Nutritional Status of Pediatric Patients with Congenital Heart Disease: Pre- and Post Cardiac Surgery

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Background: *Malnutrition is common in infants and children with congenital heart disease (CHD). Cardiac surgery has improved patient survival and nutritional status.*
Objective: *To evaluate the impact of cardiac surgery on nutritional status of pediatric patients with CHD.*
Material and Method: *A prospective cohort study was conducted in pediatric patients with CHD, admitted for cardiac surgery at Queen Sirikit National Institute of Child Health (QSNICH), Bangkok, from August 1st, 2002 to 2003. Demographic data, cardiac and related problems were obtained before operation. Anthropometry was performed at the presentation and post cardiac surgery. Nutritional status was assessed by Z-score of weight for age (ZWA), weight for height (ZWH) and height for age (ZHA). Malnutrition was defined as Z-score <- 2 and compared pre- and post-operation using Chi-square. Paired t-test was used to compare mean Z-score and p-value < 0.05 was statistically significant.*
Results: *All of 161 pediatric patients with CHD undergoing cardiac surgery were 41% males and 59% females. Patients' age ranged from 1 month to 15 years. The related problems included low birth weight (28%) and feeding problem (58%). The most common CHD was ventricular septal defect (29%). The nutritional status of the patients before surgery was defined as normal 57%, malnutrition 40% and over-nutrition 3%. Malnutrition included underweight 28%, wasting 22% and stunting 16%. Post cardiac surgery, the means of ZWA, ZWH and ZHA were significantly increased and the prevalence of underweight and wasting were decreased to 17% and 6% respectively, with statistically significant from the baseline (p < 0.05).*
Conclusion: *Malnutrition was found in 40% of pediatric patients with CHD and cardiac surgery has a significant positive effect on weight gain and nutritional status.*

Keywords: *Congenital heart disease, Cardiac surgery, Nutritional status, Malnutrition*

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Children with congenital heart disease (CHD) require adequate nutrition for growth and development. Their nutritional status may be complicated by high caloric needs and low reserves. Children with CHD are often poor feeders, having difficult eating and dyspnea leading to failure to thrive[1]. More than half of infants with CHD were malnourished, commonly in admitted cases[1-3]. Children with CHD have a high basal metabolic rate leading to high caloric requirement[3,4]. These children consumed inadequately due to fatigue, poor appetite, intestinal dysmotility and malabsorption, leading to malnutrition[1,5]. Cardiac surgeries have improved patient survival and nutritional status by reducing morbidity and energy expenditure and increasing food consumption[3]. Most children have no difficulty gaining weight post operation.

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Objective

To evaluate nutritional status of the pediatric patients with congenital heart disease before and after cardiac surgery.

Material and Method

A descriptive, prospective cohort study was performed in pediatric patients with congenital heart disease admitted for cardiac surgery at Queen Sirikit National Institute of Child Health (QSNICH), from 1st August 2002 to 1st August 2003. Information including demographic data, cardiac problems, feeding problems and growth parameters was obtained from patient

records and parental interview, before operation and after operation for 1 year. Nutritional status was assessed by Z-score of weight for age (ZWA), weight for height (ZWH) and height for age (ZHA)[6], using Thai Growth Reference of Ministry of Public Health, 1999[7].

Nutritional status was defined as follow[6]:

Normal nutritional status	ZWA, ZWH, and ZHA	$\leq +2$ to ≥ -2
Underweight	ZWA	< -2
Wasting	ZWH	< -2
Overweight	ZWH	$> +2$
Stunting	ZHA	< -2

Cardiac surgery was classified as follows: total correction without major anatomical defect after surgery and palliative surgery to improve hemodynamic problem but remained anatomical defects.

Statistical analysis

Data were analyzed descriptively. Nutritional status of these cases were identified and compared between pre- and post cardiac surgery, using Chi-square test. ZWA, ZWH and ZHA were compared periodically pre- and post operation, using paired t-test. P-value < 0.05 was statistically significant.

Results

One hundred and sixty-one pediatric patients with congenital heart disease were 41% males and 59% females, with a male to female ratio of 0.7: 1 (Table 1). Birth weights of 112 patients revealed that the majority (71%) had normal birth weight (2,500-4,000 grams), 28% had low birth weight (< 2,500 grams) and only one patient (1%) weighed more than 4,000 grams. Thirty-two percent had a history of postnatal problems and 58% had feeding problems as poor feeding and dyspnea. Age of the patients ranged between 1 month and 15 years. Forty percent of cases were older than 5 years and 25% was under 1 year (Table 2). Congenital heart diseases are classified in Table 3 as acyanotic heart diseases 127 cases (79%) and cyanotic heart diseases 34 cases (21%). The most common congenital heart diseases were: ventricular septal defect (29%), followed by patent ductus arteriosus (22%), atrial septal defect (19%) and tetralogy of Fallot (16%) (Table 3). Seventy-two percent of cases were diagnosed in the first year of life, including 19% at birth (Table 4).

Nutritional statuses of these patients before cardiac surgery were normal 57%, malnutrition 40% (underweight 28%, wasting 22% and stunting 16%) and over-nutrition 3% (Table 5). Cardiac surgery was classified as total correction 86% and palliative treatment 14%. Post cardiac surgery, mean values of ZWA, ZWH and ZHA increased significantly (Table 6) ($p < 0.05$). The prevalence of underweight, wasting and stunting at 1-year post operation was 17%, 6% and 22%, respectively (Table 7). The number of normal nutritional status increased significantly at 6 months post cardiac surgery. The prevalence of underweight and wasting post operation decreased with statistical significance at 3-6 months and all times of follow-up, respectively.

Table 1. Demographic information of patients

Demographic information		Number	(%)
Male		69	(42%)
Female		96	(58%)
Birth weight:	< 2,500 g (low)	31	(28%)
	2,500-4,000 g	80	(71%)
	> 4,000 g	1	(1%)
History of post-natal problems		52	(32%)
History of feeding problems		94	(58%)

Table 2. Patients' age on operation

Patients' age (yr)	≤ 1	> 1-2	> 2-5	> 5
Number	25	36	36	64
(%)	(16%)	(22%)	(22%)	(40%)

Table 3. Types of congenital heart diseases

Types of congenital heart diseases	Number	(%)
Acyanotic heart diseases	127	(79%)
Ventricular septal defect (VSD)	46	(29%)
Patent ductus arteriosus (PDA)	36	(22%)
Atrial septal defect (ASD)	32	(20%)
VSD & Pulmonic stenosis (PS)	8	(5%)
Coartation of aorta	5	(3%)
Cyanotic heart diseases	34	(21%)
Tetralogy of Fallot (TOF)	26	(16%)
Pulmonary atresia (PA)	5	(3%)
Double outlet of right ventricle (DORV)	3	(2%)

Table 4. Age at diagnosis of congenital heart diseases

Age at diagnosis	At birth	1-6 months	7-12 months	> 1 year
Number	30	65	21	45
(%)	(19%)	(40%)	(13%)	(28%)

Discussion

In the present study, male pediatric patients with CHD were less than female with a male to female ratio of 0.7: 1 that was different from the ratio of 1.5: 1 and 1.88: 1 reported by Shah et al and Tank et al, respectively[8,9]. All cases in the present study were referred from all regions of Thailand to QSNICH, a tertiary care hospital in Bangkok, although it still may not represent the Thai population. Low birth weight in the present study was 28%; that was higher than the 6-14% reported by Hansen et al[10] and 12.5% prevalent in Thailand, 2002[11]. Congenital heart diseases might affect fetal growth in utero. More than half of the patients with CHD in the present study had feeding problems. Because of energy imbalance[1], irrespective in types of cardiac defect and cyanosis[12], children with CHD are frequently malnourished, presenting commonly with failure to thrive (FTT)[1,8].

Table 5. Nutritional status of the patients with congenital heart diseases

Nutritional status	Cyanotic heart disease 39 cases	Acyanotic heart disease 122 cases	Total 161 cases
Underweight	14 (36%)	31 (25%)	45 (28%)
Wasting	12 (31%)	23 (19%)	35 (22%)
Normal	22 (56%)	70 (57%)	92 (57%)
Overweight	-	5 (4%)	5 (3%)
Stunting	7 (18%)	18 (15%)	25 (16%)

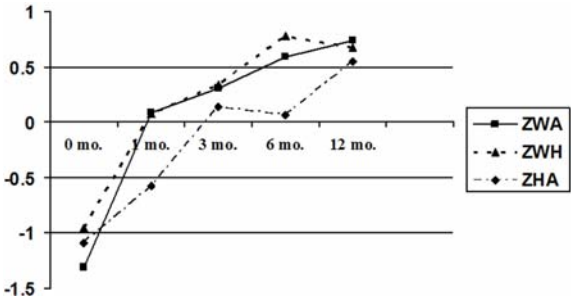

Fig. 1 Means of Z-scores: pre-opration (0 mo.) and post-operation (1-12 mos.)

Table 6. Mean ± SD of ZWA, ZWH and ZHA: pre- and post-operation (follow-up)

Z-score	Pre-operation	Post-operation (follow-up)			
	0 mo	1 mo	3 mo	6 mo	1 year
ZWA	-1.31 ± 1.33	0.09 ± 0.5	0.31 ± 0.69	0.59 ± 0.82	0.74 ± 0.88
p-value (Compared means)		< 0.001	< 0.001	< 0.001	< 0.001
ZWH	-0.95 ± 1.45	0.08 ± 1	0.34 ± 0.95	0.78 ± 1.35	0.67 ± 0.93
p-value (Compared means)		< 0.001	< 0.001	< 0.001	< 0.001
ZHA	-1.09 ± 1.95	-0.58 ± 3.9	0.14 ± 0.82	0.07 ± 0.9	0.55 ± 1.02
p-value (Compared means)		0.049	< 0.001	< 0.001	< 0.001

Table 7. Nutritional status between pre- and post-cardiac surgery (follow-up)

NutritionalStatus	Pre-operation (161 cases)	Post-operation (follow-up)			
		1 mo. (161)	3 mo. (146)	6 mo. (98)	1 yr (36)
Underweight	45 (28%)	31 (19%)	24 (16%)	13 (13%)	6 (17%)
	p-value	0.10	0.009	0.005	0.17
Wasting	35 (22%)	19 (12%)	12 (8%)	6 (6%)	2 (6%)
	p-value	0.018	0.002	0.001	0.04
Normal	92 (57%)	104 (65%)	99 (68%)	69 (70%)	26 (72%)
	p-value	0.29	0.07	0.045	0.14
Stunting	25 (16%)	25 (16%)	20 (14%)	18 (18%)	8 (22%)
	p-value	0.88	0.77	0.67	0.47

Acyanotic heart disease was reported in 79% of cases in the present study that was higher than 60-69% from previous studies of Tank et al[9] and Shah et al[8], respectively. VSD and TOF were the most common lesions in CHD in the present study, the same as the previous reports[8,9,13]. VSD was the most common acyanotic heart disease in the present study (29%) but still lower than 58% reported by Shah et al[8]. Seventy-two percent of the patients from the present study were in infancy period which was more than 46% reported by Shah et al[8]. Because some types of CHD presents late clinical manifestations.

The prevalence of malnutrition in the present study was similar to 39% from a study of Tank et al[9], but less than 85% in a study of Tokel et al[14]. Malnutrition, including underweight 28%, wasting 22% and stunting 16%; which was lower than 41%, 31%, and 25% and 59%, 56% and 26% reported respectively by Villasin et al[15] and Vaidyanathan et al[16] Malnutrition was more evident in the case of underweight in the present study and the previous studies[15-17]. In the present study, normal nutritional status was not different between groups of acyanotic and cyanotic heart diseases (57% vs. 56%), but the prevalence of underweight, wasting and stunting in cyanotic heart disease was slightly higher than in the acyanotic group (36% vs. 25%, 31% vs. 19%, 18% vs. 15%, respectively). Varan et al reported stunting cases were more common in the cyanotic group than acyanotic group[18]. Because the clinical symptoms of the cyanotic group were more severe than that of the acyanotic group, over-nutrition in the present study reported only 3% in cases with acyanotic heart diseases.

Post cardiac surgery, the mean values of ZWA, ZWH and ZHA increased significantly at all times during follow-up in the present study (Table 6) ($p < 0.05$). Vaidyanathan et al reported that ZWA and ZWH improved significantly from the baseline ($p < .001$), but ZHA was insignificantly different[16]. In previous studies, after surgical correction there was a significant reduction in total and resting energy expenditure compared to pre-operative values ($p < 0.001$)[1,3]. Significant improvements in weight and catch-up growth occurred within months[1], mostly in the first year after corrective surgery[14]. The prevalence of malnutrition in the present study decreased after cardiac surgery, but was statistically significant only in underweight and wasting. Because changes in height known as chronic changes took longer time to show the difference than acute change of weight. Dietary intake and baseline stunting influenced the weight of the patient as delayed weight gain at all times ($p < 0.05$)[14]. However, a previous study showed that post operative recovery in nutritional status and growth was limited in cases with low birth weight, FTT, palliative surgery[1], late corrective surgery and inadequate calories[14]. The age and time of corrective surgery also affects the potential for nutritional recovery[1].

Conclusion

Pediatric patients with CHD are prone to malnutrition and growth failure. Cardiac surgery has a significant, positive effect on weight gain or nutrition status in patients with congenital heart disease.

Potential conflicts of interest

None.

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ภาวะโภชนาการของผู้ป่วยเด็กโรคหัวใจพิการแต่กำเนิด: ก่อนและหลังการผ่าตัดหัวใจ

สุนทรี รัตนชูเอก, อัจจิมาวดี พงศ์ดารา

***ภูมิหลัง**: ภาวะทุพโภชนาการพบได้บ่อยในเด็กและทารกที่เป็นโรคหัวใจพิการแต่กำเนิด การผ่าตัดหัวใจจะทำให้ผู้ป่วยรอดชีวิตมากขึ้นและมีภาวะโภชนาการที่ดีขึ้น*

***วัตถุประสงค์**: เพื่อประเมินผลของการผ่าตัดหัวใจต่อภาวะโภชนาการของผู้ป่วยเด็กโรคหัวใจพิการแต่กำเนิด*

***วัสดุและวิธีการ**: การศึกษาติดตามไปข้างหน้าเชิงพรรณนาในผู้ป่วยเด็กโรคหัวใจที่มารับการผ่าตัดหัวใจที่สถาบันสุขภาพเด็กแห่งชาติมหาราชินี ตั้งแต่ 1 สิงหาคม พ.ศ. 2545 ถึง 1 สิงหาคม พ.ศ. 2546 รวบรวมข้อมูลพื้นฐาน ปัญหาโรคหัวใจ และปัญหาที่เกี่ยวข้อง การวัดสัดส่วนร่างกายก่อนทำผ่าตัด และหลังการผ่าตัดหัวใจ ภาวะโภชนาการประเมินโดยใช้ค่า Z-score สำหรับน้ำหนักตามเกณฑ์อายุและเกณฑ์ส่วนสูง และส่วนสูงตามเกณฑ์อายุ ภาวะทุพโภชนาการวินิจฉัยเมื่อค่า Z-score ที่น้อยกว่า -2 เปรียบเทียบภาวะโภชนาการ ใช้ chi-square เปรียบเทียบ ค่าเฉลี่ย z-score ใช้ paired t-test ค่า $p < 0.05$ ถือว่ามีความแตกต่างอย่างมีนัยสำคัญทางสถิติ*

***ผลการศึกษา**: ผู้ป่วยเด็กโรคหัวใจพิการแต่กำเนิดที่จะมารับการผ่าตัดหัวใจ 161 ราย เป็นชายร้อยละ 41 และหญิงร้อยละ 59 มีอายุตั้งแต่ 1 เดือน ถึง 15 ปี ปัญหาคลอดน้ำหนักน้อยร้อยละ 28 และมีปัญหาการกินร้อยละ 58 โรคหัวใจพิการแต่กำเนิดที่พบบ่อยคือ การมีรูรั่วที่ผนังหัวใจช่องล่าง (VSD) พบร้อยละ 29 ภาวะโภชนาการปกติ ทุพโภชนาการ และโภชนาการเกินพบร้อยละ 57, 40 และ 3 ตามลำดับ ภาวะทุพโภชนาการได้แก่ ภาวะน้ำหนักน้อยร้อยละ 28 ผอมร้อยละ 22 และแกรนร้อยละ 16 หลังการผ่าตัดหัวใจค่าเฉลี่ย z-scores เพิ่มขึ้นและความชุกของภาวะ น้ำหนักน้อย และผอมเป็นร้อยละ 17 และ 6 ลดลงอย่างมีนัยสำคัญทางสถิติ*

***สรุป**: ภาวะทุพโภชนาการพบร้อยละ 40 ในผู้ป่วยเด็กโรคหัวใจพิการแต่กำเนิด การผ่าตัดหัวใจมีผลดีต่อการเพิ่มของน้ำหนักและภาวะโภชนาการอย่างมีนัยสำคัญ*