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Oral feeding outcomes in infants with esophageal atresia and tracheoesophageal fistula☆,☆☆

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ABSTRACT

Purpose: The purpose of this study was to explore oral feeding outcomes in infants born with type-C esophageal atresia and tracheoesophageal fistula (EA/TEF).
Methods: A retrospective cohort study of all infants born between January 2005 and December 2015 undergoing surgery for type-C EA/TEF at the University of Alberta Hospital was performed.
Results: Fifty-seven infants were identified, of which 61.4% were exclusively orally feeding at discharge home. Variables anticipated to predict oral feeding were explored. Only 46% of babies with a structural cardiac anomaly had exclusive oral feeding compared to 79% without cardiac anomaly, $p = 0.055$. Logistic regression identified the presence of structural cardiac anomaly and corrected gestational age at discharge as significant negative predictor variables for exclusive oral feeding at discharge home. Additional regression analyses found early transanastomotic feeding to be a significant positive predictor for the discontinuation of PN.
Conclusion: We report the rate of oral feeding at discharge for infants born with type-C EA/TEF and identify predictor variables. This information is important for health care professionals and the families of children born with EA/TEF, because a significant number will go home with supplemental nutrition by gavage tube or other routes.
Level of Evidence: Level 2.

Esophageal atresia and/or tracheoesophageal fistula (EA/TEF) is an uncommon congenital abnormality occurring secondary to abnormal tracheoesophageal organogenesis during embryological development [1,2]. The overall incidence is approximately one in 2500 to 4500 live births [1–4]. The most common anatomical variation of EA/TEF is a proximal esophageal pouch with a distal tracheoesophageal fistula, classified as type-C EA/TEF, which accounts for approximately 84% of all cases of EA/TEF [1].

A surgical repair for type-C EA/TEF is typically undertaken in the first week of life to establish esophageal continuity and divide the tracheoesophageal fistula. Substantial variation, however, exists in the medical management of these infants perioperatively, and individual surgical practices also vary between and within institutions [5]. Best practices need to be established for perioperative and surgical care guided by meaningful outcomes for these infants and their families. One such important outcome is feeding.

Studies have shown that feeding difficulties are common after repair of EA/TEF including issues such as coughing, choking, vomiting, oral aversion, gastroesophageal reflux (GERD), dysphagia, and/or simply being slow to feed [6–10]. Challenges with feeding are important to consider as they may compromise the developing relationship between mother and child [11]. More so, multiple studies have shown the association of oral feeding issues and developmental outcomes in infants with varying medical conditions [12–15]. There is, however, a paucity of research specifically exploring feeding outcomes for infants born with EA/TEF. The purpose of this study was to explore oral feeding outcomes in infants born with type-C EA/TEF.

1. Materials and methods

1.1. Study design and setting

We conducted a retrospective cohort study of all infants undergoing surgery for type-C EA/TEF at the University of Alberta Hospital in Edmonton, Alberta, Canada born between January 2005 and December 2015. This level III NICU unit has an active surgical program with

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approximately 500 admissions per year. It is also the surgical site for a second level III NICU unit with high-risk perinatology services with approximately 1300 admissions per year. Patients were identified by a review of hospital databases. All infants with type-C EA/TEF were included regardless of comorbidities, anomalies, or syndromes.

Study data were collected and managed using REDCap (Research Electronic Data Capture), hosted at the University of Alberta [16]. REDCap is a secure, web-based application designed to support data capture for research studies, providing (1) an intuitive interface for validated data entry; (2) audit trails for tracking data manipulation and export procedures; (3) automated export procedures for seamless data downloads to common statistical packages; and (4) procedures for importing data from external sources. The University of Alberta Health Research Ethics Board approved the study (Pro00049254).

1.2. Patients, variables, and outcome measures

Variables were chosen based on review of the literature as well as consultation with physician experts in neonatal surgical care. Collected patient demographics included: gestational age, birth weight, gender, and identified comorbidities. Structural cardiac anomaly was defined as the presence of cardiac anomaly other than, or in addition to, a patent ductus arteriosus and/or atrial septal defect. VACTERL syndrome was defined as the presence of two anomalies known to be associated with VACTERL in addition to EA/TEF [17]. Suspected VACTERL included presence of only one additional anomaly to EA/TEF. Perioperative data included: date of surgery, use of transanastomotic feeding tube, date of initiation of oral feeds, and date of parenteral nutrition (PN) discontinuation. Early transanastomotic feeding was additionally specified as use of transanastomotic feeding tube prior to esophagram. Feeds at discharge home were categorized based on use of tube feeds and/or PN. Wound complications included: wound infection, defined as clinical signs of infection of the surgical wound treated with antibiotics for five days or more; and, wound dehiscence, defined as separation of all layers of the chest wall. Recurrent fistula, anastomotic leak, and esophageal strictures/stenosis were determined by esophagram. Medical complications included tracheomalacia documented by laryngoscopy, GERD by use of anti-reflux medications at time of discharge home, and necrotizing enterocolitis (NEC) by Bell stage 2 or higher.

1.3. Statistical analysis

Continuous variables were described by medians and ranges because of their non-normal distributions. Categorical/ordinal variables were presented as frequencies and percentages. For bivariate regression, all non-missing values were included. Infants who were transferred to another hospital were excluded, with the exception of those who were exclusively orally feeding as these were assumed to be discharged home on oral feeds. Binomial logistic regression was used to ascertain the effects of certain variables on whether the infant has exclusive oral feeding upon discharge home. Ordinal logistic regression was performed to identify variables that had an effect on the time for PN discontinuation. PN discontinuation was categorized into 4 categories: 6–9 days, 10–11 days, 12–17 days, and 18 days or more. A p-value of <0.05 was considered statistically significant. Statistical analysis was performed using SPSS, version 24 (IBM Corp, Armonk, NY, USA).

2. Results

During the study period, 68 infants with EA/TEF were identified, 57 (83.8%) of which were type-C. Clinical demographics for these 57 patients are reported in Table 1. Most infants were born at term (35/57; 61.4%). VACTERL was suspected or diagnosed in about half (31/57; 54.4%) of infants. No other clinical syndromes were identified.

Perioperative and outcome data are reported in Table 2. Age at operation was positively skewed with most infants undergoing repair in the first 2 days of life. Surgical complications were relatively uncommon in our cohort. Only two patients (3.5%) had an anastomotic leak that required withholding feeds. Recurrent fistulas were seen in two patients (3.5%). Reflux was present in almost two thirds of our cohort (36/57; 63.2%) and almost a quarter (12/57; 21.1%) were diagnosed with tracheomalacia. Four patients (4/57; 7.0%) had a symptomatic esophageal stricture/stenosis identified, which were all dilated during the same hospital admission.

Although the majority of patients had transanastomotic feeding tubes placed intraoperatively (49/57; 86%), a minority (15/57; 26.3%) had transanastomotic feeding initiated prior to postoperative esophagram. Oral feeds were typically started only after an esophagram, which was obtained at median 7 days postoperatively. Approximately a third of infants (17/57; 29.8%) received no enteral feeds for their first 7 days of life. PN was discontinued by median 11 days of age. Although most infants were exclusively orally feeding at discharge home (35/57;

Table 1
Patient demographics.

	Median (min, max); proportion (%)
Gestational age (weeks)	37.4 (26.0, 42.3)
Birth weight (grams)	2660 (840, 4190)
Male Gender	33/57 (57.9)
Structural cardiac anomaly	
No	42/57 (73.7)
Yes	15/57 (26.3)
Clinical syndrome	
VACTERL	15/57 (26.3)
Suspected VACTERL	16/57 (28.1)
None	26 /57 (45.6)

Table 2
Perioperative and outcome variables.

	Median (min, max); proportion (%)
Age at OR (days)	2 (0, 90)
Surgical complications	
Wound infection	5/57 (8.8)
Wound dehiscence	4/57 (7.0)
Recurrent fistula	2/57 (3.5)
Anastomotic leak	2/57 (3.5)
Symptomatic anastomotic stenosis/stricture[†]	4/57 (7.0)
Medical complications	
Tracheomalacia	12/57 (21.1)
GERD	36/57 (63.2)
NEC	0/57 (0)
Transanastomotic feeding tube	49/57 (86.0)
Early transanastomotic feeding[*]	15/57 (26.3)
Initiation of transanastomotic feeding (days)[**]	7.0 (1, 18)
Initiation of oral feeds (days)[§]	8.0 (6, 49)
PN discontinuation (days)[¥]	11.0 (6, 98)
Feeds at discharge home *(Gavage feeds = NG, NJ, or G-tube)*	
Exclusively oral	35/57 (61.4)
PO + Gavage	10/57 (17.5)
Gavage only	6/57 (10.5)
Gavage + PN	1/57 (1.8)
PO + Gavage + PN	1/57 (1.8)
Missing data	*5/57 (7.0)*
Discharge disposition	
Home	45/57 (78.9)
Hospital	11/57 (19.2)
Missing data	*1/57 (1.8)*
Length of stay (days)	23 (8, 150)
Corrected gestational age at discharge home (weeks)[∞]	42.4 (36.6, 61.6)

[†] Identified and treated with dilatation during same hospital admission.
[*] Tube feeds initiated prior to esophagram.
[**] Time taken for the initiation of transanastomotic feeding after surgery.
[§] Time taken for the initiation of oral feeds after surgery.
[¥] Time taken for the discontinuation of PN after surgery.
[∞] Corrected GA calculated as: GA + [(date of discharge - date of birth) / 7].