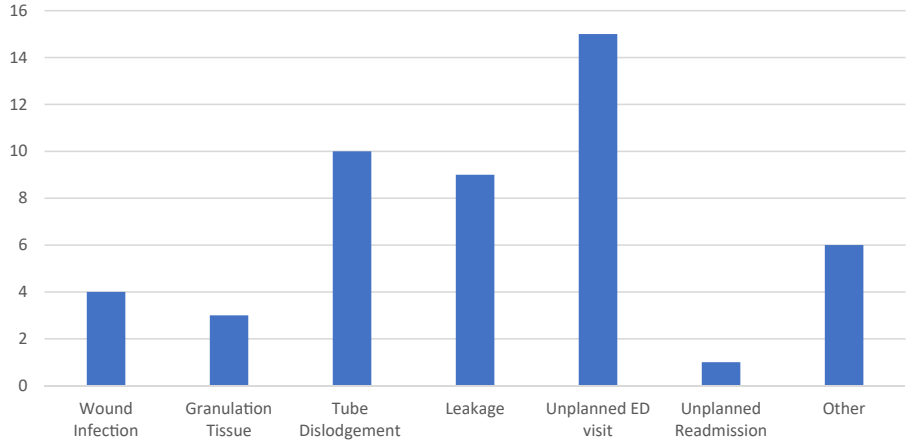

Fig. 1 – Gastrostomy tube complication occurences and type among infants with CHD following cardiac surgery.

Table 1 – Characteristics of infants who required gastrostomy for more or less than 1 y following an initial cardiac operation.

Variable	<1 y (*n* = 34)	>1 y (*n* = 99)	*P* value
Male sex, *N* (%)	22 (65%)	56 (56%)	0.43
Race, *N* (%)			0.74
White	24 (71%)	69 (69%)	
Black or African American	2 (6%)	5 (5%)	
Asian	0 (0%)	4 (4%)	
American Indian or Native Alaskan	2 (6%)	3 (3%)	
Unknown	6 (18%)	18 (18%)	
Ethnicity, *N* (%)			0.53
Hispanic or Latino	13 (38%)	33 (33%)	
Not Hispanic or Latino	17 (50%)	59 (59%)	
Unknown	4 (12%)	7 (7%)	
Gestational age at birth (wk), median (IQR)	39 (3.78, 39)	38 (36, 39)	0.003
Live in rural location, *N* (%)	7 (21%)	18 (18%)	0.8
Miles from hospital of home address, median (IQR)	43.5 (12, 294.8)	62 (18, 136)	0.33
Staged cardiac operation, *N* (%)	15 (44%)	48 (48%)	0.69
Complication from cardiac operation, *N* (%)	17 (50%)	46 (46%)	0.84
Days from cardiac operation to GT, median (IQR)	24.5 (18.8, 37)	33 (20.8, 57.3)	0.06
Day of life at GT, median (IQR)	31 (26.5, 48.25)	61 (37, 102)	<0.0001
Weight at GT (kg), median (IQR)	3.5 (3.2, 4.2)	3.85 (3.3, 4.7)	0.042

GT = gastrostomy tube; IQR = interquartile range.

seemingly simple intervention. Children with CHD have higher rates of perioperative cardiac arrest.[14] Groups at highest risk include those with SVP, severe pulmonary hypertension, those with more complex lesions such as HLHS, and decreased ventricular function.[14] Given these known risks, it is important to weigh the true risks and benefits of GT placement prior to subjecting an infant to a general anesthetic. An important takeaway from our series is the high rate of GC fistula closure in this population which is similar to other published data reporting about one-third of children requiring GC fistula closure after GT removal.[18] Given the known risks of anesthesia in this population, it is important to also counsel families about this relatively high risk of need for future surgery.

Table 2 – Comorbidities of infants who required gastrostomy for more or less than 1 y following an initial cardiac operation.

Comorbidity	<1 y (*n* = 34)	>1 y (*n* = 99)	*P* value
Medical comorbidities, any, *N* (%)	13 (38%)	23 (23%)	0.12
IVH/stroke/seizures, *N* (%)	1 (3%)	7 (7%)	0.68
Oxygen requirement at GT surgery, *N* (%)	13 (38%)	49 (49%)	0.32
Oxygen requirement at discharge, *N* (%)	10 (29%)	35 (35%)	0.68
AKI or renal failure, *N* (%)	0 (0%)	11 (11%)	0.07
Liver disease, *N* (%)	2 (6%)	3 (3%)	0.6
Genetic syndrome, *N* (%)	5 (15%)	27 (27%)	0.17
Prior episode of pneumatosis intestinalis, *N* (%)	5 (15%)	10 (10%)	0.53
Prior abdominal operation, *N* (%)	0 (0%)	2 (2%)	1
Prior ECMO run, *N* (%)	6 (18%)	17 (17%)	1
Length of ECMO (d), median (IQR)	4.5 (2, 9.5)	5.5 (3.3, 21.5)	0.39
Aspiration prior to GT, *N* (%)	19 (56%)	38 (38%)	0.11
Percentage of oral intake at time of GT, median (IQR)	7.5 (0, 25)	0 (0, 16.3)	0.18
Percentage of oral intake at discharge, median (IQR)	12 (0, 25)	0 (0, 20)	0.23

IVH = intraventricular hemorrhage; GT = gastrostomy tube; AKI = acute kidney injury; ECMO = extracorporeal membrane oxygenation; IQR = interquartile range.

The risk of any complication related to GT placement is actually lower in our series than has been previously reported. The rate of tube dislodgement has been documented to be underestimated but has been reported to occur in up to 22% of young children with GTs.[19,20] Among a similar series of infants with CHD who underwent GT placement, Tran *et al*. reported a complication rate of 66% consisting primarily of unplanned clinic visits and granulation tissue.[2] The difference in rate documented in our series is likely related to the very limited time frame in which we defined postoperative complications (within 2 wk of surgery for granulation tissue and 30 d for all others). The rate of granulation tissue at any time after surgery, necessitating intervention, is certainly higher than the rate reported here.

We hypothesized that factors such as complications following the initial cardiac operation or demographic characteristics might also aid in identifying which infants would require their GT for a longer period of time. However, our data did not support our hypotheses. We did not find that infants who had suffered a complication such as sternal wound infection or unplanned reoperation after open cardiac surgery or infants with more complex heart lesions who required staged repair were more likely to require the GT for longer than those who had not suffered such complications or required additional cardiac surgery. It is likely that our study is underpowered to detect these true differences; however, the data did not show even trend toward these findings suggesting that the conclusions of the current analysis are valid. Interestingly, we thought that infants who underwent GT due to aspiration (as opposed to inadequate oral intake) may require the tube for longer while the aspiration resolved. However, that hypothesis was also not supported by the data. Our hospital serves a seven-state region with many patients traveling long distances for specialized care. We also evaluated physical distance from the hospital as well as home address in a rural location as potential factors to help identify children who would use their GT for longer periods of time, but again, the data did not support these hypotheses. Neither did the presence of any comorbidity evaluated. The only factor that seemed to identify shorter duration of GT use was younger age at placement.

Although not common practice at our center, NG feeds are a viable alternative to permanent enteral access. The published literature documenting both the safety of home NG feeds and potential benefits is growing. Previous studies have shown home NG feeds are associated with a lower rate of complications and ED visits when compared to GT feeds.[8-11] While GT placement may be considered a more stable form of enteral supplementation, it may be beneficial to consider NG tube feeds for infants with proper family support and care. Pediatric surgeons and cardiologists should consider the risks and benefits of GT placement as well as alternative means of supplemental feeding, including NG feeding, when counseling families and making treatment recommendations.

Potential limitations of the study are important to consider. Use of a single-system electronic medical record may have caused lapses in data, notably in the rural community where families may have had medical visits in smaller community hospitals with different electronic medical record. This source of error in the data reported would underestimate the rate of complications. The true rate may be higher than reported currently and would not change the conclusions of the current dataset. Additionally, data presented regarding length of time a GT was used are based primarily on information reported by the parents. Additionally, our data are limited by the small sample size and retrospective nature of the study. Despite these limitations, we believe our data add important information to the literature that can inform parental counseling and care decisions.

Although considered safe, GT placement after cardiac surgery in infants with CHD is not risk-free, with about one-fourth of infants experiencing complications. Length of time a GT is used is associated with age at the time of GT surgery, with lower age being associated with shorter duration of use of the GT. Age, comorbidities, distance from home, and surgery type are important factors to consider in choosing the best feeding methods. During consent, risks should be discussed in detail to ensure best patient outcomes. Alternatives such as NG tube feeds should be presented and offered to parents of appropriately selected infants.

Level of Evidence

III, Retrospective Single-Center Review

Disclosure

None declared.

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CRediT authorship contribution statement

Andy Ascencio: Conceptualization, Data curation, Writing – original draft. **Stephanie Fingland:** Conceptualization, Data curation, Writing – review & editing. **Jose Diaz-Miron:** Conceptualization, Methodology, Supervision, Writing – review & editing. **Nell Weber:** Conceptualization, Data curation, Writing – review & editing. **Jonathan Hills–Dunlap:** Conceptualization, Investigation, Methodology, Supervision, Validation, Writing – review & editing. **David Partrick:** Conceptualization, Methodology, Writing – review & editing. **Shannon N. Acker:** Conceptualization, Formal analysis, Investigation, Methodology, Project administration, Resources, Supervision, Validation, Writing – original draft, Writing – review & editing.

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