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ORIGINAL ARTICLE

Accuracy of Ultrasound for Determination of Fetal Gender

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ABSTRACT

Aim: To evaluate the accuracy of ultrasound in determining the phenotypic foetal gender in all three trimesters.
Study design: Cross sectional study.
Place and duration of study: Department of Diagnostic Radiology Combined Military Hospital Lahore from 1st January 2020 to 30th April 2020.
Methodology: Three hundred and seventy two patients in the inclusion criteria were selected. Ages of patients, gestational ages of foetuses and their genders were determined according to the ultrasonographic signs using ultrasound examination. Patients were contacted 3 weeks after the estimated date of delivery and phenotypic sex recorded.
Results: Mean age was 34 years. Median gestational age was 21 weeks 3 days. Accuracy of gender determination by ultrasound in 1st, 2nd and 3rd trimesters was 62%, 97% and 95% respectively. Sensitivity and specificity of ultrasound in 1st trimester for males are 66% and 72%; and for females are 72% and 66% respectively. Positive and negative predictive values for male are 69% and 71%; and for female are 71% and 69% respectively. Sensitivity and specificity of ultrasound in 2nd trimester for males are 95% and 100%; and for females are 100% and 95% respectively. Positive and negative predictive values for male are 100% and 94%; and for female are 94% and 100% respectively. Sensitivity and specificity of ultrasound in 3rd trimester for males are 94% and 96%; and for females are 96% and 94% respectively. Positive and negative predictive values for male are 97% and 93%; and for female are 93% and 97% respectively.
Conclusion: There is a high accuracy of ultrasound in determination of fetal gender in second and third trimesters.
Keywords: Ultrasound, Gender, Trimester, Sensitivity, Specificity, Predictive Value

INTRODUCTION

There is a high likelihood among pregnant women to seek out the gender of their foetus before it is born[1]. Different reasons include curiosity, to be able to buy clothes beforehand and preference for a specific gender[2]. There are medical reasons for sex determination which include investigating the risks of hermaphroditism, X-linked disorders, genital anomalies, and determination of zygosity in twin and multiple pregnancies[3].

There are many invasive and non-invasive methods to determine the gender of the foetus parentally. These include preconception sperm separation by flow cytometry, Barr bodies, chromosomal analysis, ultrasonography and genetic methods.[3] However, with advent of non-invasive imaging modalities like ultrasound, determination of foetal sex is possible much more easily and heavily relied on it, making the other methods obsolete. Ultrasound is cheaper and readily available in the clinical settings[4].

Discordance between the karyotypic and phenotypic foetal sex has been reported to be as high as 1/1500-2000 pregnancies, which is equal to the number of some common chromosomopathies.[5] A study showed similar percentages of foetal sex discordance; approximately 0.9%, via non-invasive prenatal testing (NIPT)[6].

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There is a high sensitivity of ultrasound for foetal sex determination. However, the sensitivity is reduced depending upon the gestational age at which the scan is performed, the lie and presentation of the fetus, parity (singleton or multiple), and genetic hermaphrodism[7].

The ultrasound scans are currently recommended twice during pregnancy. The first dating scan confirms the gestation and estimated date of delivery. The second anomaly scan at about eighteen to twenty-one weeks of gestation, is performed to look for any foetal anomalies. Further scans are warranted according to clients' complaints including reduced foetal movements and vaginal spotting. Other medical reasons include the need to check for the foetal lie and presentation, placental abnormalities, and growth of the fetus[8].

There are different signs that confirm the sex of the foetus according to the gestational age. During the first trimester, the genital tubercle is formed. The direction of its growth can designate gender; upwards or cephalic is male while downwards or caudal is female; with a cranial notch and caudal notch, respectively. This has been referred to as the sagittal sign. Ultrasound at second and third trimesters details the genital organ formation to specific gender. In males, penis, and scrotal sacs with or without testes are demonstrated. The female foetuses reveal the absence of male organs; with better and newer equipment also demonstrating vulva, clitoris, and labia[9].

Various studies[10,11] have been done in this regard but limited to only specific gestational ages and a single trimester. This study will help to evaluate the gender determination accuracy in all three trimesters.

MATERIALS AND METHODS

This prospective study was carried out in Diagnostic Radiology Department of CMH Lahore from 1st January 2020 to 30th April 2020. Permission was sought and granted from the ethical committee. Out of the patients reporting for routine obstetric ultrasound, 372 patients in the inclusion criteria were selected. Thepatients with single alive healthy foetuses between 10 weeks and 36 weeks of gestation were included in the study. Those patients with twin or multiple pregnancies, single pregnancies having foetal anomalies; and foetuses of gestational ages less than 10 weeks and more than 36 weeks were excluded. The age of the patients and gestational ages of the foetuses according to LMP were recorded. The estimated due date of delivery of the baby was also documented. Patients were followed-up and contacted three weeks after the estimated date of delivery and the phenotypic gender of the newborn was asked and correlated.

All the patients underwent Ultrasound analysis on commercially available high resolution Ultrasound equipment (Xario-100, Japan) having 3.5 MHz curved linear array transducers. Verbal consent was obtained from all patients. Prints of the study were captured on Video graphic Printer MP-895 MD (Sony, Japan). The examination was performed by a senior consultant radiologist. Patients were examined while relaxed and supine. The end of the probe was covered with Aqua sonic Ultrasound Gel. The skin was smeared with gel and the probe placed on the skin. The average scanning time was 15 minutes for complete assessment of foetal wellbeing and measuring other gestational parameters like, amniotic fluid index, placental location and grading. The gender of the foetus was determined according to the ultrasonographic signs as defined by previous studies and related texts. In first trimester (ten to twelve weeks), the genital tubercle was identified and a higher genital angle[6] and a longer anogenital distance[7] corresponding to the male phenotype was recorded. In second trimester (thirteen to twenty-four weeks) and third trimester (twenty-five to thirty-six weeks), the genitalia had developed enough to be visualized distinctively. This has sometimes been linked to the turtle sign for male foetuses and hamburger sign for female foetuses (Fig. 1). The data was entered and analyzed through SPSS-20

Fig. 1: Male genitalia in a 18 weeks old fetus

RESULTS

The mean age was 34 years. Lowest and highest gestational ages were 10 weeks 6 days and 35 weeks 5 days. There 63 were in first trimester, 187 in second trimester and 122 in third trimester. Accuracy of gender determination by ultrasound in 1st, 2nd and 3rdtrimesters was 62%, 97% and 95%respectively. Sensitivity and specificity of ultrasound in 1st trimester for males are 66% and 72%; and for females are 72% and 66% respectively. Positive and negative predictive values for male are 69% and 71%; and for female are 71% and 69% respectively. Sensitivity and specificity of ultrasound in 2nd trimester for males are 95% and 100%; and for females are 100% and 95% respectively. Positive and negative predictive values for male are 100% and 94%; and for female are 94% and 100% respectively. Sensitivity and specificity of ultrasound in 3rd trimester for males are 94% and 96%; and for females are 96% and 94% respectively. Positive and negative predictive values for male are 97% and 93%; and for female are 93% and 97% respectively (Tables 1-6).

Table 1: Comparison of 1st trimester in males

USG	Phenotypic		Total
	Positive	Negative	
Positive	20	9	29
Negative	10	24	34
Total	30	33	63

Sensitivity: 20/30x100 = 66% Specificity: 24/33x100 = 72%
PPV: 20/29x100 = 69% NPV: 24/34x100 = 71%

Table 2: Comparison of 1st trimester in females

USG	Phenotypic		Total
	Positive	Negative	
Positive	24	10	34
Negative	9	20	29
Total	33	30	63

Sensitivity: 24/33x100 = 72% Specificity: 20/30x100 = 66%
PPV: 24/34x100 = 71% NPV: 20/29x100 = 69%

Table 3: Comparison of 2ndtrimester in males

USG	Phenotypic		Total
	Positive	Negative	
Positive	104	-	104
Negative	5	78	83
Total	109	78	187

Sensitivity: 104/109x100 = 95% Specificity: 78/78x100 = 100%
PPV: 104/104x100 = 100% NPV: 78/83x100 = 94%

Table 4: Comparison of 2ndtrimester in females

USG	Phenotypic		Total
	Positive	Negative	
Positive	78	5	83
Negative	0	104	104
Total	78	109	187

Sensitivity: 78/78x100 = 100% Specificity: 104/109x100=95%
PPV: 78/83x100 = 94% NPV: 104/104x100 = 100%

Table 5: Comparison of 3rdtrimester in males

USG	Phenotypic		Total
	Positive	Negative	
Positive	66	2	68
Negative	4	50	54
Total	70	52	122

Sensitivity: 66/70x100 = 96% Specificity: 50/54x100 = 96%
PPV: 66/62x100 = 97% NPV: 50/54x100 = 93%

Table 6: Comparison of 3rd trimester in females

USG	Phenotypic		Total
	Positive	Negative	
Positive	50	4	54
Negative	2	66	68
Total	52	70	122

Sensitivity: 50/54x100 = 96% Specificity: 66/70x100 = 94%
PPV: 50/54x100 = 93% NPV: 66/68x100 = 97%

DISCUSSION

Michailidis et al[14] reported that there is no effect of gestational age on fetal gender determination when 3D ultrasound is used. Our setup did not have 3D ultrasound available for its evaluation.

Many studies have been done in the past around the world related to fetal gender determination. Most of these studies have been done in early pregnancy using gestational ages between 11 and 14 weeks. These ages correspond to only 1 week of first trimester and following up to 3 weeks of second trimester. To our knowledge, only one study has been done in Nigeria by Eze et al[1] that shows evaluation of ultrasound in second and third trimesters. We have thus done this study to see the differences of gender determination by ultrasound in all three trimesters.

According to our study, there are high positive and negative predictive values for determination of fetal gender using ultrasound. Significantly higher numbers are seen in second and third trimesters as compared to first. The overall sensitivity of correctly identifying the fetal gender was 90.1% by Gonzalez-Ballano et al[15] 91% sensitivity was reported by Gharekhanloo[9], Meagher[16] reported as high as 99.3%, and while Igbinedion and Akhibge[17] reported 98.2%.

According to Kearin et al[10], Hsiao et al[18] and Efrat[11]; gender determination was less accurate in fetuses of less than 12 weeks gestation. We have also seen similar results with lower sensitivity, specificity, and predictive values in the first trimester with fetuses of gestational ages between 10 weeks 5 days to 11 weeks 6 days. Whitlow et al[19] showed a less accurate gender determination of fetuses less than 14 weeks. We had 20 patients with gestational ages of less than 14 weeks. Out of those, only one fetus was incorrectly identified as female when later phenotypically it came out to be a male child. There is a lower percentage of correct gender determination in first trimester in the conducted research which correlates well with the already published studies.

Our study shows higher sensitivity, specificity and predictive values of gender determination in second and third trimesters which correlates well with what Eze et al[1] have published.

There is higher sensitivity of male gender determination in the first trimester while a higher specificity in second and third trimesters, reaching up to 100%. Hsiao et al[18] also show higher sensitivity of detecting the male gender. Similar results have been reported by Perri et al.[20] Gharekhanloo et al[9] and Efrat et al[11] also showed a higher sensitivity of detecting the female gender in their studies. Our study also shows a higher sensitivity of detecting female gender as gestational age advances.

CONCLUSION

There is a high accuracy of ultrasound for determination of foetal gender in second and third trimesters. As routine anomaly scan is routinely performed at 18 to 21 weeks gestation, it suffices to look for foetal external genitalia. Sex determination can be conducted in first trimester if there is suspicion of chromosomal disorders.

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