Measure what is measurable and make measurable what is not: a pilot study defining the spatial relationships between 8 anatomic planes in the 11+6 - 13+6 week fetus

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Objective

Our study aims at investigating the spatial relationships between 8 anatomic planes in the 11+6 - 13+6 week fetus.

Methods

This is a retrospective pilot study where three- and four-dimensional stored data sets were manipulated to retrieve 8 anatomic planes starting from the mid-sagittal plane of the fetus. Standardization of volumes was performed at the level of the transverse abdominal circumference plane. Parallel shift was utilized and the spatial relationships between 8 anatomic planes were established utilizing the mid-sagittal volume technique (steps 1-6 described to the right). The median and the range were calculated for each of the planes, and they were evaluated as a function of the fetal crown rump length. $P < 0.05$ was considered statistically significant.

Results

A total of 63 volume data sets were analyzed. The 8 anatomic planes were found to adhere to normal distribution curves, and most of the planes were in a definable relationship to each other with statistically significant correlations.

Conclusion

To our knowledge, this is the first study to describe the possible spatial relationships between 8 two-dimensional anatomic planes in the 11+6 - 13+6 week fetus, utilizing a standardized approach, the mid-sagittal volume technique. Defining these spatial relationships may serve as the first step for the potential future development of automation software for fetal anatomic assessment at 11+6 - 13+6 weeks.

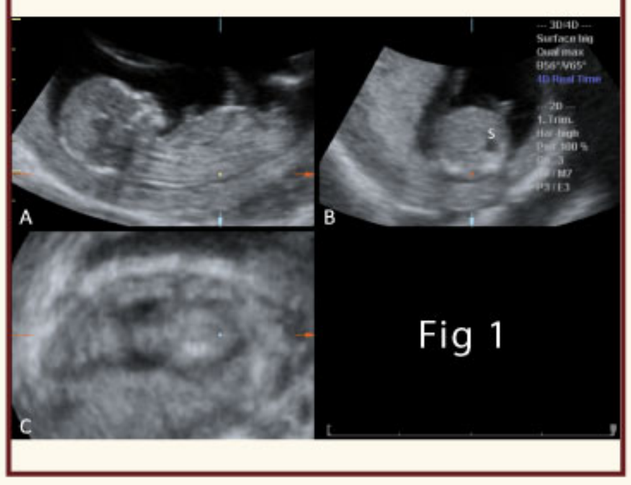
Plane	Total successful retrieval (%)	5%*	25%*	Mean, mm	75%*	95%*	SD
Plane +1	62 (98.4%)	5.37	7.08	8.27	9.46	11.17	1.76
Plane +2	49 (77.8%)	21.46	27.36	31.47	35.57	41.48	6.09
Plane +3	58 (92.1%)	24.74	31.03	35.41	39.78	46.07	6.49
Plane +4	60 (95.2%)	36.14	42.41	46.77	51.13	57.41	6.47
Plane +5	60 (95.2%)	42.48	49.02	53.57	58.11	64.65	6.74
Plane -1	50 (79.4%)	-15.16	-12.40	-10.48	-8.56	-5.80	2.84
Plane -2	61 (96.8%)	-23.91	-20.84	-18.72	-16.56	-13.49	3.17

All planes' measurements and CRL were tested for normality and were found to be normally distributed with p-values > 0.13
* based on probability estimates, assuming normality and estimating the parameters (mean and standard deviation) from the data.

Percentage of successful retrieval of designated 2D planes out of the 63 stored sets, and descriptive statistics for the spatial relationships, expressed as percentage of the fetal CRL, cephalad (+) and caudad (-) from the transverse abdominal circumference plane (parallel shift) towards the seven 2D planes.

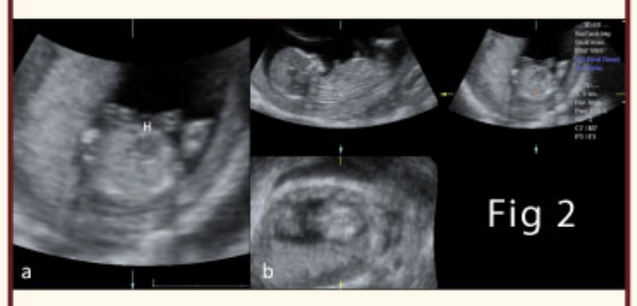
Steps 1-6 for the Application of the Mid-Sagittal Volume Technique

Step 1: Volumes are acquired from a sagittal plane with an angle of acquisition of 65 degrees.
Step 2: The volume is then standardized in reference plane (A) via rotation along the X, Y and Z axes to optimize the depiction of the fetus in the mid-sagittal plane (Fig 1).

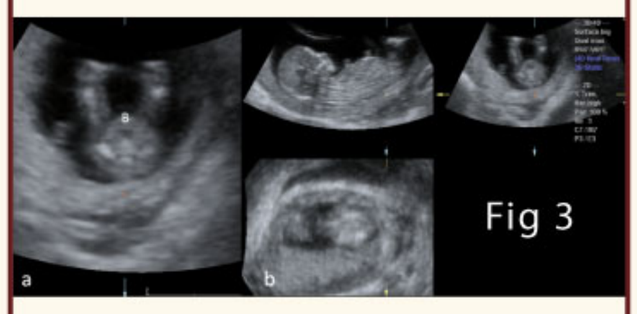


Step 3: In reference plane (A), the reference dot is then placed in the fetal spine at the level of the diaphragm, automatically generating the axial plane of the fetal abdominal circumference, with a visible stomach (S), in plane (B) (Fig 1).

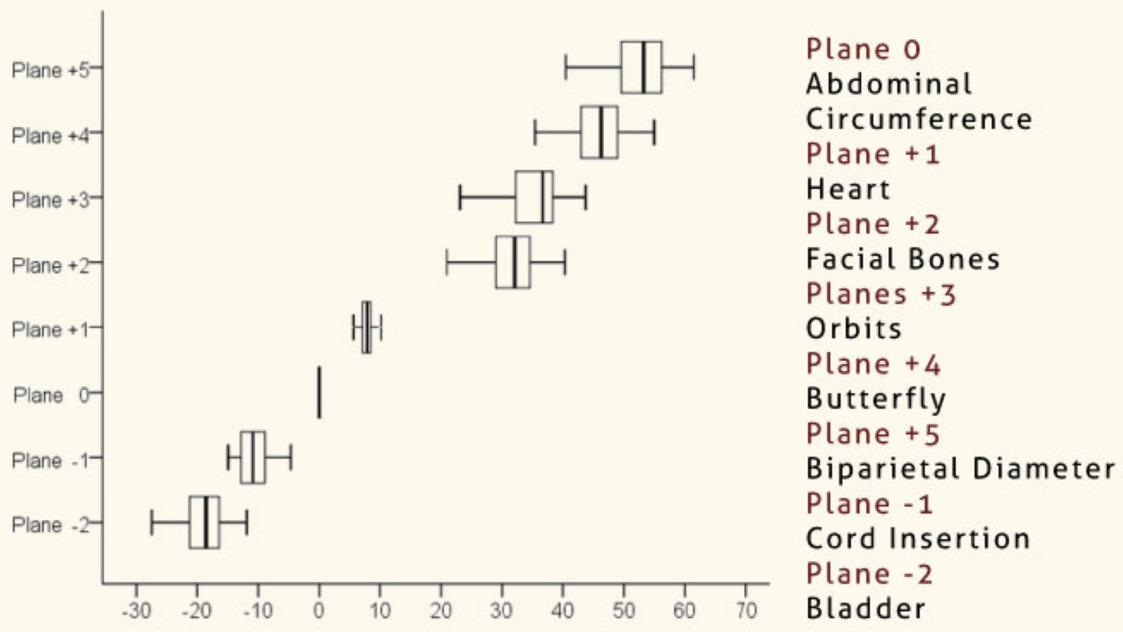
Step 4: Plane (B) is then selected as the reference plane, plane 0, (at 0 mm) and rotation along the Z axis is employed to optimize the location of the spine at 12 o'clock (Fig 1).



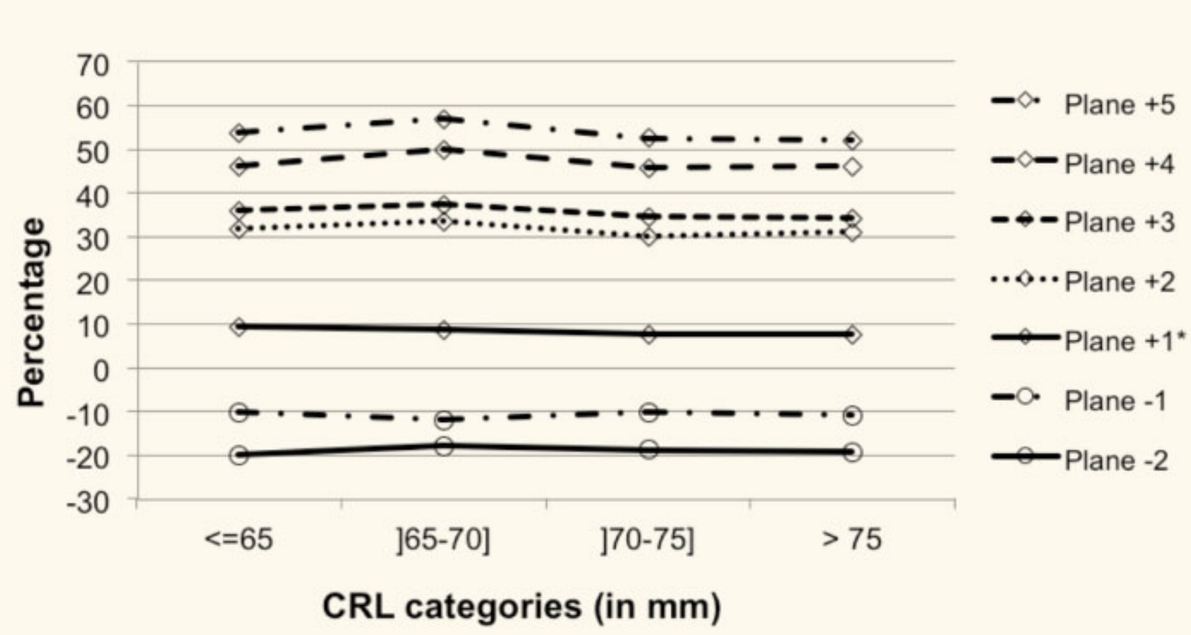
Step 5: Parallel shift is then utilized to navigate cephalad within the volume, from reference plane (B), plane 0, to generate 5 anatomic planes and to determine the spatial relationships of each of those 5 planes to plane 0 (Fig 2 which represents plane +1). (H) Designates the fetal heart.



Step 5: Parallel shift is then utilized to navigate caudad within the volume, from reference plane (B), plane 0, to generate 2 anatomic planes and to determine the spatial relationships of each of those 2 planes to plane 0 (Fig 3 which represents plane -2). (B) Designates the fetal bladder.



Box plot representation for the parallel shift (in millimeters expressed as a percentage of each fetus' CRL) from plane 0 to all seven 2D planes. The line inside each box represents the 50 centile for CRL (median). The left and right edges of each box correspond to the 25th and 75th centiles, respectively. The end points of the left and right whiskers correspond to the minimum and maximum values.



Mean measurements of the distances from plane 0 to the 5 cranial and 2 caudal planes, expressed as a percentage of each fetus' CRL, as a function of fetal CRL categories. * Denotes the anatomic plane with statistical significance.

Prenatal Diagnosis 2012 (In Print)

How good are we in the prenatal diagnosis of congenital heart disease in Lebanon?

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Objective

To determine the prenatal diagnosis rate (PDR) of congenital heart disease (CHD) in a pediatric population age ≤ 5 years.

Methods

Prospective study at 3 pediatric cardiology clinics on 74 consecutive patients at age ≤ 5 years. Patients were questioned about family history (FHx), if they were scanned prenatally and if an abnormality was suspected prenatally. The presence of other structural/chromosomal abnormalities, age at diagnosis, final diagnosis and the need for surgical/medical intervention was established. Data was analyzed using chi square and non-parametric z approximation. Scans were performed by a single pediatric cardiologist. No information was available on patients who may have been prenatally diagnosed, terminated or had spontaneous in utero demise. $P < 0.05$ was considered statistically significant.

Results

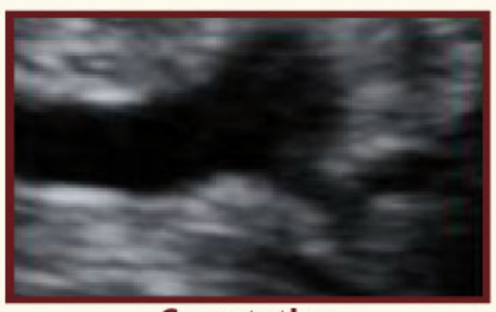
A total of 74 patients with 94 lesions were enrolled. FHx was positive in 18.9%. All were scanned prenatally and 86.5% were scanned at each prenatal visit. The PDR was 21.2%. Mean age at diagnosis was 13.4 months. The most prevalent lesions in our population were ventricular septal defect 32.4%, pulmonary artery stenosis 12.2%, patent foramen ovale 9.5%, tetralogy of fallot 8.1% and dysplastic mitral valve 6.8%. Of all cases, 39.2% already had or would require surgical intervention and 21.2% needed medical therapy. Of 6 with a known karyotype, 4 had trisomy 21, 1 had DiGeorge syndrome and 1 was normal. Of the 94 total lesions, 56.4% were amenable to prenatal diagnosis by a 4 chamber view but only 18.9% were diagnosed prenatally. Prenatal diagnosis was considered critical (cyanotic lesions) in 26/94 (27.7%) and of those, 7/26 (26.9%) were diagosed prenatally versus in 7/68 (10.3%) of those with non-critical lesions (p=0.043).

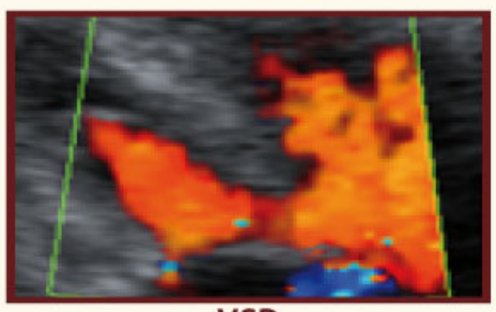
Conclusion

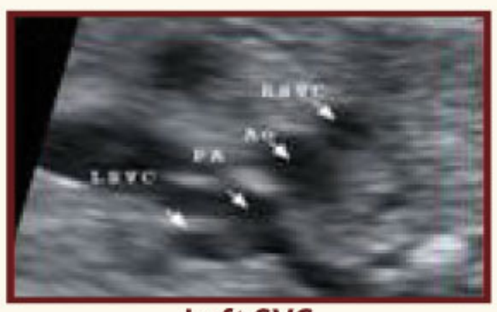
Even though 100 % of patients were scanned prenatally, the PDR for CHD was only 21.2%, and it was 18.9% for lesions diagnosable by a 4 chamber view, and 26.9% in those in whom prenatal diagnosis is critical. This calls for the urgent implementation of proper basic training in fetal echocardiography in order to maximize the utility of our sonographic machines and enhance our prenatal diagnosis rates.

Most Common Lesions	Total (% Out of 74)
Ventricular Septal Defect	24 (32.4%)
Pulmonary Artery Stenosis	9 (12.2%)
Patent Foramen Ovale	7 (9.5%)
Tetralogy of Fallot	6 (8.1%)
Dysplastic Mitral Valve	5 (6.8%)

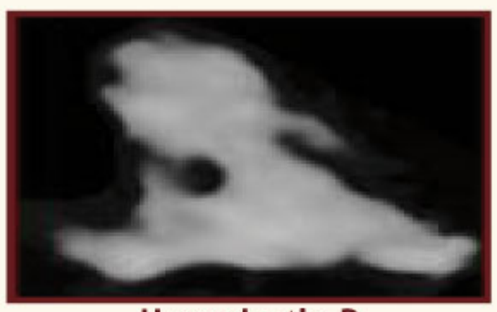
Lesions Diagnosable by a 4 Chamber View	Total Number	Prenatally Diagnosed
Ventricular Septal Defect	24	2 (8.3%)
Tetralogy of Fallot	6	1 (16%)
Dysplastic Mitral Valve	5	0
Atrioventricular Septal Defect	4	2 (50%)
Tricuspid Atresia	3	0
Pulmonary Atresia	3	1 (33%)
Dysplastic Tricuspid Valve	2	1 (50%)
Dextrocardia	1	1 (100%)
Total Anomalous PVR	1	0
Isomerism	1	0
Hypoplastic Right Heart	1	1 (100%)
Single Ventricle	1	0
Situs Inversus	1	1(100%)
Diagnosable by a 4CV	53/94 (56.4%)	10/53 (18.9%)

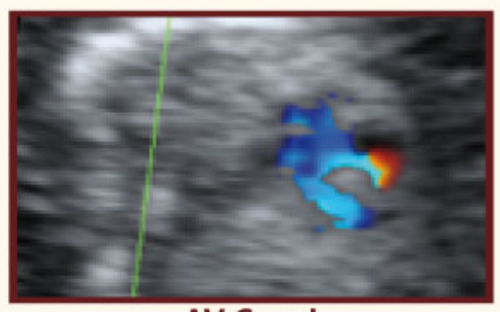

Coarctation

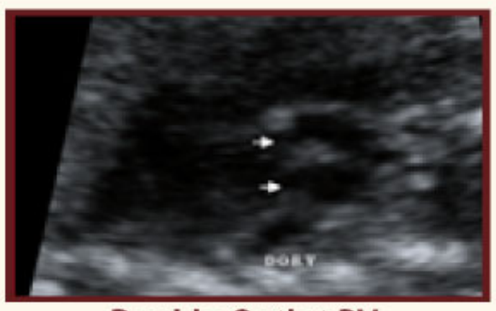

VSD

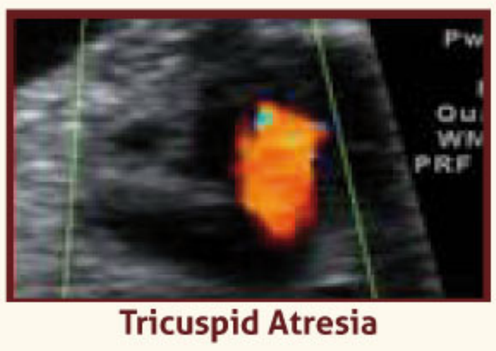


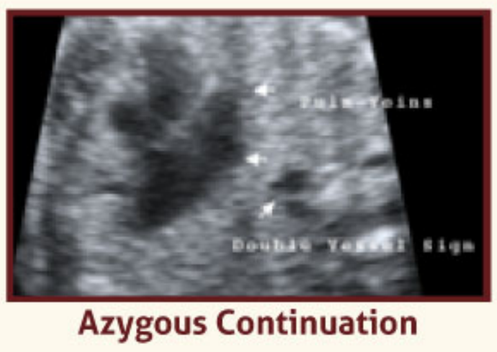
Left SVC


Hypoplastic R


AV Canal

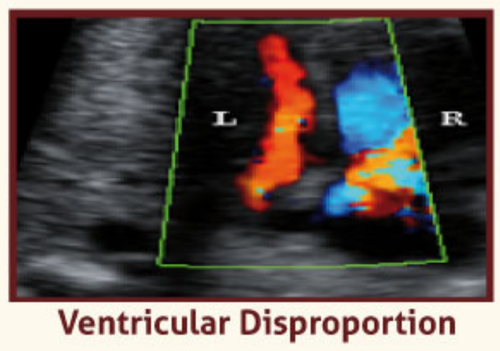

Double Outlet RV


Tricuspid Atresia



Azygous Continuation


Univentricle



Ventricular Disproportion

To coarct or not to coarct: does the third trimester 'golf club sign' help in differentiating a true from a false coarctation?

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Objective

To evaluate the role of a third trimester sonographic finding, the golf club sign (GCS), in differentiating a true from a false coarctation of the aorta (CoA).

Methods

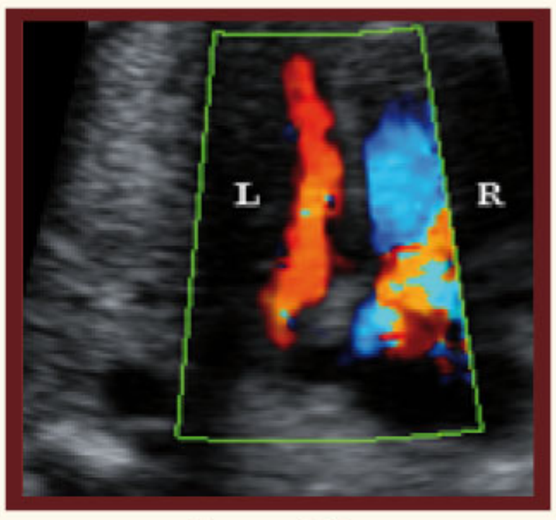
Prospective study on 243 patients in the third trimester. The four chamber view, out flow tracts and 3 vessel view (3VV) were examined. With left to right ventricular disproportion (VD), the ratio of the pulmonary artery (PA) to the aorta (Ao) at the level of the 3VV was obtained. A sagittal view of the great arteries was obtained to assess for the GCS formed by a dilated prominent ductal arch where it joins the descending Ao. All scans were performed by a single sonologist certified by the Fetal Medicine Foundation. Suspicious cases were referred to pediatric cardiology, delivered at a tertiary care center and scanned at birth. Neonatal outcome was available on all fetuses.

Results

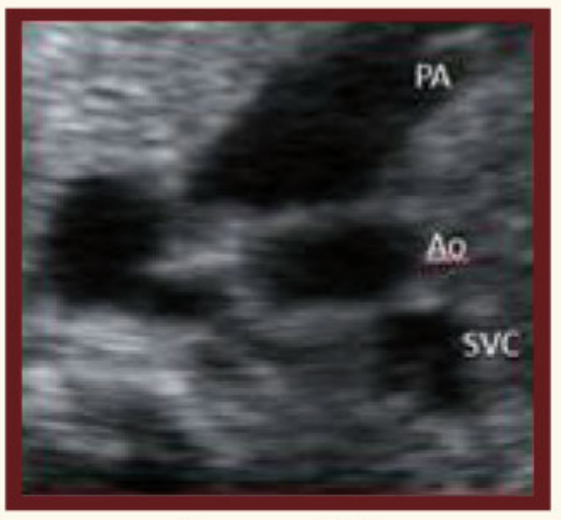
There were 243 fetuses with a mean gestational age of 32w2d. The GCS was present in 2/3 cases suspected for CoA and in none of the normals. Surgical intervention was needed in 1/3 cases. GCS had 100% sensitivity, 99% specificity, 50% positive predictive value and 100% negative predictive value (NPV). There were no additional cases of congenital heart defects.

Conclusion

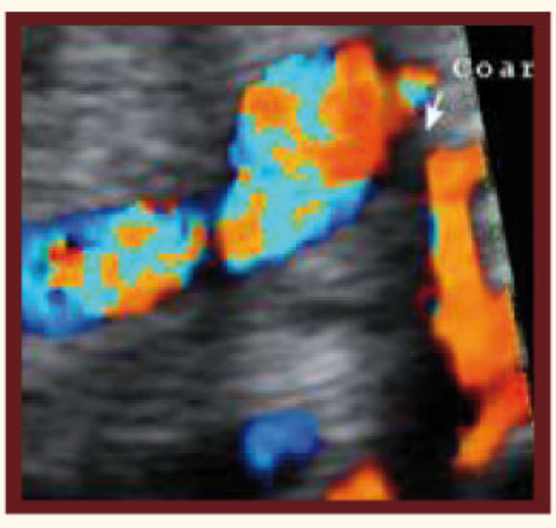
Coarctation of the aorta remains a challenging in utero diagnosis. Highly sensitive and specific sonographic markers are instrumental to decreasing undue parental anxiety, without compromising prenatal detection rates. In this very small cohort, the golf club sign at the time of the third trimester scan (TTS) was 100% sensitive and 99% specific. Its NPV of 100% may help ease parental anxiety. The GCS with PA/Ao ratio may prove to be a promising sign and needs to be evaluated in large case series. The time may have come for devising a scoring system combining all available first and second trimester markers in order to maximize our prenatal detection rates, while minimizing our false positive rate, in cases of coarctation.



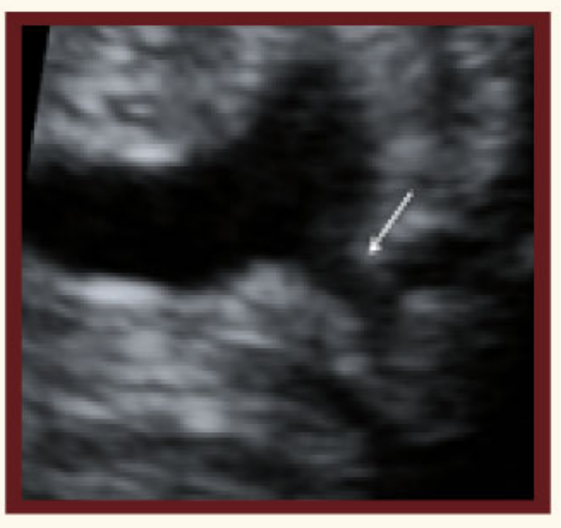
Case 1: VD



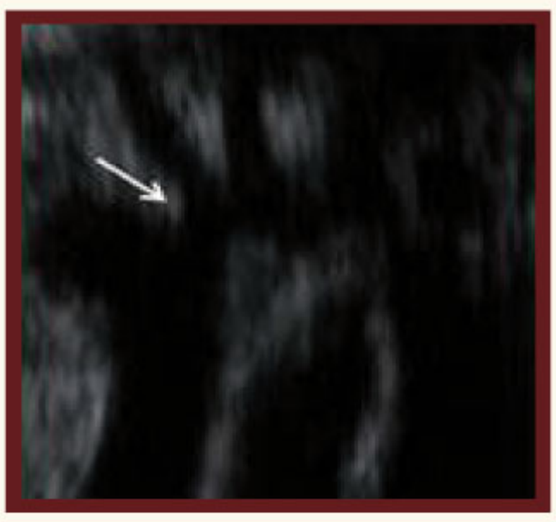
Case 1: 3VV



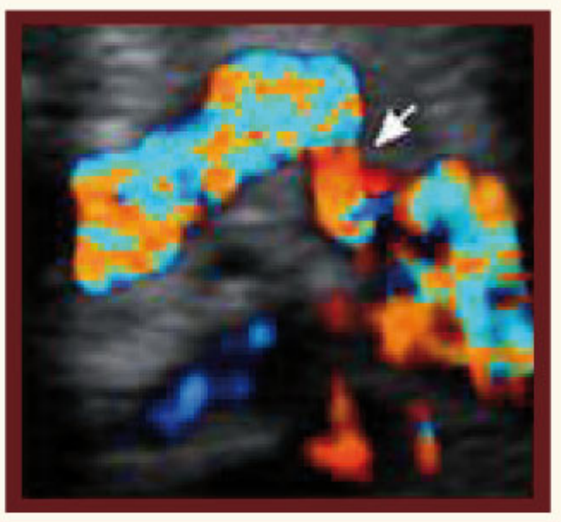
Case 1: GCS, Shelf



Case 1: GCS, Shelf



Case 3: GCS, Shelf



Case 2: No GCS, Shelf

Case	NT	FTS	STS	TTS	VD	Ao/PA <0.8	PA/Ao >1.6	Shelf	GCS	Other	Outcome
1	1.8	13w2d	22w5d	22w5d	+	5.8/10.2 0.57	10.2/5.8 1.76	+	+	VSD	Coarct
2	1.6	13w3d	22w4d	36w2d	+	5.3/7.5 0.71	7.5/5.3 1.42	+	-	-	Normal
3	2.3	12w6d	21w2d	34w0d	+	4.7/6.8 0.69	6.8/4.7 1.45	+	+	Extra Systole	Situs Inversus

Normogram for the frontomaxillary facial angle in a Lebanese population

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Objective

The frontomaxillary facial angle (FMFA) is a first trimester (FT) marker for trisomy. Recently, its role as a FT marker for spina bifida (SB) has been evaluated. Our objective was to determine the normogram for the FMFA in an unselected low risk Lebanese population and to compare our results to the established normogram of Borenstein et al to assess for any ethnic variations precluding its application in our population as an early FT marker of trisomy and SB.

Methods

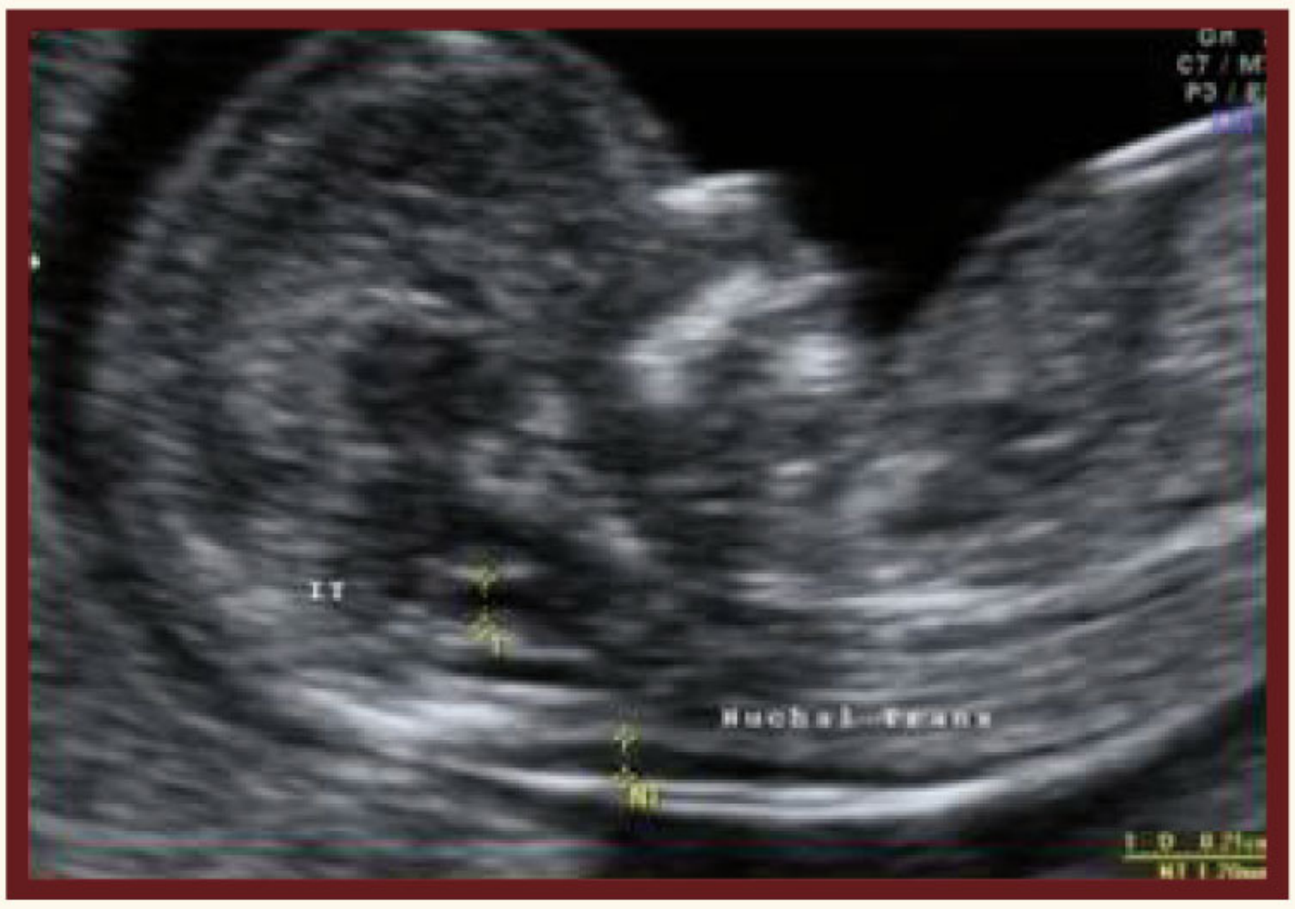
Prospective study on 361 fetuses with confirmed dating undergoing a FT scan at 11 to 14 weeks. All scans were performed by a single sonologist certified by the Fetal Medicine Foundation. The FMFA was measured in all fetuses in a mid sagittal plane according to the guidelines of the Fetal Medicine Foundation. Regression analysis was used to establish the relationship between fetal crown rump length (CRL) and FMFA. ANOVA test of means was employed to compare the mean FMFA in relation to the CRL. $P < 0.05$ was considered statistically significant. All fetuses were healthy term live births.

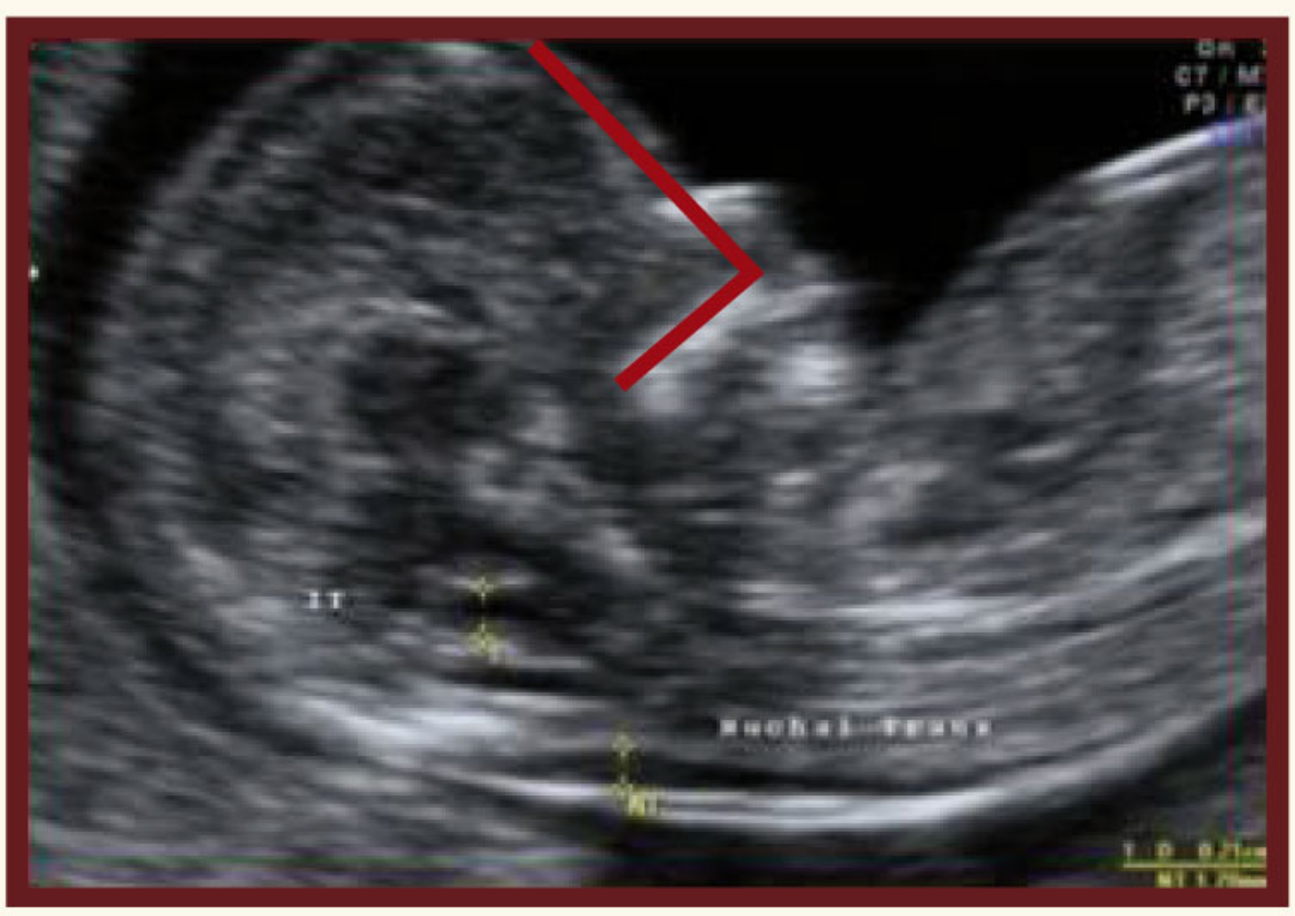
Results

A total of 361 patients were included in the analysis. Mean CRL was 72.48 mm. Mean FMFA was 77.29°. Regression analysis was employed to establish the relationship of FMFA to CRL and it revealed no significant decrease in the FMFA with advancing gestation (P=0.609) as has previously been described by Borenstein et al. Statistical analysis using ANOVA test of means comparing the mean FMFA with CRL indicated that the mean FMFA is significantly unchanged as CRL increases or decreases. For a CRL of 50-59, 60-69, 70-79 and 80-89 mm, the mean FMFA was 79.3°, 77°, 77°, 78.1° and 77.3° respectively (p=0.421). The FMFA was > 85° in 7.8% of our patients.

Conclusion

Our study demonstrates that in an unselected low risk Lebanese population, there is no statistically significant decrease in the FMFA with advancing gestation as has been previously reported by Borenstein et al. In 7.8% of our population, the FMFA is > 85°. This ethnic variation calls for employing caution when using the FMFA in our FT screening for trisomy and when screening fetuses who may be at risk for SB.





CRL mm	Total Cases	FMF			Patients (%) With FMFA >85
		Mean±SD	Min	Max	
[50-59]	20	79.3±1.1427	68.00	89.00	1 (5.0%)
[60-69]	93	77.0±.6989	57.00	94.00	5 (5.4%)
[70-79]	203	77.0±.4946	54.00	97.00	16 (7.9%)
[80-89]	45	78.1±1.0247	64.00	89.00	6 (13.3%)
Total	361	77.3±.3608	54.00	97.00	28 (7.8%)

Can the fetal NT help predict the evolution of hypoplastic left heart syndrome suspected at 11-14 weeks?

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Objective

To assess the evolution of hypoplastic left heart syndrome (HLHS) suspected at 11-14 weeks, and to evaluate the impact of the NT on predicting outcome.

Methods

Retrospective study comparing the findings and natural progression of 5 cases of HLHS suspected at 11-14 weeks. All scans were performed by a single sonologist certified by the Fetal Medicine Foundation. Fetuses suspected of having HLHS were referred to pediatric cardiology. The 5 cases were compared with respect to NT, presence of other structural/cardiac findings, karyotype (when available), final diagnosis and outcome. Chi square test was used in the analysis. $P < 0.05$ was considered statistically significant.

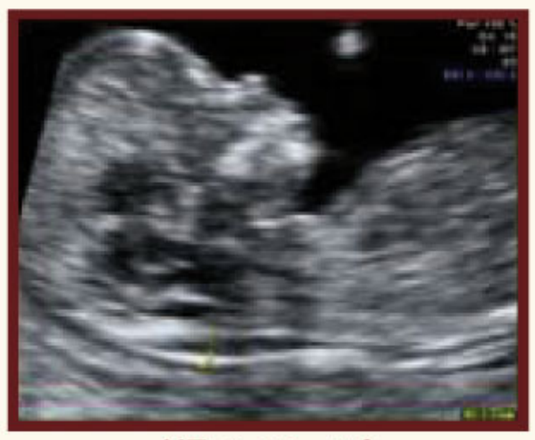
Results

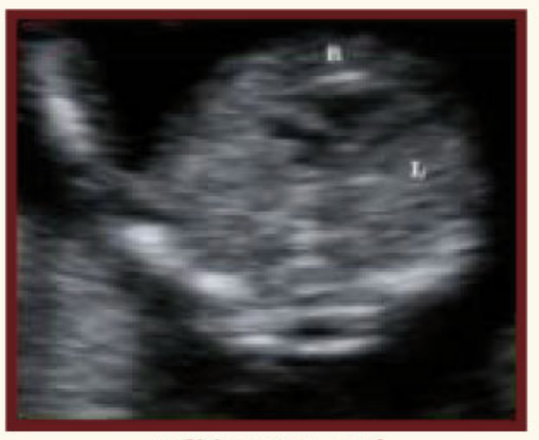
There were 5 fetuses confirmed of having HLHS. Of those 2 (40%) elected termination at 15w0d and 21w6d, and 2 (40%) had spontaneous in utero demise at 14w2d and 18w0d. All 4 had an NT > 3 mm. The 5th case had a normal NT of 2.2 mm and evaluation at 2 week intervals demonstrated a decrease in the atrio-ventricular disproportion (AVD), a persistent left superior vena cava (LSVC) and a suspected dilated coronary sinus versus an atrioventricular (AV) canal. The fetus was delivered at term and the final diagnosis was an AV canal, persisting LSVC and a dysplastic mitral valve. The fetus is alive and well at 18 months. The NT was highly predictive of the outcome in the 5 cases: the higher the NT the higher the chance for in utero demise. In the one case with a normal NT (20%), there was normalization of the AVD and a favorable neonatal outcome. Even though our sample size was very small, having an NT < 3 mm was associated with a favorable outcome (P=0.025).

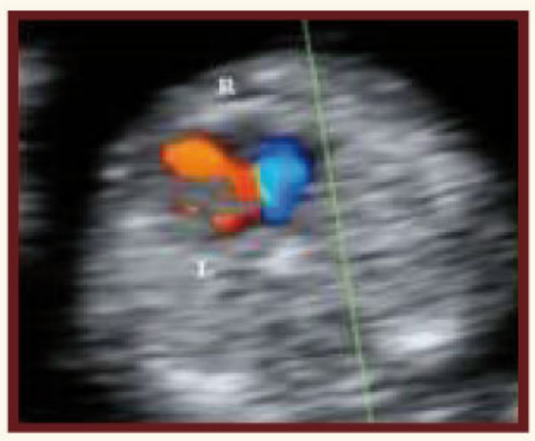
Conclusion

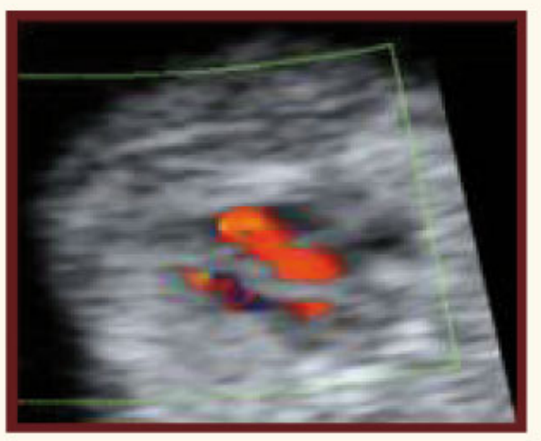
In this small cohort of patients, our study emphasizes the varied outcome of HLHS suspected at 11-14 weeks with 40% ending with spontaneous in utero demise and 20% having a favorable outcome. As has been previously shown, the larger the NT, the worse the fetal prognosis and the higher the chances of spontaneous demise. This may lessen the burden on those families electing to terminate. Whenever HLHS is encountered with a normal NT, caution must be exercised without haste in offering termination.

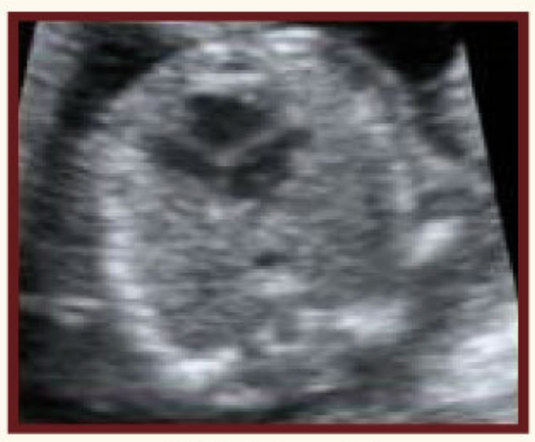
Images of Case 5

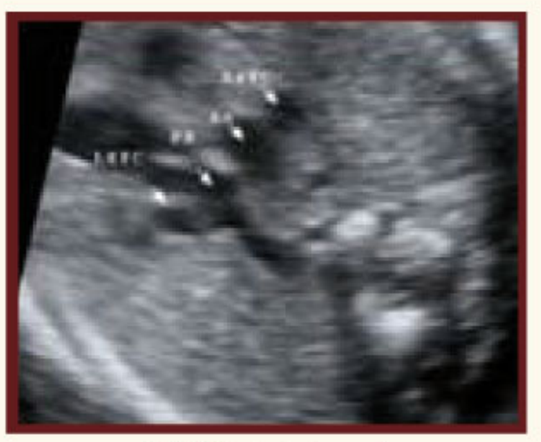

NT at 13w0d

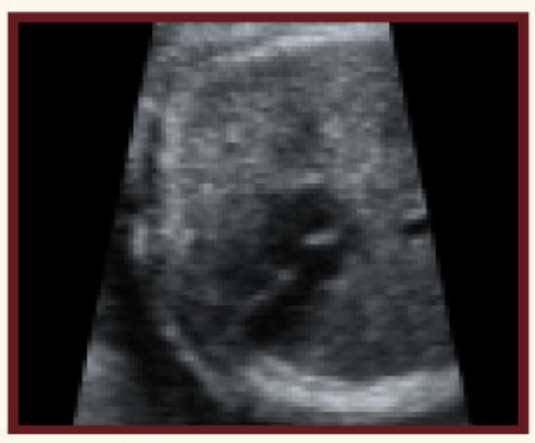

4CV at 13w0d

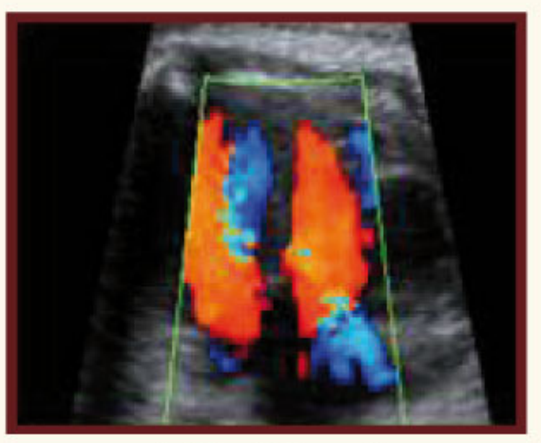

4CV at 13w0d


4CV at 15w0d


4CV at 17w0d


LSVC at 21w3d


4CV at 21w3d


4CV at 32w3d

	Age	G	P	GA	NT	NB	4CV	TR	Karyotype	Other Findings	Final Diagnosis	Outcome
1	19	4	1021	14w2d	3.1	+	HLH	Abn	N/A	Megacystis, Limb Amputation	Multiple Anomalies with HLHS	TOP at 15w0d
2	34	5	3103	13w1d	4.2	+	HLH	Nl	N/A	-	HLHS	TOP at 21w6d
3	37	4	3003	12w6d	7.9	+	HLH	Abn	N/A	-	HLHS	FDIU at 14w2d
4	22	2	1001	13w3d	8	+	HLH	Nl	45XO	Cystic Hygroma	Turner Syndrome with HLHS	FDIU at 18w0d
5	18	1	0	13w0d	2.2	+	HLH	Nl	N/A	Nl at 21w3d and 24 LSVC	AV Canal, Dysplastic MV, LSVC	Alive at 18 months

Is the size of the fetal renal pelvis gender-dependent at 20-24 weeks?

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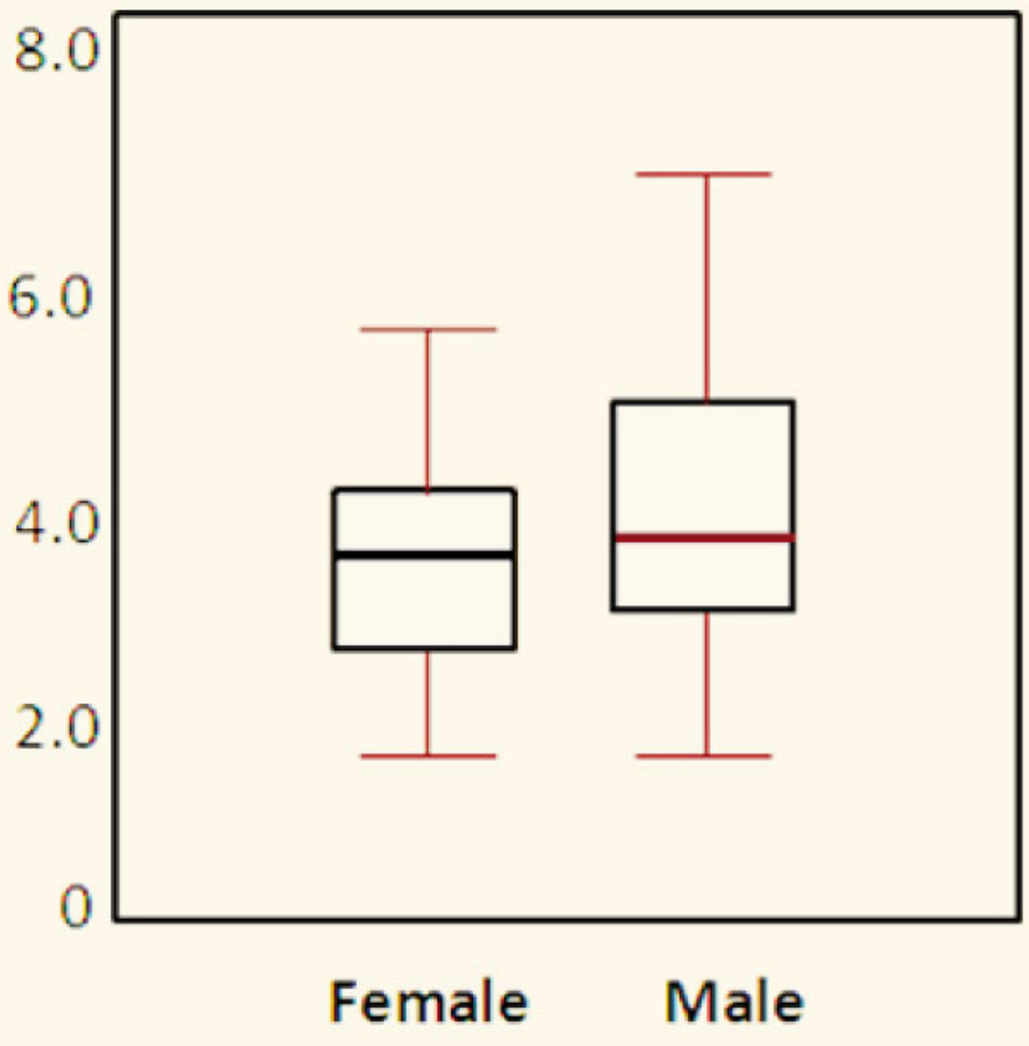
Objective

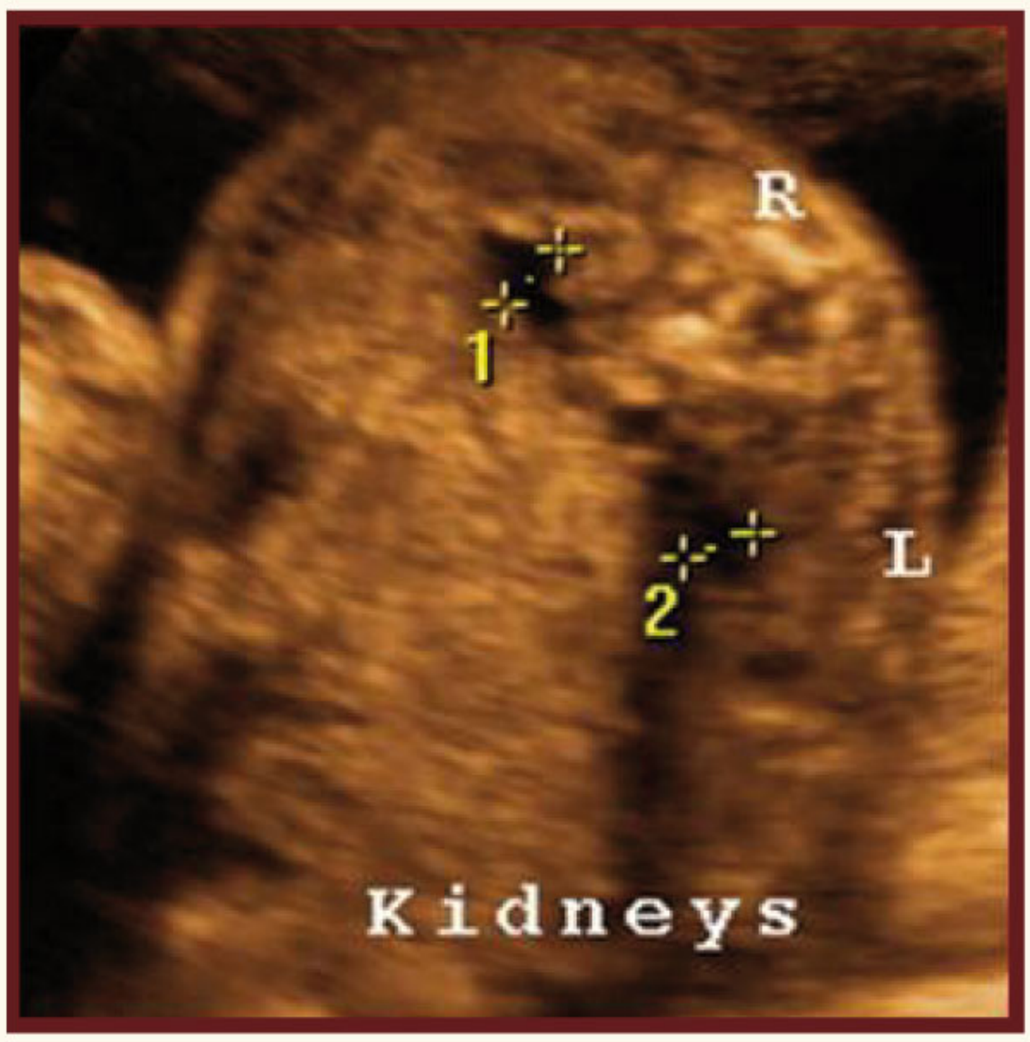
Clinically we have noted that male fetuses tend to have a more prominent renal pelvis than female fetuses at 20-24 weeks. For this reason, this study was conducted with the aim of comparing the antero-posterior diameter of the renal pelvis in male fetuses versus female fetuses at 20-24 weeks of gestation given the role of pyelectasis as a second trimester marker for trisomy 21.

Methods

Prospective study on 203 euploid fetuses who had confirmed dating and who underwent first trimester scanning between 11 and 14 weeks. A second trimester scan was done at 20-24 weeks. When prominent, the antero-posterior diameter of both renal pelvises was measured in all fetuses in an axial plane. All scans were performed by a single sonologist certified by the Fetal Medicine Foundation. All fetuses had a known outcome and were healthy term live births. We excluded twin gestations, anomalous fetuses, fetuses born at less than 37 weeks, and those who were lost to follow up beyond the first trimester scan. T-test and chi square were used for the statistical analysis. $P < 0.05$ was considered statistically significant.



Renal Pelvis (mm)



Male Pelvis

Results

Using the paired test in comparing the right to left pelvises in all fetuses, no statistical difference was found. As a result, the average of each fetus' renal pelvises was used in the analysis. There was a statistically significant difference between the mean female pelvis of 3.41 mm and the mean male pelvis of 3.84 mm ($p=0.007$). Looking at fetuses with an average renal pelvis of ≥ 6 mm, there was a statistically significant difference between the males and females. In 8% of males and 1.3% of females, the renal pelvis measured ≥ 6 mm ($p=0.04$).

Conclusion

In a representative sample of our population under study, the renal pelvis in the euploid male fetus is larger than that in the euploid female fetus. As a result, it may be worthwhile to establish gender specific normograms and gender specific cutoffs for pyelectasis when incorporating it into the second trimester risk assessment of trisomy 21.