FULL LENGTH ARTICLE

Normal reference ranges for aortic diameters in preterm infants

Lulu Abushaban [a,b,*], Mariappa Thinakar Vel [a], Jebaraj Rathinasamy [a], Prem N. Sharma [c]

[a] Chest Diseases Hospital, Ministry of Health, Kuwait City
[b] Kuwait University, Kuwait City
[c] Faculty of Medicine, Health Sciences Center, Kuwait University, Kuwait City

[a,b,c] Kuwait

Objective: To establish normal reference ranges and *Z*-scores for aortic diameters in preterm infants according to the body surface area and assess their correlation with body weight, body surface area, and gestational age.

Patients and methods: In a prospective study, 268 preterm infants who fulfilled the criteria for inclusion were examined. Echocardiograms were performed to measure the ascending aorta, transverse aorta, and aortic isthmus diameters on 0 days to 6 days of life and at weekly intervals until the babies reached 36 weeks. Body surface area was divided into 13 groups from 0.07 m^2 to 0.19 m^2.

Results: The mean gestational age was 29.8 [þ 2.38 standard deviation (SD)] weeks, ranging from 24 weeks to 35 weeks. The mean body weight was 1479 (þ 413 SD) g, ranging from 588 g to 3380 g, and the mean body surface area was 0.13 m^2, ranging from 0.07 m^2 to 0.19 m^2. All the aortic diameters correlated well with both body weight and body surface area. Reference ranges with the mean þ SD, range, and *Z*-scores were calculated for aortic diameters according to the body surface area. A significant gradual increase was observed in ascending aorta, transverse aorta, and aortic isthmus diameters with increasing body surface area. Overall, a progressive and significant increase in ascending aorta, transverse aorta, and aortic isthmus diameters was observed during the first 9 weeks of life.

Conclusion: The ascending aorta, transverse aorta, and aortic isthmus diameters exhibited a significant correlation with the body surface area and body weight. This study provides reference data with *Z*-scores that can be used as a normal reference tool for the ascending aorta, transverse aorta, and aortic isthmus diameters for preterm infants based on the body surface area.

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Keywords: Aortic diameters, Body surface area, Preterm infants, Reference ranges, *Z*-scores

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* Corresponding author at: Chest Diseases Hospital, Ministry of Health, Kuwait City, Kuwait.
E-mail address: lulu@hsc.edu.kw (L. Abushaban).

P.O. Box 2925 Riyadh – 11461KSA
Tel: +966 1 2520088 ext 40151
Fax: +966 1 2520718
Email: sha@sha.org.sa
URL: www.sha.org.sa

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Introduction

For the past 60 years, echocardiography has been practiced as the primary mode of investigation to evaluate the anatomy and function of the heart [1,2], yet there are few studies that describe a normal premature neonate's heart. Preterm hearts differ significantly from a term neonate's heart, and there is a gradual transition to a mature neonate heart. This study aimed to evaluate the anatomic and physiologic characteristics of the premature infant's heart, and the changes that occur during the early postnatal period. As more preterm infants survive because of improved critical care services, an increasing number of preterm infants require at least one echocardiogram during the 1st month of life. Thus, it is vital to have adequate reference values. Unfortunately, there are currently no universally accepted normal values. Few studies in the literature involve the hearts of premature infants [3,4]. Our aim was to establish these normal values by studying a large number of healthy premature babies. The main objective of the study was to establish these normal reference values with *Z*-scores during the first 9 weeks of life and also to determine whether these diameters correlate with other variables, such as body surface area, body weight, and chronological age.

Abbreviations

GA	Gestational Age
BSA	Body Surface Area
SD	standard deviation
IQ	Inter Quartile

Materials and methods

Patients

In this prospective study, 400 premature infants under 36 weeks of gestation, admitted to the neonatal units between January 2008 and December 2010, were consecutively recruited and studied. The babies were from mixed populations; the majority were Arabs, and the remainder were from other Asian nations. Of the 400 premature infants, 268 (Table 1) fulfilled the following inclusion criteria:

- Infants with normal hearts (infants with small patent foramen ovale or small patent ductus arteriosus were not excluded).
- Healthy preterm infant with no evidence of sepsis, renal failure, etc.
- Absence of other major congenital anomalies or syndromes.
- Absence of gestational diabetes in the maternal history.
- Preterm infants on low ventilator settings (low ventilator settings when infant did not require high-frequency ventilation nor unusually high rates and pressures) or nonventilated preterm infants.

We excluded sick preterm infants and those with major congenital anomalies, either cardiac or noncardiac.

Ethical approval was obtained from the ethical committees of both the Kuwait Ministry of Health and the Faculty of Medicine of Kuwait University. The study was funded by a grant from the Kuwait Foundation for the Advancement of Sciences. The parents were informed that the infants would be enrolled in an observational study and not in any therapeutic trial. Prior written consent was also obtained from the parents.

Methods

Before the study was undertaken, the pediatric cardiologist responsible for conducting the echocardiograms was trained and observed by two senior pediatric cardiologists through the pretest echocardiograms for external validity and generalization. Interpersonal variability was evaluated, and once no significant variability in the readings was found, that doctor was assigned to conduct the study. Two different senior pediatric cardiologists also supervised these interpretations for generalization. The assigned cardiologist was not directly involved in the patient's care. Echocardiographic studies were obtained with a

Table 1. General characteristics of the preterm babies.

Characteristics	Result
Male:Female (*N*)	126:142
Gestational age (wk)	
Mean ± SD	29.8 ± 2.38
Median (range) IQ	30 (24–35) 28–32
Weight (g)	
Mean ± SD	1479 ± 413
Median (range) IQ	1460 (588–3380) 1164–1730
Length (cm)	
Mean ± SD	40.1 ± 3.56
Median (range) IQ	40 (25–50) 38–42
Body surface area (m^2), mean (range)	0.123 (0.07–0.19)
Echocardiograms per baby (min–max)	1–5
Age (wk) at study (min–max)	1 day–9 weeks

IQ = interquartile; SD = standard deviation.

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