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Assessment of Diastolic Myocardial Function in Neonates with Patent Ductus Arteriosus by Tissue Doppler Imaging

Raafat A. Khattab
Pediatrics department, Faculty of Medicine, Al-Azhar University, Cairo ,Egypt

Mohamed F. Bayoumi
Pediatrics department, Faculty of Medicine – Al-Azhar University, Cairo, Egypt

Mohamed A. Seif
Neonatology Resident – Agoza hospital(M.B.B.Ch), muhamedasaadseif@gmail.com

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ORIGINAL ARTICLE

Assessment of Diastolic Myocardial Function in Neonates with Patent Ductus Arteriosus by Tissue Doppler Imaging

Raafat Abdelraouf Mohamed Khattab, Mohamed Farouk Bayoumi, Mohamed Asaad Seif Aldawy*

Department of Pediatrics, Faculty of Medicine, Al-Azhar University, Cairo, Egypt

Abstract

Background: **PDA connects aorta and pulmonary artery during intrafetal life and allows intrauterine blood flow from right side to left side. It is common to stay patent after birth especially in preterm.**

Study purpose: **To correlate the effect of PDA hemodynamic significance on diastolic myocardial functions using tissue doppler.**

Methods: **This study was conducted on 50 babies delivered in or admitted to Bab-Sheria Hospital University hospital categorized into three groups: Control, Patent ductus arteriosus cases with hemodynamic significance (HD-Sig. PDA) and PDA cases with no hemodynamic significance (NHSPDA).**

Results: **There was higher (statistically significant) LA/AO ratio and lower (E/A) ratio in HD-Sig. PDA in comparison to NHSPDA and control group. There was statistically significant lower septal E' velocity and lower lateral wall E' velocity in both HD-Sig PDA and NHSPDA cases compared to the control group. There was lower mean values of both septal E' and lateral wall E' in HD-Sig. PDA compared to NHSPDA.**

Conclusion: **Neonates with HD-Sig. PDA have lower diastolic left ventricular velocities indicating relative degrees of left ventricular diastolic dysfunction compared to NHSPDA cases and control group. Tissue Doppler echocardiography is highly sensitive and non invasive procedure to evaluate diastolic myocardial functions in PDA cases.**

Keywords: Haemodynamic significant, Prematurity, Tissue doppler imaging

1. Introduction

DA connects aorta and pulmonary artery during intrafetal life and allows intrauterine blood flow from right side to left side.[1] *The duct closes rapidly after birth.*[2] *PDA is common in preterms due to higher smooth muscle sensitivity to prostaglandins.*[3] T*he effect of PDA depends to large extent on the actual size of the duct and the pressure deference between aorta and pulmonary artery.*[4] TD*I provides important data by measuring peak velocities to assess diastolic myocardial functions*[5]. Study done to correlate the impact of PDA with hemodynamic significance on diastolic myocardial functions using tissue doppler echocardiography.

2. Patients and methods

This study was conducted between June 2018 and June 2021 on 50 babies delivered in or admitted to Bab-Sheria Hospital University hospital and categorized into three groups: Control, Hemodynamically significant ductus arteriosus cases (HD-Sig. PDA) and Non hemodynamically significant ductus arteriosus cases(NHSPDA).

Neonates admitted to intensive care units with variable degrees of respiratory distress, neonates with audible cardiac murmur, and neonates accidently discovered as PDA cases by echocardiography were included in the study,whereas neonates delivered to diabetic mothers, and those diagnosed

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* Corresponding author. Neonatology Resident – Agoza hospital (M.B.B.Ch), Pediatrics Department, Faculty of Medicine, Al-Azhar University, Cairo, Egypt
E-mail address: muhamedasaadseif@gmail.com (M.A. Seif Aldawy).

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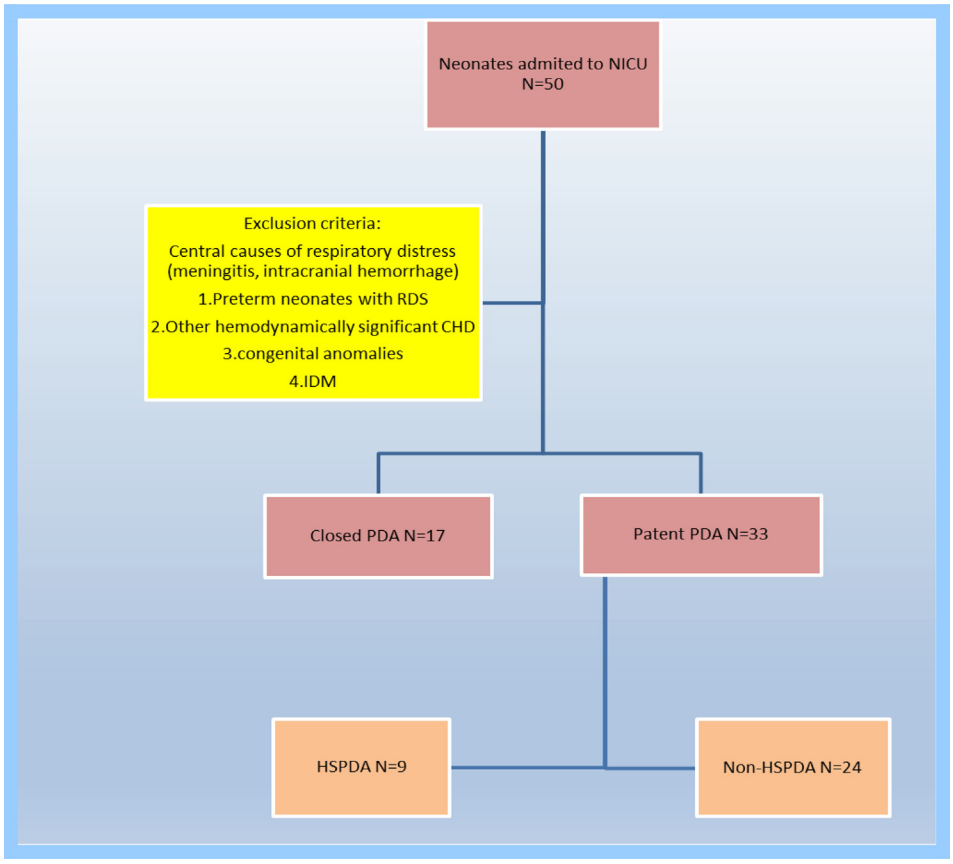

Fig. 1. Study design flow chart.

as meningitis, intracranial hemorrhage, respiratory distress syndrome or other congenital heart defects rather than PDA were precluded from our study. Precise medical history was taken from parents and medical records, the present history including the newborn age, gestational age in weeks, his/her sex, mode of delivery either normal vaginal or cesarian section. maternal history is also taken regarding occurrence of urinary tract infection,fever, rash during pregnancy. Also history of maternal diabetes or hypertension either primary or gestational was considered. Then general and systematic examination was done. General examination focusing on birth weight, presence of cyanosis, signs of respiratory distress and evaluation of the degree of distress from one to four. Cardiac examination empathizing on presence of cardiac murmur. Chest examination to identify Down score and the nature of air entry on both lungs. Neurological examination to exclude presence of convulsions. Laboratory investigations included complete blood picture to check for sepsis and thrombocytopenia, CRP to exclude sepsis, Arterial blood gases. CXR done for all cases to exclude RDS .2D echo were done at 1st 3 days of life to identify duct size, flow direction, ratio between left atrium to aorta. Pulsed wave doppler was done to identify mitral E/A ratio. TDI was done emphasizing on Apical A4 view and probe was

Table 1. Description and sex distribution.

	Count	%
Groups		
Control	17	34.0%
NON SIG	24	48.0%
HD-SIG. PDA	9	18.0%
Sex		
Male	25	50.0%
Female	25	50.0%

Table 2. Gestational age among groups.

	Control		NHSPDA		HD-Sig. PDA		
	Count	%	Count	%	Count	%	*P* value
Gestational age							
Pre term	2	11.8%	5	20.8%	9	100.0%	<0.001
Term	14	82.4%	16	66.7%	0	0.0%	
Post term	1	5.9%	3	12.5%	0	0.0%	

Table 3. Mode of delivery among various groups.

Mode of delivery	SVD	13	26.0%
	NVD	11	22.0%
	CS	26	52.0%

Table 4. Oxygen needs among different groups.

	Control		NON HD-SIG		HD-Sig. DPA		
	Count	%	Count	%	Count	%	*P* value
Oxygen needs							
NASAL	0	0.0%	16	66.7%	6	66.7%	0.722
CPAP	0	0.0%	3	12.5%	2	22.2%	
MV	0	0.0%	5	20.8%	1	11.1%	

placed over septum and lateral wall of left ventricle to assess early diastolic and late diastolic filling named as E' and A' respectively. Higher values indicates better myocardial functions. Statistical analysis: the above data was gathered and analyzed by the statistical package for the Social Sciences (SPSS) version 26 (IBM Corp., Armonk, NY, USA). Summarization of our data was done through central tendency tools(mode, median, minimum and maximum) and dispersion tools (standard deviation) in quantitative data. Frequency and relative frequency was used for qualitative data. Comparisons between quantitative variables were done using the non-parametric Kruskal-Wallis and Mann-Whitney tests. Chi square ($\chi 2$) test used to compare qualitative data. The confidence interval was set to 95% and the accepted error margin was set to 5%. So, the p value was considered significant as the following: (P less than 0.05 = Non significant), (P equals or less than 0.05 is Significant),($P \leq 0.01$ = Very Significant) and ($P \leq 0.00$ considered Highly Significant) (Fig. 1).

3. Results

The study population categorized into three groups: Control(17), Patent ductus arteriosus cases with hemodynamic significance (HD-Sig. PDA = 9) and Non hemodynamically significant ductus arteiosus cases (NHSPDA = 17) (Tables 1–6, Figs. 2 and 3).

4. Discussion

PDA incidence is strongly related to gestational age and the liability to stay open increases when geational age is lower. prevalence of PDA is around 20% at 32 weeks gestational age.[6] *large PDA can lead to many complications as left side heart failure, pulmonary hypertension*.[7] This study was conducted between June 2018 and June 2021 on 50 babies delivered in or admitted to Bab-Sheria Hospital University hospital from and categorized into three groups: Control (, Hemodynamically significant ductus arteriosus cases (HD-Sig. PDA) and Non hemodynamically significant ductus arteriosus cases(NHSPDA). We aimed to correlate the effect of PDA hemodynamic significance on diastolic myocardial functions using TDI. The results of the present study showed statistical significance correlation between hemodynamically significance of PDA and prematurity, 100% of our hemodynamically significant dusctus arteriosus cases were premature, the mode was 34 weeks, and the median was 34 weeks of gestation which comes in concordance with the study of *Asrani et al.*[8] claimed that HD-Sig. PDA cases were born at a lower gestation age with a lower birth weight. ***Shepherd and Noori***[9] study conducted at 2019 revealed that PDA occurs in spectrum of gestational age and this should be clinically considered when defining the patent duct. Regarding the demographic characteristics of the study groups; (50%) of the study patients were male. There was equal distribution between males and female. As regards the effect of gender on persistent patency of the ductus arteriosus; ***Hammoud et al.***[10] claimed that male gender was a risk factor for PDA. However, pooled data in ***Liu et al.***[11] meta-analysis revealed no apparent relation between ductal patency and sex. In our study, (52.0%) were delivered by cesarean section (CS), These results agreed with previous reports such the study of *Asrani et al.*,[8] they found that infants with HD-Sig. PDA were also more often born by cesarean section. Regarding risk factors; it was found that

Table 5. Compare ABG values between the groups.

	Control		NON HD-SIG		HD-Sig. PDA		
	Count	%	Count	%	Count	%	*P* value
PH							
METABOLIC ACIDOSIS	1	5.9%	12	50.0%	8	88.9%	<0.001
NORMAL	15	88.2%	11	45.8%	1	11.1%	
METABOLIC ALKALOSIS	1	5.9%	1	4.2%	0	0.0%	

Table 6. Compares TDI values among groups(P1 compares control to NHSPDA, P2 compares Control to HD-Sig. PDA, P3 compares NHSPDA to HD-Sig. PDA).

	Control					NHSPDA					HD-Sig. PDA							
	Mean	SD	Median	Minimum	Maximum	Mean	SD	Median	Minimum	Maximum	Mean	SD	Median	Minimum	Maximum	*P* value	*P1* value	*P2*	*P3*
DUCT SIZE						2.384	0.9	2.45	0.818	3.1	4.34	1.03	3.2	2.5	4.47	0.157			
LA/AO RATIO	0.94	0.18	0.94	0.56	1.29	0.90	0.29	0.98	0.05	1.30	2.11	0.78	1.77	1.50	3.80	<0.001	1.000	<0.001	<0.001
E/A RATIO	1.38	0.38	1.20	0.99	2.40	1.15	0.47	1.07	0.40	2.40	0.69	0.09	0.70	0.50	0.80	<0.001	0.143	<0.001	0.004
septal 'e	7.60	1.50	8.00	4.28	9.00	4.92	1.94	4.76	0.05	9.05	4.41	1.10	4.23	3.00	7.00	<0.001	<0.001	<0.001	1.000
Septum e/a ratio	1.00	0.31	0.98	0.66	1.75	0.93	0.32	0.88	0.40	1.78	0.89	0.19	0.98	0.55	1.19	0.682			
lateral 'e	9.14	2.44	8.06	5.37	13.00	5.73	2.57	5.79	1.60	12.00	4.57	1.23	5.00	2.00	6.00	<0.001	<0.001	<0.001	0.866
Lateral wall e/a ratio	1.21	0.37	1.30	0.10	1.70	0.96	0.34	0.88	0.37	1.55	0.67	0.19	0.60	0.37	0.98	0.001	0.073	0.001	0.101

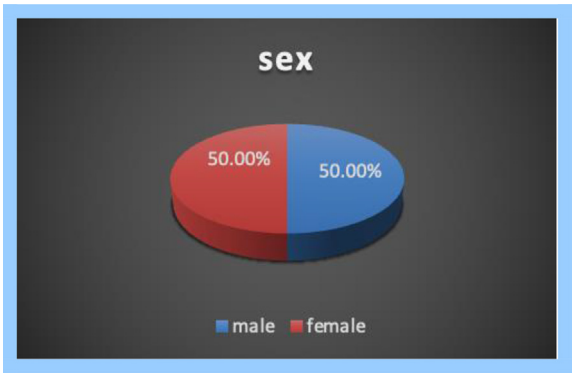

Fig. 2. The sample exhibits equal distribution between males and female.

majority of mothers of the cases had no apparent risk factors like DM or hypertension, also it was noted that all of mothers had no rash during pregnancy. In contrast to our results; maternal risk factors in the study of ***Soliman et al.***[12] study included gestational hypertension which was more common among mothers of NHSPDA group ($P = 0.03$). ***Terrin et al.***[13] study stated that gestational hypertension was recorded in (26.3%) of PDA cases. Cardiac examination revealed that only 26% of all neonates had murmur. There was statistically significant difference between groups regarding presence of mumur heard clinically (p value = 0.004). In our study, (50%) of cases with HD-Sig. PDA had apparent murmur. All neonates with closed PDA had no murmur and (41%) of cases with NHSPDA had murmur. cardiac murmur is a sensitive finding in PDA cases and audible murmur can help in early diagnosis.[14] Other findings were obtained in ***Pourarian et al.***[14] they showed that 45 infants had PDA on echocardiography; the most apparent sign was cardiac murmur in 100% of cases. Our study showed the number of babies who needed to be mechanically ventilated were significantly higher in HD-Sig. PDA in comparison to NHSPDA group which agrees with ***Okur et al.***[15] who found that duration of mechanical ventilation was longer in the HD-Sig. PDA group when compared to NHSPDA group. E/A values in neonates with PDA appeared to be greater than those in closed PDA infants in the study of ***Murase et al.***[16] There was lower values of septum E' velocity and lower lateral wall E' velocity in both HD-Sig. PDA cases and NHSPDA cases compared to the control group. There was lower mean measurments of both septum E' and lateral wall E' in HD-Sig. PDA compared to NHSPDA. Comparable results were obtained in previous study by **Parikh *et al.***[17] **which**

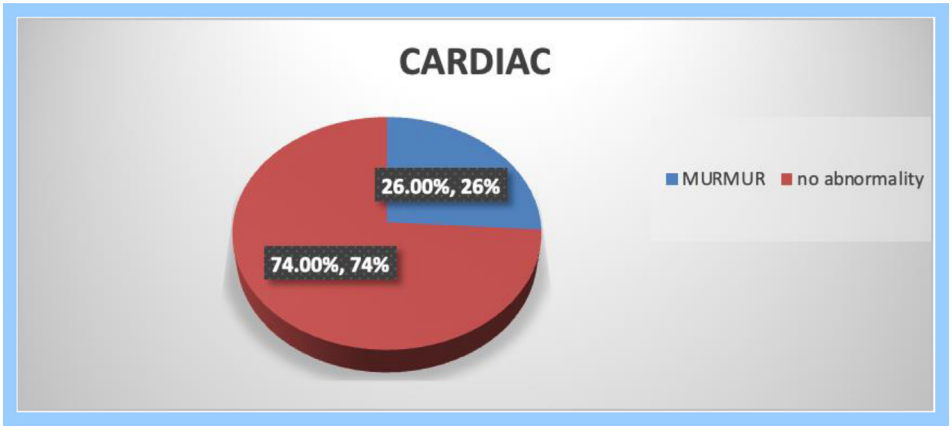

Fig. 3. Pie chart of neonates with cardiac murmur compared to those with no murmur.

confirmed lower myocardial velocities and myocardial performance index in HD-Sig. PDA group.

4.1. Conclusion

Neonates with HD-Sig. PDA had lower diastolic left ventricular values indicating variable degrees of diastolic myocardial dysfunction in these cases when compared to NHSPDA cases and control group. Tissue Doppler imaging is a reliable and non invasive procedure to evaluate diastolic myocardial functions in PDA cases.

Conflicts of interest

Authors declare that there is no conflict of interest, no financial issues to be declared.

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