Journal of Cardiovascular Disease Research
ISSN: 0975-3583, 0976-2833 VOL 13, ISSUE 05, 2022

Original Research Article

A RETROSPECTIVE STUDY ON ENTERAL FEEDING IN NEONATES WITH CONGENITAL HEART DISEASE AT A TERTIARY CARE CENTER

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Abstract
Introduction: The incidence of congenital heart defects (CHD) is about 8 per 1000 live births, and the defects are generally classified into cyanotic and acyanotic CHD.[1] Both these groups have different pathophysiology, medical-surgical needs and also varying morbidity related to nutrition and growth failure.[2]
Materials & Methods: This is a Retrospective Observational Study which will be done at the Department of Pediatrics, Gulbarga Institute of medical Sciences, Kalaburagi, Karnataka.
Results: The sample size realized as 72 (n = 72). The overall prevalence of malnutrition was 48%. The change in height of the PN group was significantly higher than the EF group (14.2 ± 7.6 cm vs. 7.4 ± 6.3, P = 0.010), but the weight change was not significantly different (P = 0.28).
Conclusion: Malnutrition occurs frequently with CHD. PN does not add any nutritional benefits compared with EF. EF should always be the preferred method of nutrition unless contraindicated.
Keywords: Congenital heart disease, enteral feeding, malnutrition, parenteral nutrition

Introduction
The incidence of congenital heart defects (CHD) is about 8 per 1000 live births, and the defects are generally classified into cyanotic and acyanotic CHD.[1] Both these groups have different pathophysiology, medical surgical needs and also varying morbidity related to nutrition and growth failure.[2] Furthermore, recent advances in fetal diagnosis, perinatal care, cardiovascular anesthesiology and surgery in neonates with CHD have improved life expectancy.[1,3] However, more infants are now surviving with special needs; these requirements include the need for parenteral nutrition, modified enteral feeding strategies or prolonged respiratory support.[2,4,5] Poor nutritional status resulting from inadequate feeding capabilities in neonates with CHD often leads to an imbalance of energy intake, thus resulting in growth failure. Malnutrition is a recognized problem in this patient population, and often

affects the subsequent stages of cardiovascular surgery depending on the etiology.[6,7] The nature of feeding related disabilities or the timeline for acquisition of feeding abilities in neonates with CHD is not well understood. Knowledge of these facts will help with counseling and also with improving the feeding practice strategies prospectively. Swallowing is present in the fetus by 16 weeks gestation, and these swallowing and feeding functions are expected to be functional at birth in full term healthy neonates.[8,9] Therefore, it is also a hope among parents of high risk infants to expect achievement of feeding skills in their infants. However, in the neonate with CHD, the development of swallowing and feeding related difficulties are frequent concerns. This is more so after correction of CHD, and an estimated incidence of dysphagia varies depending on the risk factors including preoperative acuity, duration of intubation, nature of CHD, vocal cord injury, weight characteristics or type of surgical procedures.[10-12]Our rationale for reporting the characteristics of feeding abilities among acyanotic and cyanotic CHD are obviously due to the developmental heterogeneity of the CHD, and also due to the subsequent variabilities in management strategies as required by their respective patho physiological needs. For example, the treatment and intensive care support strategies depend on the type and severity of the lesion, as neonates with acyanotic CHD receive fewer interventions than those with cyanotic CHD. This may reflect in the duration of respiratory support, narcotic usage, vasopressor usage, the need for cardiopulmonary bypass or enteral tube feeding strategies. Any or all of these may influence feeding milestones. Therefore, our primary objective will be to characterize the feeding milestones in neonates with CHD and identify the associated variables.

Materials& Methods

This is a Retrospective Observational Study which will be done at the Department of Pediatrics, Gulbarga Institute of medical Sciences, Kalaburagi, Karnataka.

Inclusion criteria

All Neonates with Congenital Heart Disease admitted to Sick Newborn Care Unit of Gulbarga Institute of Medical Sciences Hospital between January 2021 to June 2022 will be included.

Exclusion criteria

Neonates with other congenital anamolies.
Neonates with chromosomal syndromes.
Neonates with inborn errors of metabolism.
Neonates with inadequate treatment details.

- Study includes both inborn and outborn neonates admitted to SNCU.
- Data pertaining to the baby's details, maternal details (parity, gestational age, mode of delivery, pre-existing maternal illness, illness during pregnancy, drug intake, etc.), clinical conditions (primary diagnosis, APGAR score, requirement of ventilation, type of ventilation,

duration of ventilation, types of drugs, duration of neonatal intensive care unit [NICU] stay, etc.), and outcome (discharged or expired) will be recorded.

- To assess the feeding abilities, Data will be collected on the timing of feeding initiation, maximal feeds and the feeding methods (oral or gavage). The changes in feeding methods with respect to initiation, gavage, nippling and assisted feeding methods were recorded.
- CHD was classified into the acyanotic and cyanotic groups. The acyanotic group included infants with aortic stenosis, coarctation of the aorta or atrioventricular canal defect, and received intensive care for aortoplasty, repair of coarctations and septal defects or pulmonary artery banding. The cyanotic group included infants with transposition of the great arteries, tetralogy of Fallot, total anomalous pulmonary venous return or hypoplastic left heart syndrome who underwent procedures such as arterial switch operation, Blalock-Taussig shunt or Norwood procedures.
- For the purpose of this study, oro-motor readiness will be defined as ability to take first oral feed; and successful oro-motor skills will be defined as an ability to take maximal oral feeds.
- For the purpose of measuring a fixed milestone in all categories, maximal feeds, whether by gavage or nippling routes will be defined as an ability to tolerate a volume of at least 120 ml/kg/day .
- We will be documenting the age at which these milestones were attained with respect to first gavage feed, maximum gavage feeds, first nipple feeds and maximal nipple feeds.
- The records will be tracked until the end point, which was discharge or death, whichever occurred earlier.

Results

In total, 72 patients were included in the study. The descriptive statistics of the sample are displayed in Table 1. The age mean ± SD was 34.8 ± 14.9 months and the median (IQR range) = 29 (25–38.5) with 54% of female. The mean ± SD baseline (pre-surgery) height was 67.8 ± 17.0 cm and the median (IQR range) 65 (57–75). The mean ± SD baseline (pre-surgery) weight was 6.9 ± 4.4 Kg and the median (IQR range) 5.7 (3.5–9.2). Overall, the average baseline Z-score = −1.8 (SD = 2.4) and the median (IQR) = −1.9 (−3.1–0.6). Significant differences were observed between the PN and EF groups in terms of age and baseline height and weight [Table 1]. The PN group was significantly younger and had a lower height and weight pre-surgery ($P = 0.032$ and $P < 0.001$, respectively). The Z-score at baseline was not significantly different by PN status ($P = 0.68$). The two groups were significantly different in terms of height pre-surgery ($P < 0.001$) and weight pre-surgery ($P < 0.001$). Descriptive statistics for the pre-, post surgery and change in height, weight, and Z-score, overall and by PN status are displayed in Table 2. Patients receiving PN had lower height levels pre- and post surgery and their height change was significantly more than the EF group [14.2 ± 7.6 cm vs.7.4 ± 6.3, p = 0.010]. The PN group also had significantly decreased weight pre-surgery, but their weight change was not significantly different from the EF group (p = 0.28). Descriptive statistics for the pre-, post-surgery and change in height, weight, and Z-score, overall and by PN status are displayed in Table 2. Patients receiving PN had lower height levels pre-and post-surgery and their height change was significantly more than the EF group

ISSN: 0975-3583, 0976-2833 VOL 13, ISSUE 05, 2022

(14.2 ± 7.6 cm vs. 7.4 ± 6.3, *P* = 0.010). The PN group also had significantly decreased weight pre surgery, but their weight change was not significantly different from the EF group (*P* = 0.28). Although the baseline Z-score was not different in the two groups (*P* = 0.68), the post surgery Z-scores were significantly lower in the PN group and their Z-score change was marginally smaller (*P* = 0.086), indicating less improvement or lower growth levels post surgery. Almost half (47.6%) of the patients had malnutrition (defined Z-score <−2). The PN group had a significantly higher incidence of post-surgical malnutrition compared to the EF group (*P* = 0.046). No significant differences were observed between the PN and EF groups in terms of pre surgical malnutrition (*P* = 0.78).The mean and 95% CI change in the Z-score, overall and by PN status are shown in Figure 1. The figure clearly demonstrates the significantly smaller change in the Z-scores of the PN group compared to the EF group. The results from the fitting the multivariate linear regression model for the Z-score change are shown in Table 3. The results show that the PN group had significantly less improvement (more negative change) in the Z-score levels compared to the EF group (parameter estimate [PE] = −1.42, 95% CI = (−2.48,−0.35); *P* = 0.011]. The significantly lower improvement in the Z-score levels was also related to higher Z-score levels pre- surgery [PE = −0.66, 95% CI = (−0.8, −0.51); *P* < 0.001]. Age and gender were not related to change in Z-score levels (*P* > 0.05). The results from the fitting a multivariate logistic regression model for malnutrition post-surgery are displayed in Table 4. The results show that the PN group had higher odds of malnutrition compared to the EF group (OR = 3.77), however, this result was not statistically significant (*P* = 0.17). None of the other factors listed in the model were related to malnutrition (*P* > 0.05). Additional results (not shown) showed that there were no significant differences in post-surgical malnutrition between the patients who were or were not sedated postoperatively (15% vs. 21%; *P* = 0.59)

Table 1: Baseline demographic and clinical factors, overall and byPN status, *n*=72

Factor	Group			*P*-value[a]
	All patients	EF (*n*=63,87.5%)	PN (*n*=9,12.5%)	
Age (months) mean±SD	34.8±14.9	36.2±15.4	24.9±2.1	0.032
Median (IQR)	29 (25–38.5)	30 (26–42)	24 (23–26.5)	
Gender				0.93
Male	33 (45.8%)	29 (87.9%)	4 (12.1%)	
Female	39 (54.2%)	34 (87.2%)	5 (12.8%)	
Height (cm) mean±SD	67.8±17.0	70.3±16.6	50.3±6.2	<0.001
Median (IQR)	65 (57–75)	67 (59–80)	49 (46.3–55.5)	
Weight (kg) mean±SD	6.9±4.4	7.4±4.4	3.0±0.6	<0.001
Median (IQR)	5.7 (3.5–9.2)	6.1 (4.3–10)	3.1 (2.3–3.5)	
Baseline Z-score mean±SD	−1.8±2.4	−1.7±2.3	−2.1±3.0	0.68

median (IQR)	−1.9 (−3.1–0.6)	−2.0 (−3.0–0.6)	−1.0 (−5.1–0.9)	
Malnutrition[b] at baseline *n* (%)	32 (47.6%)	29 (48.3%)	3 (42.9%)	0.78

[a]Based on the Chi-square test or T-test. [b]Indicated by Z-score <−2

Table 2: Descriptive statistics for pre-, post-surgery and change in height, weight, and z-score, overall and by PN status, *n*=72

Factor	Group			*P*-value[a]
	All patients (*n*=72)	EF (*n*=63, 87.5%)	PN (*n*=9, 12.5%)	
Height (cm)				
Baseline (pre-surgery)	67.8±17.0	70.3±16.6	50.3±6.2	<0.001
	65 (57–75)	67 (59–80)	49 (46.3–55.5)	
Post-surgery	76.6±14.3	78.4±14.3	64.5±6.9	0.002
	75.7 (67.3–82.7)	76.7 (71–84.7)	64.8 (60.6–69.6)	
Change (post-pre-surgery)	8.3±6.9	7.4±6.3	14.2±7.6	0.010
	8.6 (3.9–12.5)	7.8 (3.1–11.1)	14.9 (8.6–21.3)	
Weight (kg)				
Baseline (pre-surgery)	6.9±4.4	7.4±4.4	3.0±0.6	<0.001
	5.7 (3.5–9.2)	6.1 (4.3–10)	3.1 (2.3–3.5)	
Post-surgery	9.5±4.4	10.0±4.4	6.1±1.7	0.001
	8.8 (7.0–10.7)	9.2 (7.6–11.7)	6.4 (5.4–7.5)	
Change (post-pre-surgery)	2.6±1.6	2.5±1.7	3.1±1.4	0.28
	2.7 (1.3–4.1)	2.6 (1.0–4.0)	3.8 (2.3–4.1)	
Z-score				
Baseline (pre-surgery)	−1.8±2.4	−1.7±2.3	−2.1±3.0	0.68
	−1.9 (−3.1–0.6)	−2.0 (−3.0–0.6)	−1.0 (−5.1–0.9)	
Post-surgery	−1.3±5.9	−1.2±6.3	−2.0±1.4	0.008
	−0.6 (−1.5–0.03)	−0.5 (−1.3–0.2)	−1.8 (−2.6–0.9)	

Change (post-pre-surgery)	1.3±2.0	1.5±1.9	0.1±2.5	0.086
	1.1 (0–2.6)	1.3 (0.1–2.6)	−0.03 (−1.7–2.9)	
Malnutrition[b] n (%)				
Baseline (pre-surgery)	32 (47.6)	29 (48.3)	3 (42.9)	0.78
Post-surgery	11 (15.9)	8 (13.3)	3 (42.9)	0.046

[a]Based on the T-test or Mann–Whitney U-test. [b]Indicated by Z-score <−2.

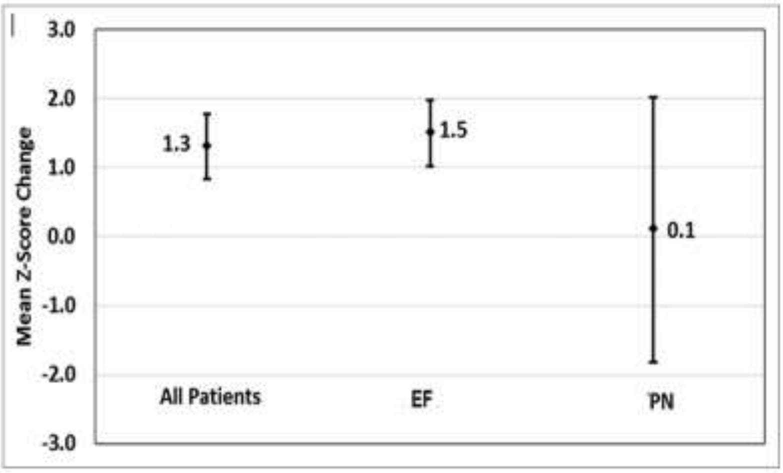

Figure 1: Z-score change = post-pre-surgery Z-score

Table 3: Multivariate linear regression model for Z-score change, *n*=72

Factor	Mean or %	Beta	95% CI	*P*-value
Constant		−0.26	(−1.37,0.85)	
Group				
PN	12.5%	−1.42	(−2.48, −0.35)	0.011
EF	87.5%	0.00	Ref.	
Age (per 10 months)	34.8	0.19	(−0.04, 0.42)	0.12
Gender (male vs. female)	45.8%	−0.34	(−0.98, 0.31)	0.31
Baseline Z-score (per 1 unit)	−1.79	−0.66	(−0.8, −0.51)	<0.001

CI: Confidence interval

Table 4: Multivariate logistic regression model for malnutrition post-surgery, *n*=72

Factor	Mean or %	OR	95% CI	*P*-value
Group				
PN	12.5%	3.77	(0.58, 24.62)	0.17
EF	87.5%	1.00	Ref.	
Age (per 10 months)	34.8	0.44	(0.12, 1.54)	0.20
Gender (male vs. female)	45.8%	0.98	(0.23, 4.13)	0.98

Baseline malnutrition (yes vs. no)	47.6%	3.54	(0.74, 17.03)	0.11

CI: Confidence interval, OR: Odds ratio

Discussion

The WHO recommends using anthropometric indices, weight for age, height for age, and weight for height, to qualify and define nutrition disorders. Malnutrition is characterized by a significant deficit in one or more of these indices. In our study, we used weight for height to classify malnutrition, as this index is more accurate in describing the term "wasting," which is widely used when the malnutrition is secondary to starvation or severe illness. Consequently, we classified the patient as malnourished if the child had a WHZ < (−2).[15]Due to physiologic differences between parenteral and enteral delivery of nutrients, an accurate comparison of the two methods is difficult. However, most clinicians report that feeding through the enteral route should always be the preferred method. A randomized clinical trial[16] reported that early initiation of PN was associated with longer duration of ICU stay, longer duration of mechanical ventilation, and increased rate of new infections. Based on these findings the Society of Critical Care Medicine and the American Society for Parenteral and Enteral Nutrition recommended against early initiation of PN after admission to the pediatric intensive care unit (PICU). In contrast, early initiation and advancement of EF as tolerated was recommended after PICU admission.[17]Malnutrition is known to affect morbidity and mortality.[18,19] According to the WHO, 52 million patients, <5 years old, suffer from wasting, 17 million from severe wasting, and 155 million from stunting.[15] The percentage of malnutrition (wasting) in the current study was 47.6%, similar to the prevalence reported by Okoromah *et al*. (41%) in a case control study conducted at a tertiary teaching hospital in Lagos, Nigeria.[21] The prevalence of the current study was higher than the 22% reported by Ratanachu ek and Pongdara but lower than the 59.9% reported by Vaidyanathan *et al*.[21] The combined proportion of malnutrition for Ratanachu ek and Pongdara, which included weight for height, weight for age, and height for age Z-scores, was 40%.[21] In another study, the prevalence (28.2%) was determined based on the weight for age Z-score (WAZ) to define malnutrition.[19]The dietary intake of a patient plays a major role in determining the nutritional status. Children are continuously developing beings that depend on food as a source for development. The patients who required PN were younger and had a significantly lower height and weight, even after adjusting for their age. PN use was associated with a negative nutritional status. The only positive significant effect of PN on the patients' nutritional status was the height. The Z-score improvement was significantly enhanced for patients receiving EF. Kelleher *et al*. reported that a short time on PN was associated with a reduced weight for age Z-score.[22]Patients who needed post surgical PN obviously had a poor nutritional status before the surgery. In addition, their nutritional status development after the surgery was not adequate and most were malnourished. We suggested that post surgical sedation possibly played a role in affecting the nutritional status, but in this study, it was not affected by the sedation status. The current study did not show any correlation between age at the time of surgery and the nutritional status. Controversially, Arodiwe *et al*. and Venugopalan *et al*. reported a significant correlation between age at presentation and malnutrition, and they concluded that an older age was a predictor of poor growth.[23] Of the sample, 32 children were malnourished at the baseline; however, only 11 children maintained their malnourished status after the surgery. We can deduce that more than 60% of the status of the malnourished children improved after thecorrectional heart surgery.

Conclusion

Malnutrition occurs frequently in children with CHD; the prevalence is 48%. There was no correlation between the age at presentation (at surgery) or post-surgical sedation, and the prevalence of post operative malnutrition. Surgical correction of the defect obviously improves the nutritional status. The baseline weight and height, in addition to the need for PN use, are considered predictors of a poor prognosis. We encourage the use of EF over PN for the child post cardiac surgery wheneverpossible.

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