Evaluation of Referral Pattern for Fetal Echocardiography at a Tertiary Care Center in Northern India and Its Implications

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About the Author

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Abstract

Objective To determine the referral pattern for fetal echocardiography (FE) at our tertiary referral center for pediatric cardiac care in northern India. We also aimed to determine the incidence of CHD in each group and intend to highlight the need of identifying the various risk factors

and appropriate timely referral of patients for detailed evaluation.

Methods This is a prospective study including 201 consecutive patients referred for fetal echo to our center. Data collected included referral indication, gestational age, maternal age, the gravida, and the final diagnosis after detailed fetal echo. Various indications that were evaluated included maternal diabetes (pre-gestational or gestational), echogenic cardiac nodule, abnormal four chamber on ultrasound, other extra-cardiac abnormalities detected on ultrasound, and twin pregnancies or IVF conceptions. Some women had opted for fetal echo electively and they were defined as self referral.

Results The mean gestational age of referral was 24 ± 5 weeks. Out of these, 196 had specific referral

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indication while five were self referrals. The most common indication for referral was echogenic cardiac foci. CHD was diagnosed in 38 (19 %) patients. Indication that yielded the highest number of CHD cases was cardiac abnormality on USG. The mean gestational age at referral in those detected to have CHD was 27 ± 4 weeks. The commonest CHD detected was tiny VSD, while most of the complex CHD's were diagnosed in those referred for cardiac abnormality on USG.

Conclusion CHD detection is highest in those referred for abnormal cardiac imaging on USG, and hence a careful assessment of fetal heart during routine prenatal screening would increase the CHD detection markedly. Nuchal translucency needs to be measured accurately and those with value greater than 99th centile should be referred for FE. Mothers with pre-gestational diabetes should have a FE prior to 20 weeks to rule out CHD. A FE scan in third trimester is indicated in diabetic females (gestational and pre-gestational) if the glycemic control is poor evidenced by $HbA1c > 6\%$. Timely referral is absolutely essential so that appropriate counseling of the parents can be done.

Keywords Fetal echocardiography · Referral patterns · Congenital heart defects

Introduction

Congenital heart defects (CHDs) are the most common congenital malformation with a reported incidence of 8–10 per 1000 live births. The severity of heart defect varies with one-third cases being severe (i.e., fatal or requiring intervention in first year of life). Prenatal detection of CHD is important since heart defects are associated with significant morbidity and mortality in both fetus and neonate. With advancements in fetal echocardiography, most of the CHD's can be detected in utero during second trimester or even in late first trimester with a detection rate of 85–95 % in specialized units. The yield of fetal echo in detection of CHD depends not only on the expertise of the performer but also on the indication of referral.

Aim

The aim of this study was to determine the referral pattern for fetal echocardiography (FE) seen at our institute which is an important tertiary referral center for pediatric cardiac care in northern India. We also aimed to determine the incidence of CHD in each group and intend to highlight the need of identifying the various risk factors and appropriate timely referral of patients for detailed evaluation.

Materials and Methods

This is a prospective study which included 201 consecutive patients referred for fetal echo to our center. A detailed fetal echo was performed using the C5-2 curved array transducer and iE33 imaging system (Philips Healthcare). Data collected included referral indication, gestational age, maternal age, the gravida and the final diagnosis after detailed fetal echo. Various indications that were evaluated included maternal diabetes (pre-gestational or gestational), echogenic cardiac nodule, abnormal four chamber on ultrasound, other abnormalities detected on ultrasound like single umbilical artery, choroid plexus cyst, abnormal blood flow patterns in major arteries, twin pregnancies, or IVF conceptions. Some women had opted for fetal echo electively and they were defined as self referral.

Statistical Analysis

Categorical data were presented as number and percentage while the measured data were presented as mean and range. Chi-square test or Fisher's exact test (whichever was applicable) was used to determine the association between the various risk factors and occurrence of CHD. A p value of <0.05 was considered significant. All analyses were performed by using statistical software SPSS version 13.0.

Result

A total of 201 patients were included in the study. The mean age of mothers referred for FE was 28 ± 4.5 years. The mean gestational age of referral was 24 ± 5 weeks. Out of these, 196 had specific referral indication while five were self referrals. The most common indication for referral was echogenic cardiac foci. The categorization of patients as per various indications and the yield of CHD by indication are presented in Table 1. Cardiac pathology was diagnosed in 42 (21 %) patients. This included CHD in 38 (19 %) patients and arrhythmia in 4. A normal heart was found in 159 (79 %) patients. Indication that yielded the highest number of CHD cases was cardiac abnormality on USG. Miscellaneous group included three patients—one referred for maternal Toxoplasma IgM positivity, other for previous child with long QT syndrome, and the third one for previous child with multiple extra-cardiac congenital anomalies. Of these three, fetus of mother with toxoplasmosis was detected to have significant CHD.

Of the 11 fetuses referred for extra-cardiac malformations, six had choroid plexus cysts and five had single umbilical artery. Out of these, only one patient referred for

choroid plexus cyst had CHD. In the arrhythmia group, three were referred for irregular fetal heart rate due to atrial ectopics, three for bradycardia and one for complete heart block, and none had CHD.

Cardiac abnormalities on USG included tricuspid regurgitation in 3 patients, abnormal four-chamber view in 21, and inadequate 4C view or suspicion of CHD in 8

patients. Extra-cardiac functional abnormality (2 cases) included one fetus with increased resistance in middle cerebral artery and other one with abnormal uterine artery flow. Both these fetuses had a normal heart. An unusual finding was that in the entire cohort there were only two patient referred for fetal echo in view of increased nuchal translucency.

The distribution of cases diagnosed with CHD according to the defect is shown in Table 2 and the types of CHD in each group of indication is shown in Table 3.

The mean gestational age at referral in those detected to have CHD was 27 ± 4 weeks.

Table 1 Referral indications and yield of CHD by indication

Referral indication	Number (% of total)	CHD n (%)
Echogenic cardiac foci	60 (30 %)	4 (7 %)
Maternal diabetes	38 (19 %)	6 (16 %)
Cardiac abnormality on USG	32 (16 %)	22 (69 %)
Extra-cardiac malformations	11 (5.5 %)	1 (9 %)
IUGR	2 (1 %)	0
Self referral	5 (2.5 %)	0
Previous child with CHD	14 (7 %)	3 (21 %)
Previous unexplained neonatal death/IUD	5 (2.5 %)	0
Twin pregnancy	3 (1.5 %)	0
IVF pregnancy	1 (0.5 %)	0
Arrhythmia	7 (3.5 %)	0
Polyhydramnios	1 (0.5 %)	0
Extra-cardiac functional abnormality	2 (1 %)	0
Family history of CHD	2 (1 %)	0
Abnormal nuchal translucency	2 (1 %)	0
Bad obstetric history (BOH)	3 (1.5 %)	0
Advanced maternal age	8 (4 %)	1 (12 %)
PIH	2 (1 %)	0
Miscellaneous	3 (1.5 %)	1 (33 %)
Total	201	38 (19 %)

Table 2 Spectrum of defects among fetuses diagnosed with CHD

Type of cardiac defect	Number of cases
Tiny VSD	11
Multiple VSD's	1
HLHS	6
DORV/VSD	2
Tricuspid atresia	2
Pulmonary atresia/VSD	1
Pulmonary atresia/intact IVS	3
Pulmonary stenosis	3
Aortic stenosis	1
Mitral valve abnormality	2
Coarctation of aorta	2
Premature duct constriction	1
Asymmetric septal hypertrophy	1
Truncus arteriosus	1
Ebstein anomaly	1

Discussion

In our study, the commonest indication for referral was an echogenic cardiac foci accounting for 30 % referrals. However, the yield of CHD was only 7 % and the association was not statistically significant ($p = 0.004$). Our finding was similar to that of Michael et al. [1] who in a study of 10,406 fetuses found that out of 230 fetuses with isolated echogenic foci only one had CHD (prevalence—

Table 3 Type of CHD in each group

Referral Indication	CHD (n)
Echogenic cardiac foci	4 (7 %) Tiny VSD—4
Maternal diabetes	6 (16 %) Pulmonary stenosis—2 Aortic stenosis—1 Tiny VSD—1 COA—1 Asymmetric septal hypertrophy—1
Cardiac abnormality on USG	22 (69 %) Tiny VSD—2 Premature duct closure—1 Truncus—1 Pulmonary atresia—3 Pulmonary atresia/VSD—1 Tricuspid atresia—2 HLHS—6 COA—1 Pulmonary stenosis—1 Ebstein—1 DORV/VSD/PS—2 Inlet VSD/hypoplastic MV—1
Extra-cardiac malformations	1 (9 %) Multiple VSD—1
Previous child with CHD	3 (21 %) Tiny VSD—3
Advanced maternal age	1 (12 %) Tiny VSD—1
Miscellaneous	1 (33 %) Tiny VSD + myxomatous MV—1

2.2 %) and concluded that an isolated echogenic cardiac foci is not an efficacious marker for CHD. However, Carrico et al. [7] reported a prevalence of 8 % for CHD in fetuses with echogenic foci and thus emphasized the need for FE in such fetuses. There was no further increase in the risk of CHD in fetuses having multiple echogenic foci compared to those with single foci. In view of variable experiences by numerous authors, we advocate a detailed FE to be performed in these fetuses at appropriate time (16–20 weeks).

The next commonest indication for referral was maternal diabetes and 16 % of these fetuses had CHD of variable severity; however, the correlation was not statistically significant ($p = 0.53$). Fetuses of mothers with diabetes have a higher incidence of heart defects (2.5–12 %) which are mainly of two types. One group is of structural CHD which is more common in mothers who have diabetes peri-conceptionally, while other group is of hypertrophic cardiomyopathy which usually develops late in gestation. Hunter et al. [8] reviewed 543 pregnant females with gestational diabetes (GDM) and reported a 2.7 % risk of CHD in fetuses of these mothers while the risk of CHD was 3.1 % in fetuses of mothers with pre-gestational diabetes. Chu et al. [2] have demonstrated that fetuses of mothers with pre-gestational diabetes were prone to develop ventricular diastolic dysfunction in late gestation. Hence in diabetic mothers a detailed FE should be done at 16–20 weeks to rule out CHD & strict glycemic control should be maintained. Mothers with HbA1c > 6 % in third trimester should have a FE repeated at around 30 weeks to detect asymmetric hypertrophic cardiomyopathy or ventricular dysfunction [6].

In this study the indication that yielded the highest number of CHD was a cardiac abnormality suspected on USG (detection rate 58 %). The association between an abnormal cardiac image on USG and detection of CHD was highly significant ($p < 0.001$). Similar findings were observed by Li et al. [9] with a CHD detection rate of 64 %, Castro et al. [5] with detection rate of 53.8 % and by Maciej et al. [3]. Benjamin et al. [4] in their review of 7710 FE referrals also reported that the yield of CHD was highest among those referred for an abnormal cardiac image on USG. We also found that most of the complex CHD's were found in this group. The commonest CHD detected was tiny VSD. Shen et al. have reported at the 35 % of prenatally detected VSD had closed by the time a neonatal echo was done, and this either represented spontaneous closure in utero or false-positive detection.

Congenital heart defect in previous baby was an indication for referral in 14 (7 %) patients and of these 3 patients (21 %) had CHD. However, the association was not statistically significant ($p = 0.51$). Recurrence of CHD is a well-known fact, and the incidence varies with the type of CHD in previous sibling. For example, with one affected sibling, recurrence risk for atrial or ventricular septal defect

or patent ductus arteriosus is 2.5–3 %, for truncus arteriosus or Ebstein anomaly is 1 %, for HLHS is 2 %. Extra-cardiac malformations accounted for 5.5 % of referrals but only one fetus was found to have CHD [statistically insignificant ($p = 0.39$)]. None of the patient referred for fetal arrhythmia had CHD though the number of such mothers was less.

Only two patients were referred for FE due to increased nuchal translucency (NT). This may be either because actually the number of fetuses with increased NT is very less or there is lack of awareness about the important correlation between increased NT and CHD. NT increases with crown rump length (CRL) and hence is usually measured in percentiles in relation to CRL. The 95th centile of NT for a CRL of 38 is 2.2 mm and for a CRL of 84 is 2.8 mm, whereas the 99th centile (3.5 mm) does not change significantly with CRL [10]. Increased NT has been well known to be associated with higher incidence of CHD, and this incidence increases with higher values of NT. Hyett et al. [10] demonstrated that the CHD prevalence was 0.8/1000 pregnancy when the NT was below 95th centile, while it increased to 63.5 per 1000 when NT was above 99th centile. Due to the proven correlation between NT and CHD, we would like to impress the need for a uniform pattern of NT measurement and referral for a detailed fetal echo if NT value is greater than at least 99th centile. Such fetuses should be referred for early fetal echo rather than waiting till 18–20 weeks.

An important aspect of this study which needs to be highlighted is the gestational age at which the mothers were referred for FE. The mean GA at referral for the entire cohort was 24 weeks while it was 27 weeks in the CHD detected group, both of which were significantly late for any decision.

Limitation

According to us this study has few limitations. A larger cohort might have been better. Secondly we do not have the post natal details of the fetuses detected to have CHD. Thirdly the diabetic group included both pre-gestational and gestational diabetes.

Conclusion

Despite few limitations of this study, our data show that CHD detection is highest in those referred for abnormal cardiac imaging on USG and hence a careful assessment of fetal heart during routine prenatal screening would increase the CHD detection markedly. Nuchal translucency needs to be measured accurately, and those with value greater than 99th centile should be referred for FE. Mothers with pre-

gestational diabetes should have a FE prior to 20 weeks to rule out CHD. A FE scan in third trimester is indicated in diabetic females (gestational and pre-gestational) if the glycemic control is poor evidenced by HbA1c > 6 %.

This study showed that mean gestational age of referral in those diagnosed with CHD was 27 weeks which is much beyond the legal as well as safe age for pregnancy termination. Thus a timely referral before 20-week gestation is essential, and for this educating the referring gynecologist or ultrasonologist is crucial. It is absolutely essential to emphasize the need for timely referral so that appropriate counselling of the parents can be done.

Compliance with Ethical Standards

Conflict of interest There is no conflict of interest between the two authors.

Ethics Standards The ethics committee was not involved as it was a routine fetal scan that is normally done for the patients referred.

Informed consent statement Informed consent was obtained.

References

1. Barsoom MJ, Deborah M. Is an isolated fetal cardiac echogenic focus an indication for fetal echocardiography? *J Ultrasound Med.* 2001;20:1043–6.
2. Chu CL, Gui YH, Ren YY, et al. The impacts of maternal gestational diabetes mellitus (GDM) on fetal hearts. *Biomed Environ Sci.* 2012;25(1):15–22.
3. Slodki M, Szymkiewicz-Dangel J, Tobota Z, et al. The polish national registry for fetal cardiac pathology: organization, diagnoses, management, educational aspects and telemedicine endeavors. *Prenat Diagn.* 2012;32:1–5.
4. Hamar BD, Dziura J, Friedman A, et al. Trends in Fetal Echocardiography and Implications for Clinical Practice 1985 to 2003. *J Ultrasound Med.* 1985;2006(25):197–202.
5. Castro-Coelho F, Freitas T, Silva M, et al. Referral indications for fetal echocardiography in the Madeira islands. 13th World Congress in Fetal Medicine, Hospital Dr. Nélio Mendonça, Funchal, Portugal.
6. Donofrio MT, Moon-Grady AJ, Hornberger LK, et al. Diagnosis and treatment of fetal cardiac disease a scientific statement from the american heart association. *Circulation.* 2014;129:2183–242.
7. Carriço AL, Matias A, Areias JC. How important is a cardiac echogenic focus in a routine fetal examination? *Rev Port Cardiol.* 2004;23(3):459–61.
8. Hunter LE, Sharland GK. Maternal gestational diabetes and fetal congenital heart disease: an observational study. *J Pregnancy Child Health.* 2015;2:132.
9. Li M, Wang W, Yang X, et al. Evaluation of referral indications for fetal echocardiography in Beijing. *J Ultrasound Med.* 2008;27(9):1291–6.
10. Hyett J, Perdu M, Sharland G, et al. Using fetal nuchal translucency to screen for major congenital cardiac defects at 10–14 weeks of gestation: population based cohort study. *BMJ.* 1999;318:81–5.