Original Research Article

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Evaluation of children with cardiac murmur using Nadas criteria

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ABSTRACT

Background: Pediatricians often encounter children with heart murmurs during routine follow up visits or while assessment of intercurrent illness. Clinical differentiation between pathologic and innocent murmurs would be important. It is important to identify those children who need further evaluation. The aim of the study was to evaluate whether Nadas criteria can be applied as a screening test to decide on further workup.

Methods: This was a prospective descriptive study done in Government T. D. Medical College, Alappuzha over a period of 12 months from July 2013 to June 2014. All children in the age group one month to 12 years, attending the outpatient department were screened for presence of murmur of grade 2 and more. They were further evaluated carefully. They were also studied for association of variables like maternal age, birthweight, dysmorphism and family history of heart disease. Nadas criteria was then applied to the study population. A score of 2 and 1 were given to major and minor criteria respectively.

Results: 3070 children were screened. 150 children were detected to have murmur of grade2 and more.66 children were detected to have a structural heart disease by an echo study.74% of the study population in the age group <1 year had a heart disease.8 out of 78 children with a Nadas score of 1 and 10 out of 24 with a score of 2 had a heart disease. All with a score 3 and more had congenital heart disease (CHD).

Conclusions: Nadas criteria can be used as screening test with a sensitivity of 87% and specificity of 83%.

Keywords: Associations, Cardiac murmur, Evaluation, Nadas criteria

INTRODUCTION

Congenital heart disease (CHD) is defined as an abnormality in cardio circulatory structure present since birth. In Latin con means together and genitus means born.¹

Prevalence of congenital heart disease is approximately 8/1000 live births as per literature.² Majority of them are diagnosed during evaluation of a murmur detected either during a routine follow-up or while assessment during an intercurrent illness. It is important to differentiate significant murmurs from innocent murmurs clinically.³⁻⁵

This will avoid unnecessarily investigating some children with innocent murmurs. The index of suspicion depends mainly on the murmur itself usually. Innocent murmurs constitute the majority of murmurs detected in the pediatric age group. They are usually found in children in the age group 3 to 7 years. Innocent murmurs usually do not radiate, and the intensity may change with the child's position or respiration. Haney et al evaluated the ability of 30 office based pediatricians to correctly identify pathologic murmurs in a group of patients with a known cardiac defect. They reported a mean sensitivity of 82% and specificity of 72% regarding ability to differentiate pathologic from innocent murmurs.

Danford et al found that approximately 9% of children diagnosed to have innocent murmurs by pediatric cardiologists demonstrated a structural abnormality in the echo study. This study aims at detecting a congenital heart disease applying Nadas criteria and assessing whether it could be used as a screening test in the evaluation of a child with a murmur. The study evaluated whether a child identified to have a significant murmur as per Nadas criteria only need further investigations.

As per Blatimore Washington infant study the risk of congenital heart disease in general population is 0.4 to 0.6%. If the mother is affected the risk of having a congenital heart disease is 6.7%. If father is affected the risk is around 2%. If a sibling is affected the risk is 2.3%.

METHODS

All children in the age group 1 month to 12 years who attended the outpatient department of government T. D. Medical College Alappuzha during the study period were screened. Children with murmur of grade 2 or more were selected for study during the period of July 2013 to June 2014. Out of the 152 children detected with a murmur of grade 2 or more, 2 were lost for follow-up. Detailed history and clinical examination was done on all 150 children. All children were further investigated with a chest x ray, ECG and echocardiogram. Echocardiogram was done by cardiologist using 2D, M-mode Doppler and CMF using Toshiba 140SH equipment.5MHz pediatric probe was used. Significance of Nadas criteria in the detection of congenital heart disease was then assessed using statistical analysis of data.

Grading of murmurs by Levine in 1933 was used to evaluate all children. Murmurs are graded into 6 as per the grading by Levine.

- Grade 1 is a barely audible murmur and require several cycles to detect
- Grade 2 is a soft murmur that can be readily heard
- Grade 3 is a moderately loud murmur without a thrill
- Grade 4 is a loud murmur with a thrill
- Grade 5 is a loud murmur that can be heard with edge of stethoscope touching the chest wall
- Grade 6 is a loud murmur that can be heard without the stethoscope touching the chest wall.

Nadas criteria has 4 major and 5 minor components. Major criteria include systolic murmur of grade 3 or more, diastolic murmurs, cyanosis and congestive cardiac failure. Minor criteria include systolic murmur of grade less than 3, abnormal second sound, abnormal ECG, abnormal x-ray and abnormal blood pressure.

Abnormalities of the aortic and pulmonary components were assessed. Abnormalities in intensity, timing and wide splitting of aortic and pulmonary components were examined.

Chest x-ray was assessed for abnormalities in size and shape of heart, situs, pulmonary blood flow and other associated anomalies. A cardiothoracic ratio more than 55% and 50% were taken as cardiomegaly in infants and other children respectively. Cardiothoracic ratio was calculated by dividing the largest horizontal measurement of the heart by the largest internal diameter of the chest in a postero-anterior view. A 14 lead ECG was looked for evidence of pressure and volume overload, chamber hypertrophy, PR and QRS abnormalities. Blood pressure was taken for all children using an appropriate BP Cuff.

RESULTS

A murmur of grade 2 or more could be detected in 152 children out of 3070 children who attended the outpatient department of Government T.D Medical College Alappuzha. 2 were lost for follow-up. 150 children were followed up for detecting congenital heart disease (CHD). Maternal risk factors like heart disease, gestational diabetes mellitus, history of abortions and infertility treatment were recorded. Since number of children in each group were small, no significant association could be found. 1 mother had a PDA whose child also had a PDA. 2 mothers had gestational diabetes mellitus, and 1 child had atrial septal defect. 2 mothers were on infertility treatment. Out of this 1 child had a PDA along with cleft lip and palate.

Table 1: Association of mother's age at conception and congenital heart disease.

Mother's age at conception	No. of mother's	Children with CHD
<20	4	0
20- 24	84	36
25- 29	34	16
30- 34	24	10
35- 39	2	2
40- 44	2	2

Majority of the children with murmur (84 out of 150) were born to mothers of the age group 20- 24 yrs. There were only 4 children born to mothers above the age of 35 and all had CHD.

Table 2: Association of family history and congenital heart disease.

Family history	No. of children	Children with CHD
Family history of CHD	4	2
Consanguinity	2	0
No family history	146	64

Family history of heart disease was present in 4 children. 1 child with PDA had a mother who also had PDA. 1 child who had VSD had a sibling who also had VSD. For 2 other children with murmur there was family history of congenital heart disease in first degree relatives, but these

children had structurally normal heart on echo. No association between family history and congenital heart disease could be made out since there were only 4 cases with family history of congenital heart disease in the study group.

Table 3: Association of birth weight and CHD.

Birth weight	No. of children	Children with CHD
SGA	16	8
AGA	132	58
LGA	2	0

16 babies were small for gestational age (birth weight <2.5Kg) and 8 (50%) had CHD. 132 were appropriate for gestational age and 58 (44%) had congenital heart disease. 2 were large for gestational age but had structurally normal heart on echo. No association was found between birth weight and CHD. In this study there was only 1 preterm baby and no association between prematurity and CHD could be made out.

Table 4: Association between Gender and CHD.

Gender	No. of children	Children with CHD
Male	100	40
Female	50	26

Out of 100 male children 40% had CHD and out of 50 females 26 (52%) had CHD. No association was found between gender and congenital heart disease.

Table 5: Gender wise distribution of cardiac lesions.

Type of CHD	Male	Female
Ventricular septal defect (VSD)	22	9
Atrial septal defect (ASD)	9	4
Patent ductus arteriosus (PDA)	0	6
Atrioventricular septal defect (AVSD)	4	0
Mitral valve prolapse (MVP)	2	3
Corrected Transposition of great arteries (TGA)	1	0
Valvular Pulmonary stenosis (PS)	0	2
AS, AR, Trileaflet aortic valve	0	2
Tetrology of Fallot (TOF)	2	0

There were 13 cases of ASD of which 9 were in males and 4 were in females. All 6 cases of patent ductus arteriosus (PDA) were females.

Table 6: Association of age of child and CHD.

Age group in years	No. of children	Children with CHD
<1	38	28
1-5	58	28
5-10	50	10
>10	4	0

28 (74%) out of 38 children belonging to age <1 year age group had CHD. 28 (48%) out of 58 children in the 1-5 years age group had CHD. 10 (20%) out of 50 children in the 5-10 years age group had CHD. Association of age of the child and congenital heart disease was found to be significant. As age advances the chance of murmur being innocent also increases.

Physical findings and CHD

Of the 15 cases with cardiomegaly all had CHD.

Table 7: Association of major anomalies and CHD.

Major anomaly	No. of children	Children with CHD
Nil	134	52
Present	16	14

Out of the 134 children with no major anomaly, 52 (38.8%) had CHD. Out of 16 children with a major anomaly, 14 (87.5%) had CHD. Out of the children with major anomalies there were 9 with Down syndrome, 1 with Noonan syndrome, 1 with Turner syndrome, 1 with absent toes, 1 with cleft palate and lip. 3 children had dysmorphism probably part of some syndrome.

Out of 16 children with a minor anomaly, 14 (87.5) had CHD. Minor anomalies present included accessory nipple in 2 children, abnormal dermatoglyphics in 2 children, epicanthal fold in 1 child, pectus excavatum in 1 child, umbilical hernia in 2 children, hypertelorism in 2 children, low set ears in 3 children, preauricular tag in 1 child, polydactyly in 1 child, syndactyly in 1 child.

Table 8: Nadas criteria and CHD.

NADAS criteria	No. of children	Children with CHD
No CHD	78	8
CHD	72	58

Out of 150 children with murmur grade 2 or more, 78 had no CHD based on Nadas criteria and 72 had CHD based on the same criteria.

Table 9: Association of NADAS score and CHD.

NADAS score	No. of children	Children with CHD
1	78	8
2	24	10
3	12	12
4	32	32
5	2	2
6	2	2

When NADAS score was 1 majority of the murmurs were innocent (90%). When NADAS score was 2, 41.6%

(10 out of 24) murmurs were pathological. When NADAS score was 3 or above, 100% of murmurs were pathological.

Grade of murmur and CHD

When the grade of murmur was 3/6 or above, 89% (32 out of 36) murmurs were pathological. All children with grade 4 and 5 murmurs had a structural heart disease (16 and 6 children respectively). When the grade of murmur was 2/6, only 26% (30 out of 114) of murmurs were pathological. When the grade of the murmur was 3/6, 71% (10 out of 14) were pathological.

Abnormal S2 was present in 21 cases. Wide split S2 in 13 cases of ASD, loud P2 in 6 cases of large VSD, and single S2 in 2 cases of TOF. All of them with abnormal S2 had a congenital heart disease.

Abnormal ECG was found in 26 out of 150 children and all had CHD. Abnormal chest x-ray was present in 32 out of 150 children out of whom 23(72%) had CHD.⁹ children with abnormal chest x-ray had no cardiomegaly clinically though x-ray demonstrated an increased cardiothoracic ratio.

Out of 78 cases with no CHD based on NADAS criteria, 8 had CHD demonstrated by doing Echo. These included 2 cases of mild pulmonary stenosis, 1 case of AS AR Trileaflet Aortic valve, 4 case of MVP and a two months old baby with ASD.

Over diagnosis of 14 cases by nadas criteria was due to abnormal chest x ray in 9 cases, grade 3 murmur in 4 cases and abnormal blood pressure in one syndromic child

Table 10: Sensitivity and specificity of NADAS criteria.

True +ve (a) 58	False +ve (b) 14	Total (a+b) 72	
False –ve (c) 8	True -ve (d) 70	Total (c+d) 78	
Sensitivity= 87.87%;	Specificity = 83.3%;	Positive predictivity	
= 80.55%; Negative predictivity = 89.74%; Percentage of false			
negativity = 12.12%; Percentage of false positivity =16.66%.			

DISCUSSION

In this study association of maternal diseases like heart disease, gestational diabetes mellitus, abortion and infertility treatment was noted and no significant association was found. One mother and her child had PDA. One child and his sibling had VSD.¹⁰

Association between age of the child and CHD was found to be significant. As age advances the chance of murmur being innocent increases. In a study by Rahim F et al, 68% children with CHD were below 5 years. Here in this study 84.8% children with CHD were below 5 years.

Association of physical findings and heart disease was assessed, and cardiomegaly was found to be significant. All children with cardiomegaly had CHD. All 21 children with abnormal second heart sound had a structural heart disease. All children with abnormal ECG and 72% of children with abnormal chest x-ray were found to have CHD.

Association between NADAS criteria and CHD was noted. Of the 78 cases with no CHD based on NADAS criteria 8 had CHD which was demonstrated by ECHO. Out of these 8 children there were 2 with mild PS, 1 with AS AR, 4 with MVP and a 2 month old baby with ASD.

All these cases could have been picked by using NADAS criteria if other characters of pathological murmurs as shown in other studies done by Crindle BW et al and by Connel ME et al were included. Presence of early or mid-systolic click, postural variation of murmur, harsh quality of murmur, radiation, pansystolic murmur, and maximum intensity in pulmonary area could indicate pathological murmur.

Though score of 2 or above indicates CHD according to NADAS criteria, in this study score of 3 and above indicated definite CHD.

All children with grade 4 and 5 murmur had a structural heart disease. When the grade of murmur was 2, 26% had structural heart disease and when the grade was 3, 71% had structural heart disease.

Though S_2 and ECG were considered only as minor criteria in NADAS criteria, all children with abnormal S_2 and ECG in this study had CHD. A diagnosis of spurious cardiomegaly is done in children with large thymus or poor inspiratory effort which further degrades the value of x-ray. ^{14,15} In this study the sensitivity of NADAS criteria for detecting CHD was 87.87% and specificity was 83.3%.

CONCLUSION

Among 150 children included in this study murmurs were more in male children. Extra cardiac anomalies were pointers to congenital heart disease. 44% of children with grade 2 or more murmurs had structural heart disease with majority having left to right shunts. Abnormal S2 and ECG were found to be associated with congenital heart disease than an abnormal x-ray. NADAS criteria can be used as a screening test for evaluation of a murmur with a sensitivity of 87.87% and specificity was 83.3%. Its sensitivity can be significantly improved by including other characteristics of systolic murmur especially when the grade of murmur is less than 3.

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