Early Human Development 103 (2016) 97–100

Contents lists available at ScienceDirect

Early Human Development

journal homepage: www.elsevier.com/locate/earlhumdev

Gastrostomy tube placement in infants with congenital diaphragmatic hernia: Frequency, predictors, and growth outcomes

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ARTICLE INFO

Article history:
Received 10 June 2016
Received in revised form 8 August 2016
Accepted 9 August 2016
Available online xxxx

Keywords:
Neonate
G-tube
Feeding

ABSTRACT

Background: Gastrostomy tube (G-tube) placement is a common intervention for newborns with severe feeding difficulties. Infants with congenital diaphragmatic hernia (CDH) are at high risk for feeding problems. Prevalence of G-tube placement and consequent nutritional outcomes of infants with CDH and G-tubes has not been described.
Aims: Determine factors associated with G-tube placement and growth in infants with congenital diaphragmatic hernia.
Study design: Retrospective cohort study of infants with CDH to evaluate the association of G-tube placement with risk factors using logistic regression. We also assessed the association between growth velocity and G-tube placement and other risk factors using linear regression.
Subjects: The subjects of the study were infants with CDH treated at Duke University Medical Center from 1997 to 2013.
Outcome measures: Weight gain in infants with CDH that had G-tube placement compared to those infants with CDH that did not.
Result: Of the 123 infants with CDH, 85 (69%) survived and G-tubes were placed in 25/85 (29%) survivors. On adjusted analysis, extracorporeal membrane oxygenation (OR = 11.26 [95% CI: 1.92–65.89]; P = 0.01) and proton pump inhibitor use (OR = 17.29 [3.98–75.14], P ≤ 0.001) were associated with G-tube placement. Infants without G-tubes had a growth velocity of 6.5 g/day (95% CI: 2.5–10.4) more than infants with G-tubes.
Conclusion: Survivors with more complex inpatient courses were more likely to receive G-tubes. Further investigation is needed to identify optimal feeding practices for infants with CDH.

1. Introduction

Congenital diaphragmatic hernia is associated with 30–50% mortality despite ongoing efforts to improve outcomes by establishing management guidelines [1–4]. Surviving infants experience long term health complications that affect multiple organ systems, including the lungs, heart, and gastrointestinal tract. Gastrointestinal morbidity can be particularly severe and can manifest in oral aversion, gastroesophageal reflux disease (GERD), or malnutrition as evidenced by growth failure or delayed growth [2,5]. Clinical practices involved with addressing feeding issues vary across physicians and institutions, and one such practice includes placement of a G-tube to address severe feeding difficulties [1].

Risk factors that predict placement of G-tubes and guidelines which prompt the use of G-tubes, along with the consequent nutritional outcomes, in infants with CDH are not well established. Our current approach at Duke University Medical Center is to make a multidisciplinary decision among the primary medical provider, patient's family, occupational and speech therapists, and pediatric surgeons for the need for and timing of G-tube placement, with minimal objective standard approach. The primary aim of this study is to report the frequency of G-tube placement in infants with CDH at a single tertiary intensive care nursery over a 16 year period using this relatively subjective strategy, and identify factors that are associated with G-

Abbreviations: CDH, congenital diaphragmatic hernia; CLD, chronic lung disease; ECMO, extracorporeal membrane oxygenation; GERD, gastroesophageal reflux disease; G-tube, gastrostomy tube; ICN, intensive care nursery; OT, occupational therapy; PFT, pulmonary function tests; PPI, proton pump inhibitor; REE, resting energy expenditure.

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http://dx.doi.org/10.1016/j.earlhumdev.2016.08.003
0378-3782/

tube placement. The secondary aim is to assess how our current practice with use of G-tubes is associated with long term growth outcomes in infants with CDH.

2. Methods

2.1. Study design

This was a retrospective cohort study of infants with CDH cared for at the Duke University Medical Center ICN from 1997 to 2013. We included all surviving infants who: 1) received care at Duke University ICN, including transfers; 2) were diagnosed with right- or left-sided CDH prenatally via ultrasound or postnatally via clinical or imaging findings. Using electronic medical records, we collected demographic and clinical information including birth weight, gestational age, Apgar score at 5 min, chromosomal anomaly, extracorporeal membrane oxygenation (ECMO) requirement, ventilator support, type of repair, side of defect, inpatient medications (dexmedetomidine, sildenafil, nitrous oxide, proton pump inhibitor (PPI), H2 antagonist, metoclopramide, vasopressors, diuretics), discharge medications, G-tube placement in the first 12 months of life, and feeding information (including number of days before initiating feeds, TPN use, and type of feeds: mother's milk, donor human milk or formula). Outpatient data, focusing on weight and development, were also collected from the NICU follow-up clinic visit closest to one year of age. Growth percentiles were determined using WHO Child Growth Standards [6]. The Duke Institutional Review Board gave permission to conduct the study.

2.2. Definitions

Presence of chromosomal anomaly, or clinical signs consistent with a chromosomal anomaly, was recorded based on prenatal ultrasound diagnosis or genetic testing conducted prenatally or postnatally. Infants with a structural cardiac abnormality on echocardiogram (including ventricular septal defect, atrial septal defect, hypoplastic left heart, and coarctation of the aorta) were classified as having congenital heart disease. Infants whose only structural cardiac defect(s) consisted of patent ductus arteriosus or patent foramen ovale were not classified as having congenital heart disease. We classified the source of feedings throughout hospitalization: mother's milk, donor human milk, cow's milk formula, or elemental formula. Type of repair included either patch repair or primary repair. The following comorbidities were defined by the types of medications that were prescribed: GERD (PPI, H2 antagonist, or metoclopramide); pulmonary hypertension (sildenafil or nitric oxide); hypotension (epinephrine); or chronic lung disease (inhaled budesonide, diuretics, supplemental oxygen). We also recorded the use of dexmedetomidine, which is often administered for sedation during and after ECMO at our center. Growth velocity was defined as the change in weight between date of discharge for the non G-tube group or G-tube placement and follow-up divided by the number of days between those time points. We determined growth to be “adequate” if an infant met at least 1 of 2 criteria: 1) weight percentile of >10% at approximately one year post-discharge follow-up; or 2) increased weight percentile at follow-up compared to time of G-tube placement or discharge from the hospital.

2.3. Statistical analysis

We divided surviving infants into 2 groups: those with G-tube placement and those without G-tube placement. Because our center instituted management guidelines for infants with CDH in 2002 [4], we evaluated the number of survivors and percentage of survivors with G-tubes over time. In order to evaluate the presence of long-term morbidities, we compared the prevalence of certain discharge medications (PPIs, ranitidine, metoclopramide, diuretics, and budesonide) between groups using Fisher's exact test. We also compared the presence of modifiable and non-modifiable risk factors for G-tube placement and growth velocity between these 2 groups using Fisher's exact test. Risk factors were divided into 3 categories: category 1) non-modifiable risk factors; category 2) modifiable risk factors that usually occur within the first week of life; and category 3) modifiable risk factors that usually occur after the first week of life.

We used multivariable logistic regression to identify significant risk factors associated with the decision to place a G-tube. We used multivariable linear regression to identify significant risk factors associated with growth velocity. In the first step of the logistic and linear regression analyses, Category 1 risk factors were entered to create a model (Model 1). Risk factors with $P < 0.1$ in this analysis were entered into a new model (Model 2) along with addition of Category 2 risk factors. Risk factors with $P < 0.1$ from Model 1 or Model 2 were entered into a new model (Model 3) with addition of risk factors from Category 3. The final model (Model 4) was created using all risk factors with $P < 0.1$ from Models 1, 2, or 3. P-values < 0.05 were considered significant. Preliminary data was collected using Microsoft Excel 2010, and statistical analyses were performed using Stata 13 (College Station, TX).

3. Results

In the cohort of 123 infants with CDH, 85 (69%) survived. For these survivors, diaphragmatic hernia repair surgery was performed on median day of life 6 (25th–75th percentile: 3–11), and G-tubes were placed in 25/85 (29%). Of those with G-tube placement, 14/25 (56%) also had Nissen fundoplication, and 3/25 (12%) G-tubes were placed after discharge (26, 93, and 159 days after). The non-modifiable factors in the survivors were comparable between those with and without G-tube placement (Table 1). Those survivors who required G-tube placement had more intensive medical therapeutic interventions within the first week of life, including ECMO and epinephrine exposure and longer duration of hospitalization. The median length of initial hospitalization for infants with G-tube placement was 101 days (77–122), compared to 22 days (11 — 31) in those who did not have G-tube placement. Over the 16 year time span, there was variability in the frequency of G-tube placement and in the number of surviving infants with CDH without any apparent trends (Fig. 1). A greater proportion of survivors with G-tubes received GERD treatment during hospitalization (68% with PPI)

Table 1
Demographics.

	G-tube (n = 25)	No G-tube (n = 60)	P-value
Category 1: non-modifiable risk factors			
Birth weight ≥ 2500 g	80%	93%	0.08
Gestational age ≥ 36 weeks	88%	93%	0.41
Prenatal diagnosis	72%	47%	0.06
Female	40%	28%	0.32
Hispanic ethnicity	20%	23%	>0.99
Apgar at 5 min ≥ 5	84%	83%	0.15
Chromosomal anomaly	4%	5%	0.79
Congenital heart disease	28%	28%	>0.99
Category 2: modifiable risk factors within first week			
ECMO	48%	3%	<0.001
Epinephrine	76%	42%	0.01
Nitric oxide	84%	40%	<0.001
Repair by 1 week	24%	72%	<0.001
Category 3: modifiable risk factors after first week			
Proton pump inhibitor	68%	10%	<0.001
H2 receptor antagonist	76%	37%	0.002
Sildenafil	24%	2%	0.002
Dexmedetomidine	28%	5%	0.01
Any maternal breast milk	36%	65%	0.02

ECMO: extracorporeal membrane oxygenation; G-tube: gastrostomy tube.