The Left Ventricular Wall Dimensions & Mass in The Early Post-Natal Life: A Comparison between Term and Preterm Neonates

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ABSTRACT

Background: The early post-natal period is critical for left ventricular (LV) development, with significant structural differences between term and preterm neonates. Gestational age and birth weight influence LV wall dimensions and mass, which is vital for assessing neonatal cardiac health. This study compares LV dimensions and mass in term and preterm neonates to highlight developmental variations.

Objectives: This study compares the left ventricular wall dimensions, left ventricular mass, and index throughout the 1st 7 days of the post-natal period in preterm and term neonates.

Methods: The (50) term neonates and the (30) preterm neonates enrolled in the study who fulfilled the inclusion criteria were assessed by echocardiography to measure the left ventricular wall dimensions, left ventricular mass, and index throughout the early post-natal period of life as well as it's correlations with body weight, body surface area, and gestational age.

Results: A statistically significant difference between the research groups was found for all variables including left ventricular wall dimensions, left ventricular mass, and index. Preterm newborns had less values in the first week of life than mature neonates, which could be explained by the latter having less time to nurture and grow in the uterus.

Conclusion: At the 1st week of post-natal life, neonates had a greater value of left ventricular dimensions, left ventricular mass, and index when compared with the values obtained from the preterm neonates.

Keywords: Left ventricular wall, Left ventricular wall Dimensions, Neonates.

تقييم مقاييس وظيفة البطين الايسر عند الاطفال حديثي الولادة

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الخلاصة

الخلفية: تُعد الفترة المبكرة بعد الولادة حاسمة لتطور البطين الأيسر(LV) ، حيث تظهر اختلافات هيكلية كبيرة بين حديثي الولادة الناضجين والخُدّج. يؤثر كل من عمر الحمل ووزن الولادة على أبعاد جدار البطين الأيسر وكتلته، وهي عوامل مهمة لتقييم صحة القلب لدى حديثي الولادة. تهدف هذه الدراسة إلى مقارنة أبعاد البطين الأيسر وكتلته بين حديثي الولادة الناضجين والخُدّج لتسليط الضوء على الفروق التطورية.

الأهداف: تهدف هذه الدراسة إلى مقارنة أبعاد جدار البطين الأيسر، وكتلة البطين الأيسر، ومؤشرها خلال الأيام السبعة الأولى بعد الولادة بين حديثي الولادة الناضجين والخُدّج.

المنهجية: شملت الدراسة ٥٠ من حديثي الولادة الناضجين و٣٠ من حديثي الولادة الخُدّج ممن استوفوا معايير الشمل بالدراسة. تم تقييمهم باستخدام تخطيط صدى القلب لقياس أبعاد جدار البطين الأيسر، وكتلته، ومؤشرها خلال الفترة المبكرة بعد الولادة، بالإضافة إلى دراسة علاقتها بوزن الجسم، مساحة سطح الجسم، وعمر الحمل.

النتائج: أظهرت جميع المتغيرات، بما في ذلك أبعاد جدار البطين الأيسر، وكتلته، ومؤشرها، فروقًا ذات دلالة إحصائية بين مجموعتي البحث. كانت القيم أقل لدى حديثي الولادة الخُدّج في الأسبوع الأول من الحياة مقارنة بحديثي الولادة الناضجين، وهو ما يمكن تفسيره بعدم كفاية الوقت للنمو داخل الرحم بالنسبة للأولى.

الاستنتاج: خلال الأسبوع الأول من الحياة، كانت قيم أبعاد البطين الأيسر، وكتلته، ومؤشرها أعلى لدى حديثي الولادة الناضجين مقارنة بالقيم التي تم الحصول عليها من حديثي الولادة الخُدّج.

الكلمات المفتاحية: جدار البطين الأيسر، أبعاد جدار البطين الأيسر، حديثو الولادة.

INTRODUCTION

A gradual cardiac enlargement and expansion can be detected from the early embryogenic stage of life until shortly after delivery and throughout childhood. As well as an increase in left ventricular mass. Left ventricular mass is considered an essential quantifiable clinical parameter since it indicates hypertrophy of the left ventricle and is an essential risk factor for cardiovascular disease development and mortality increase. Studies conducted on the topic found that the identification of a hypertrophied heart had a significant impact on managing children suffering from congenital or acquired heart diseases. [1-4]

Transthoracic echocardiography has been the principal form of examination to assess the structure and function of the heart in the past decades. [5,6]. However, just a few studies have documented the heart of a normal preterm newborn. The heart of a preterm neonate differs greatly from that of a term neonate, and the transition to a mature heart is gradual. The LVM can be assessed using M-mode echocardiography, which measures heart dimensions and wall thicknesses.[7]

MATERIALS AND METHODS

The participants in the study entailed (80) neonates divided into (50) neonates who were born when they reached their due date and (30) preterm neonates; the study design is a descriptive-analytic / case-control study that was conducted at Al-khansaa Hospital - Echocardiography unit in the city of Mosul for six consecutive months (10/2020 – 4/2021). The full-term newborns enrolled appeared healthy with no significant ongoing diseases and were delivered either via vaginal delivery or abdominal delivery. The preterm neonates included in the study were born before their due date.

All neonates who suffered from a congenital abnormality or a genetic aberration resulting in a syndrome, as well as those with prematurity-related respiratory issues like severe respiratory distress syndrome, which may necessitate respiratory support, the presence of sepsis, and patent ductus arteriosus. Neonates who were born to mothers suffering from diabetes mellitus that could affect myocardial function and cause hypertrophy of the left ventricular walls were also excluded from the study population. A pediatric cardiologist did an auscultation of the heart to exclude a cardiac murmur, which was found to be normal. The scientific community warranted approval, and written or verbal consent was obtained from the caregiver. For each neonate included in the study, an initial Two-dimensional (2D) and then M-mode echocardiographic study was done in the recumbent position via the use of "Philips Effiniti 30 machine" and with a 10 MHz transducer). The images were recorded on the machine for further offline measurement and analysis. A Two-dimensional visualization was first used to obtain the best position and angle of the M-mode line. Each diameter was measured following the American Society of Echocardiography (ASE) [8] guidelines.

The end-diastolic left ventricular internal dimension (LVIDd), end-diastolic left ventricular posterior wall thickness (LVPWd), and end-diastolic interventricular septum (IVSd) values were determined by echocardiographic examination. Subsequently, LVM was calculated according to the formula of Dubois .[9] "BSA (m^2) = (0.0001) (71.84) (wt.0.425) (ht.0.725)".

Statistical Evaluation

Data was analyzed using the Statistical Package for the Social Sciences (SPSS) software (version 25). The obtained data were expressed as mean and standard deviation (SD).[10] to designate numerous factors in the study and descriptive data analysis was performed using frequency distribution and histogram diagrams. The unpaired independent t-test was used to compare terms with the preterm study population. The degree and direction of a linear relationship between several characteristics in the term and preterm research groups were assessed through further analysis utilizing Pearson's correlation. A P-value of 0.05 and less was considered statistically significant in all tests.

RESULTS Tables

The baseline clinical characteristics of the neonates are presented in Table 1. The mean gestational age was (38.62 $\pm$ 1.14) in term and (34.37 $\pm$ 1.586) in preterm neonates, the mean body weight wt. was (3.222 $\pm$ 0.213) in term and (1.713 $\pm$ 0.289) in preterm neonates, and the mean BSA was (0.209 $\pm$ 0.007) in term and (0.135 $\pm$ 0.014) in preterm neonates.

Table 1: The baseline characteristics in full-term and preterm neonates.

Character	Full-term		Preterm	
Gestational age at delivery in weeks **(Mean ± SD)**	**38.62 ± 1.14**		**34.37 ± 1.586**	
Male/Female Sex **(Number Frequency)**	**35 / 15**		**17 / 13**	
Weight/Kg **(Mean ± SD)**	**3.222 ± 0.213**		**1.713 ± 0.289**	
Height/cm **(Mean ± SD)**	**49.000 ± 1.195**		**38.800 ± 1.954**	
Body surface area/cm^2 **(Mean ± SD)**	**0.209 ± 0.007**		**0.135 ± 0.014**	
Mode of delivery **(Frequency of Number)**	**CS = 21**	**ND = 29**	**CS = 15**	**ND = 15**

Table 2 Displays that term neonates had a significantly higher IVSDd of (0.347 ± 0.032), LPWDd of (0.426 ± 0.028) and LVIDd of (1.697 ± 0.072). Whilst in preterm neonates, the IVSDd was (0.292 ± 0.025), LPWDd of (0.367 ± 0.049), and LVIDd of (1.337 ± 0.101) in preterm neonates and hence term neonates had significantly higher LVM and LVMI.

Table 2: Comparison of left ventricular dimensions variables between term and preterm neonates.

Variable	Term	Preterm
Interventricular septum diameter in diastole /cm **(Mean ± SD), P Value**	**0.347 ± 0.032**	**0.292 ± 0.025**
	(t = 8.586) P- value = 0.000**	
Left ventricular posterior wall diameter in diastole /cm **(Mean ± SD), P Value**	**0.426 ± 0.028**	**0.367 ± 0.049**
	(t = 6.049) P- value = 0.000**	
Left ventricular internal diameter /cm **(Mean ± SD), P Value**	**1.697 ± 0.072**	**1.337 ± 0.101**
	(t = 17.051) P- value = 0.000**	
Left ventricular mass /gram **(Mean ± SD), P Value**	**9.113 ± 0.822**	**5.249 ± 0.710**
	(t = 22.188) P- value = 0.000**	
Left ventricular mass index gram/m^2 **(Mean ± SD), P Value** ** Highly Significant at p ≤ 0.01	**41.490 ± 2.895**	**38.857 ± 4.671**
	(t = 4.897) P- value = 0.000**	

There was a statistically significant relationship in term and preterm neonates between GA and LVM (r= 0.652) (r=0.502) at a P Value of 0.01 as shown in (Table 3&Table 4) and (Figs. 1&2).

Table 3: Correlation between left ventricular mass and gestational age in weeks in the term study population.

Term Correlations		
		Gestational Age (in Weeks)
Left Ventricular Mass (g)	Pearson's Correlation Factor	.652**
	Sig. (2-tailed)	.000
**. Correlation is significant at the 0.01 level (2-tailed).		

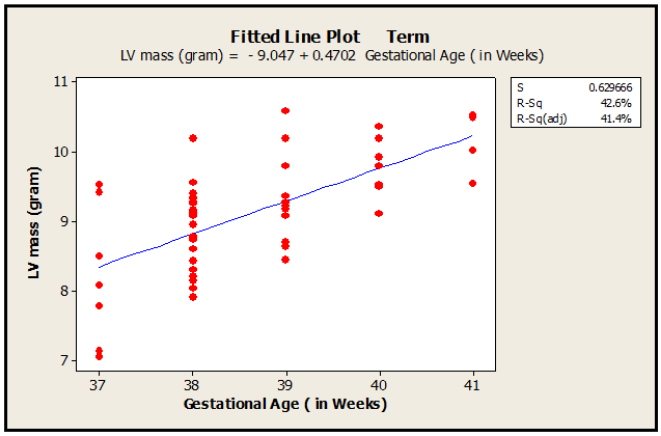

Figure {1}: Correlation between left ventricular mass and gestational age in weeks in the term study population.

Table 4: Correlation between left ventricular mass and gestational age in weeks in the preterm study population.

Preterm Correlations		
		Gestational age (in Weeks)
Left Ventricular Mass (g)	Pearson's Correlation Factor	.502**
	Sig. (2-tailed)	.005
**. Correlation is significant at the 0.01 level (2-tailed).		

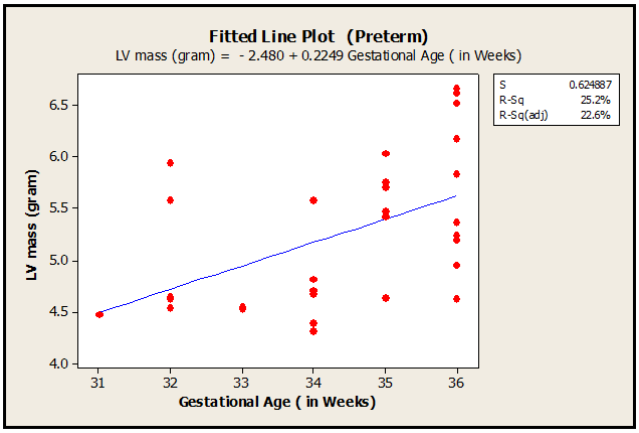

Figure {2}: Correlation between gestational age in weeks and left ventricular mass in the preterm study population.

A statistically significant correlation was demonstrated between wt. and LVM in both of the study groups (r= 0.806) (r=0.493) at a P-Value of 0.01 as can be noticed in (Table 5&Table 6) and (Figs. 3&4).

Table 5: Weight and left ventricular mass correlation in the term study population.

Term Correlations		
		Weight (kg)
Left Ventricular Mass (g)	Pearson's Correlation Factor	.806**
	Sig. (2-tailed)	.000
**. Correlation is significant at the 0.01 level (2-tailed).		

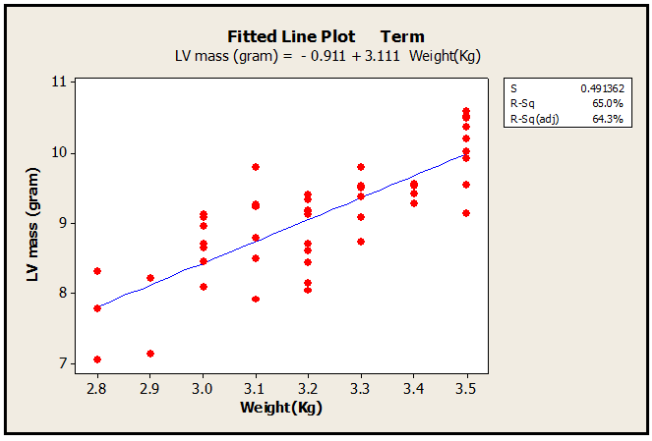

Figure {3}: Weight and left ventricular mass correlation in the term study population.

Table 6: Weight and left ventricular mass correlation in the preterm study population.

Preterm Correlations		
		Weight (Kg)
Left Ventricular Mass (g)	Pearson's Correlation Factor	.493**
	Sig. (2-tailed)	.006
**. Correlation is significant at the 0.01 level (2-tailed).		

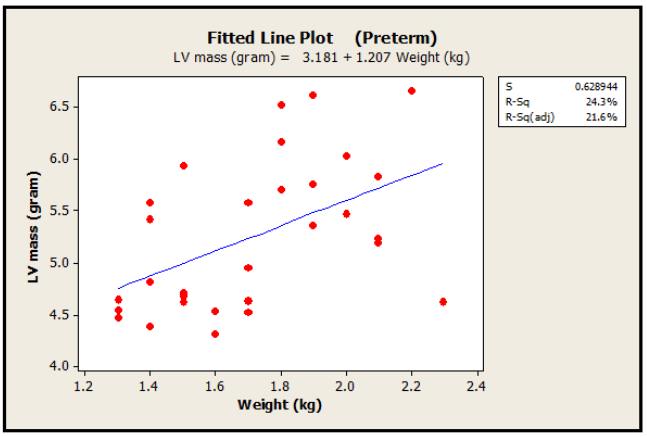

Figure {4}: The preterm study population's weight and left ventricular mass correlation.

Furthermore, a statistically significant correlation between BSA and LVM was found in this study in term and preterm infants (r= 0.791) (r=0.480) at a P-Value of 0.01 as presented in (Table 7&Table8) and (Figs. 5&6).

Table 7: Body surface area and left ventricular mass correlation in the term study population.

Term Correlation		
		Body Surface Area (cm^2)
Left Ventricular Mass (g)	Pearson's Correlation Factor	.791**
	Sig. (2-tailed)	.000
**. Correlation is significant at the 0.01 level (2-tailed).		

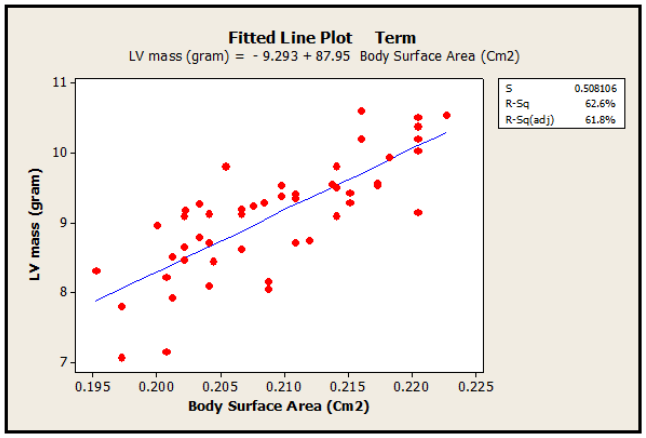

Figure {5}: Body surface area and left ventricular mass correlation in the term study population.

Table 8: The preterm study population's body surface area and left ventricular mass correlation.

Preterm Correlation		
		Body Surface Area (cm^2)
Left Ventricular Mass (g)	Pearson's Correlation Factor	.480**
	Sig. (2-tailed)	.007
**. Correlation is significant at the 0.01 level (2-tailed).		

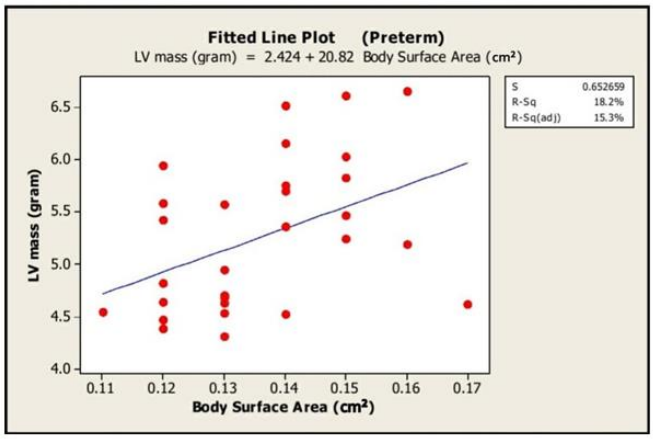

Figure {6}: The preterm study population's body surface area and left ventricular mass correlation.

DISCUSSION

The myocardial growth in the post-natal period primarily arises from an increase in myocyte volume. In contrast, myocyte proliferation contributes to the expansion of ventricular mass predominantly during the early post-natal period. Consequently, left ventricular mass (LVM) and left ventricular mass index (LVMI) were significantly greater in term neonates compared to preterm neonates, who exhibited lower values of LVM and LVMI, as demonstrated in the preceding table (2).[11]

This can be attributed to several factors related to their differing developmental stages. Term neonates have had more myocardial growth and maturation time, allowing for greater myocyte volume and ventricular mass.

In contrast, preterm neonates are born before they have fully developed, leading to less time for myocyte proliferation and myocardial growth; after birth, the heart grows in unison and at a predictable rate in response to skeletal growth. It could also be attributed to physiological myocardial excessive growth that could affect the mature myocardium's ability to withstand afterload variations.[11-14]

This study also shed light on several important correlations, such as the linear association between gestational age, weight, and body surface area with left ventricular mass.

In the literature, no agreement exists on which anthropometric characteristic has the best association with echocardiographic data. Some studies suggest a stronger link between LVM and wt., whereas others demonstrate a link between LVM with BSA and ht.

The results of this research corroborate the earlier findings about left ventricular dimensions and their associations by Bonatto et al. (2006), Dai et al. (2009). , Güzeltaş et al. (2011), and Kervancioglu et al. (2011) [15-18]

This could be explained by the fact that body size is a major determinant of cardiac size; usually, when one individual is bigger than another, their heart size is subsequently larger. Thus, the gestational age, weight, and body surface area variables must correlate well with left ventricular mass.[19,20]

CONCLUSIONS

A statistically significant difference was observed in (the left ventricular wall dimension, mass, and index) between preterm and term neonates. In addition, a statistically significant correlations were demonstrated between the body weight and BSA and the LVM.

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