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ARTICLE *in* RADIOGRAPHY · NOVEMBER 2010

DOI: 10.1016/j.radi.2010.02.009

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Sonographic determination of fetal gender in the second and third trimesters in a private hospital in Enugu, southeast Nigeria

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Received 30 April 2008; revised 23 December 2009; accepted 28 February 2010
Available online 26 March 2010

KEYWORDS
2D ultrasound;
Efficacy;
Fetal gender;
Gestational age

Abstract *Background:* Pregnant Nigeria women are usually anxious about the gender of their fetuses for social reasons.
Objective: The purpose of this study was to determine the accuracy of ultrasound in the determination of fetal gender in women who wished to know the gender of their fetuses and in those whom the gender of their fetuses were requested for on clinical grounds in the second and third trimesters.
Methods: A prospective longitudinal study was performed on 1480 singleton pregnancies who met the inclusion criteria between February 2004 and January 2008. Ultrasound examination was performed on GE ALOKA 500 machine, transabdominally between 14 and 40 weeks gestational age (GA). Both transverse and mid-sagittal planes of a section of the fetal genital tubercle were performed to identify the gender. The subsequent gender at birth was obtained from the hospital birth records.
Results: During the study, 1211 (81.8%) women requested gender information while the gender information from 269 (18.2%) women was requested for on clinical grounds. The mean GA at which the fetuses were scanned was $29^{+2} \pm 3^{+6}$ weeks (range 14–40 weeks). Fetal gender assignment was possible in 1350 (91.2%) out of 1480 fetuses; 680 assigned male and 670 female. Of these, the fetal gender corroborated birth sex in 1325 (89.5%) and disagreed in 25 (1.7%) cases. The overall estimated sensitivity of the scan is 98.1%, while the estimated specificity for identification of the male sex (100%) was higher than the female (78.3%). Of the 130 cases where no identification of gender was possible, 50 were in the second trimester and 80 were in the third trimester.

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doi:10.1016/j.radi.2010.02.009

Conclusion: This study demonstrated that the accuracy of fetal gender determination increased with gestational age, from 97.1% in the second trimester to 98.5% in the third trimester. The overall fetal gender accuracy rate for male fetus was better than female and was statistically significant ($P < 0.05$).

Introduction

Ultrasound scanning is firmly embedded in antenatal care around the world and there is a clear difference between selective and routine use of ultrasound. The value of the selective use of ultrasound screening for specific indications such as possible fetal malformation, placental position and multiple pregnancies has been clearly shown.[1] However, the routine use of ultrasound for antenatal screening of normal pregnancy has not yet been firmly established.

Although fetal gender assignment is typically performed in response to parental wishes, the evaluation is medically indicated in cases with suspected ambiguous genitalia, in cases at risk for sex and X-linked disorders, in cases with potential maternal cell contamination during amniocentesis samples resulting in a mosaicism 46, xx/46, xy karyotype, in counseling for cases with mosaicism 45, x/46, xy, and in multifetal pregnancies with uncertain chorionicity.[2] Accurate fetal gender assignment by conventional sonographic evaluation of the external fetal genitalia is possible in most cases with modern sonographic equipment and trained personnel even towards the end of the first trimester.[3–5] The use of high resolution 3 dimensional multiplanar ultrasound for early fetal gender assignment is not readily available in Nigeria at present.

Pregnant Nigerian women are usually anxious about the gender of their fetuses for social reasons.[6] As an addition to other indications many of such women presenting for ultrasonography often demand gender determination.[7] However, not all women attending for ultrasound in Nigeria are offered the opportunity to find out the gender of their fetuses because this can impact profound psychological effect on the women especially when the gender is not the women's preference.[6] Identification of gender is not available to Nigerian women by amniocentesis, cordocentesis or karyotyping.[7] Ultrasound is the only method available for assessment of fetal gender for these women, therefore in Nigeria care should be taken when identifying the gender in the setting of identifiable chromosomal anomalies.

Patients and methods

This is a prospective longitudinal study done at St. Patrick's hospital and maternity, a busy private clinic in Enugu, southeast Nigeria. The following patients were included in the study.

1. Pregnant women who had ultrasound examination either in the second or third trimesters. The GA varied from 14 to 40 weeks. Trimester 2 was defined as 14–26 weeks gestation, and trimester 3 was defined as 27–40 weeks gestation.[2]
2. Women who wished to know the gender of their fetuses gave their consent.
3. Women in whom the gender of their fetuses were requested for on clinical ground.

Women who were scanned but did not deliver their babies in the clinic were excluded from the study.

Ethical approval was obtained from the local hospital committee. Ultrasound examination of a total of 1480 fetuses by an experienced and certified sonographer using an Aloka 500 machine with a curvilinear probe was done from February 2004 to January 2008. The transabdominal route was used in all cases with the mother in the supine or oblique position as required to maximally demonstrate the fetal parts.[7]

Both transverse and mid-sagittal planes of a section of the fetal genital tubercle were performed to identify the gender.[8] The transverse plane shows the male fetus as a clone shaped genital swelling with cephalic directed phallus and females as two parallel lines representing the labia.[9]

At ultrasound an attempt was usually made to identify the fetal genitalia as part of the routine prenatal scan for fetal well being from the women who met the selection criteria. One sonographer performed the scan for all the patients to avoid inter-observer errors. Several scans were done by the sonographer for each patient to minimize intra-observer errors. The sonographically determined gender and GA of the fetuses were recorded in the scan report to help to follow up the delivery outcome for each patient. The actual gender at delivery from the hospital record for each baby was compared with the sonographic findings. The femur length (FL), abdominal circumference (AC) and the women's last menstrual period (LMP) were used in the estimation of the GA.

To determine the efficacy of ultrasound in the determination of fetal gender, the sensitivity and specificity of sex determination were calculated from the data obtained from the study. The sensitivity of sex determination by ultrasound is defined as the ability of the ultrasound to recognize gender,[7]

$$= \frac{\text{True positives(TP)}}{\text{TP} + \text{False negatives(FN)}} \times 100$$

The specificity of sex determination by ultrasound is the ability of the scan to differentiate male and female gender,[7]

$$= \frac{\text{True negatives(TN)}}{\text{TN} + \text{False positives(FP)}} \times 100$$

Z-test statistic was used to find out if there is any significant difference between the accuracy rate of male and female fetuses at 5% level of significance.

Results

A total of 1480 fetuses including 760 (51.4%) females and 720 (48.6%) males were scanned. During the study, 1211 (81.8%) women requested gender assignment while the genders of the remaining 269 (18.2%) fetuses were requested by the referring clinicians. In 130 cases, 40 (30.8%) males and 90 (69.2%) females, it was not possible to determine the fetal gender. For the cases that the sonographer could not determine the fetal gender, the reasons were:

1. Fetal position most frequently the thighs were close together or the fetus was in breech presentation (80 cases).
2. Umbilical cords between the legs (30 cases).
3. Unsatisfactory images of the fetal genitalia due to movement artifacts (20 cases).

Fetal gender identification was possible in 1350 (91.2%) cases. Of these, the fetal gender corroborated birth sex in 1325 (89.5%) and disagreed in 25 (1.7%) cases (Table 1).

The estimated sensitivity of the scan in fetal gender determination is 98.1%. Of the 1325 fetuses in whom the gender was correctly identified by ultrasound, 680 (51.3%) were males and 645 (58.7%) were females. The 25 fetuses that were incorrectly identified were all females. The estimated specificity for identification of the male sex (100%) was higher than the female sex (78.3%) and was statistically significant ($P < 0.05$).

Table 2 shows the accuracy of ultrasound in fetal gender determination in relation to GA. The mean GA at which the fetuses were scanned was $29^{+2} \pm 3^{+6}$ weeks with a range of 14—40 weeks. Three hundred and ninety (26.4%) and 1090 (73.6%) women were scanned in the second and third trimesters respectively. Ultrasound fetal gender identification (sensitivity) increased from 97.1% in trimester 2 to 98.5% in trimester 3 periods.

Fig. 1 shows sonogram of male genitalia at 26 weeks GA while Fig. 2 shows sonogram of female genitalia at 34 weeks GA.

Discussion

Accurate fetal gender assignment is important for satisfying parental curiosity.[6,10] It also can be of critical information in X-linked conditions, in autosomal conditions such as congenital adrenal hyperplasia where the phenotypic sex is important in the decision to discontinue maternal treatment with steroids, in chromosomal abnormalities such as 45, X/46, XY where the phenotypic sex is important in determining the prognosis, and in cases with ambiguous genitalia of unknown aetiology where the correlation between the chromosomal sex and phenotypic sex in future pregnancies is the only way to rule out a recurrence.[11,12]

Ultrasound is the only means available for Nigerian women to have gender determined, as other methods (karyotyping, amniocentesis and or cordocentesis) are not available.[7] It is, therefore, critical for the sonographer to assess the fetal gender accurately.

The medico-legal implications of determining the fetal gender by ultrasound in Nigeria are important. This is because Nigeria like many developed countries such as UK[13] and USA[14] faces a future culture of increasing litigation.[15] Errors in fetal gender determination will occur occasionally and there is need to take the necessary precautions to minimize the errors as much as possible and to also inform the patients of this possibility beforehand.

The GA of the fetus in this study was estimated using sonographic measurement parameters of FL and AC as well as the women's LMP. This helped to follow up the delivery outcome of each patient. The equipment used in this study cannot be considered current or state of the art. The fetal gender was correctly identified in 98.1% of those fetuses in whom the sonographer was able to visualize the fetal genitalia. This result is not surprising as previous reports have recorded accuracy ranging from 80% to 100%.[4—7] In the UK, accuracy of 95% is typically cited in information provided to patients for assessment of fetal gender between 16 and 20 weeks.[16] Notably, this 98.1% accuracy is higher than the 80%[6] and 86.5%[7] accuracies obtained in previous studies in a similar population with smaller sample sizes. These variations could be due to varying experiences and skills of the operator, resolution of machine used, probe dimension and or fetal lie. The scan in this study was done by a certified and an experienced sonographer and this may have increased the level of the accuracy obtained. A previous study has shown that experience has an influence on accuracy in obstetric scanning.[17]

In the present study, the overall fetal gender accuracy rate for male fetus was better than female and this was statistically significant ($P < 0.05$). This finding agrees with a previous report.[8] This is presumed to be due to the fact that it is easier to recognize the male genitalia than the female genitalia at sonography. The success rate for correctly identifying fetal gender (where identification was possible) increased with GA (Table 2). This result is in

Table 1 Sensitivity and specificity of fetal gender determination in the studied population.

Ultrasound parameters	Ultrasound fetal sex	Sex at birth	
		Male	Female
Not identified	130 (8.8%)	40/130 (30.8%)	90/130 (69.2%)
Correctly identified	1325 (89.5%)	680/1325 (51.3%)	645/1325 (48.7%)
Incorrectly identified	25 (1.7%)	0/25 (0%)	25/25 (100%)
Total	1480 (100%)	720/1480 (48.6%)	760/1480 (51.4%)
Sensitivity	98.1%		
Specificity		100%	78.3%

Table 2 Relationship of fetal gender and ultrasound GA.

GA (weeks)	Ultrasound fetal sex			Total	Sensitivity
	Not identified	Correctly identified	Incorrectly identified		
Second trimester (14—26 weeks)	50 (12.8%)	330 (84.6)	10 (2.6%)	390 (100%)	97.1%
Third trimester (27—40 weeks)	80 (7.3%)	995(91.3%)	15 (1.4%)	1090 (100%)	98.5%
Total	130	1325	25	1480	98.1%

agreement with previous reports.[7,8,18] However, the fact that only 390 (26.4%) women scanned were in the second trimester as against 1090 (73.6%) scanned in the third trimester may have biased this result positively. Further study should use similar sample sizes in both trimesters.

It is not unusual for fetal sex to be indeterminate during a routine scan as values of 10—13% have been previously documented[7,18] which are in agreement with our finding of 8.8%. Failure to demonstrate the fetal gender may be due to a number of reasons. These include unfavourable fetal position, umbilical cord between the legs and unsatisfactory volumes due to movement artefacts.[19]

Absolute accuracy in gender prediction by sonography was achieved in a previous study at 69 days from fertilization corresponding to 11^{+6} weeks based on the LMP[4] due to use of high resolution 3D ultrasound and or harmonic imaging. In our environment opportunity for such early gender determination below 14 weeks GA is limited by scarcity of such sophisticated equipment in our clinics.

Present study reveals that 81.8% ($n = 1211$) of the women were anxious to know the gender of their fetuses. Sonographers usually tell the mother the gender of her fetus in Nigeria from 14 weeks onwards using 2D ultrasound if the mother wants to know.[7] However, not all women attending for ultrasound in Nigeria are offered the opportunity to find out the gender of their fetuses just for social reasons. This is because of the anticipated psychological effects especially if the gender does not correspond to the woman's preference. Therefore, pregnant women seeking for sonographic gender determination should be adequately counseled because of the medico-legal aspect of this examination. A written consent from the patient may be obtained prior to the investigation to avoid litigation.

Although consent was obtained before the onset of the exam by the sonographer, this resulted in a non consecutive enrollment of our patients. This bias may have pre-selected an ''optimal'' scanning population which may have resulted in a positive bias in the results. Further study using consecutive enrollment of patients will need to be performed to determine the generalizability of the results.

The implications from our study for the Nigerian ultrasound community are obvious. Firstly, it is critical for sonographers to assess the fetal gender accurately as sonography appears to be the only means available to most Nigerian women for the assessment of chromosome related anomalies. Secondly, accurate early gender determination in the first trimester by ultrasound in Nigeria is limited because the use of sophisticated 3D ultrasound equipment and harmonic imaging are not readily available at present. Thirdly, sonographers who need to determine the fetal gender should obtain a written consent from the patient and be very meticulous in their technique to improve on their accuracy as Nigeria like many developed countries faces a future culture of increasing litigation.

Our results could be extrapolated to the wider international community, where in developed countries, results would possibly be better when more up to date equipment was used; also relevance to other countries would also depend on when women were offered a scan.

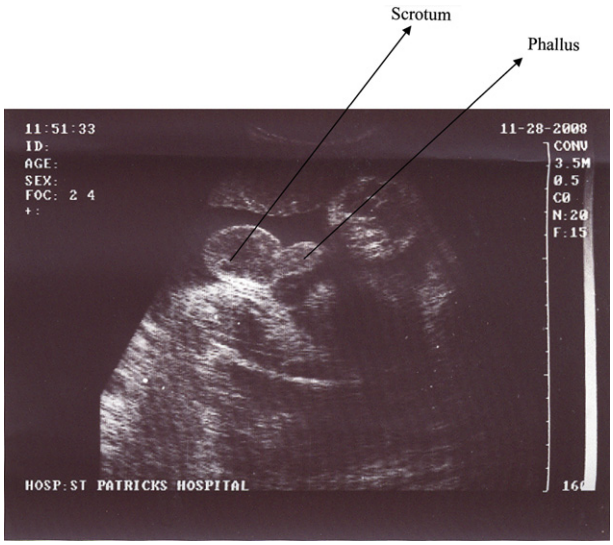

Figure 1 Male genitalia at 26 weeks GA showing the cylindrical echopenic phallus in front of the oval shaped echogenic scrotal sac.

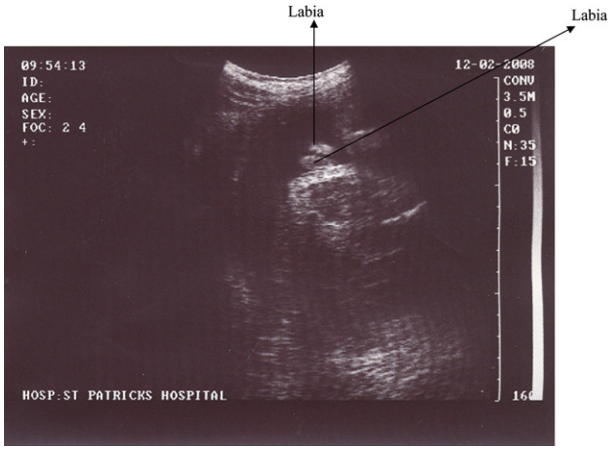

Figure 2 Female genitalia at 34 weeks GA showing the two labia as oblong echogenic structures separated by an echo free space.

Recommendations

1. A written consent should be obtained from the patient prior to sonographic gender determination in Nigeria.
2. The errors and failure rates of sonographic gender determination should be made known to mothers who are willing to know the gender of their fetuses.
3. Modern sophisticated ultrasound equipment should be readily available in our hospitals and clinics by government and private agencies.
4. Amniocentesis, cordocentesis and karyotyping facilities should be readily available in our hospitals and clinics.

Conclusion

This study demonstrated that using 2D ultrasound, the GA at the time of scan appears to be one of the predictors of the accuracy of fetal gender identification. The overall fetal gender accuracy rate for male fetus was better than female ($P < 0.05$).

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