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# The Association between Placental Location in the First Trimester and Fetal Sex

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***Authors' contributions***

*This work was carried out in collaboration among all authors. Author FM designed the study and wrote the protocol. Author MM performed the statistical analysis. Author EKL wrote the protocol, wrote the first draft of the manuscript and managed the analyses of the study. Author SFDH managed the literature searches and wrote the manuscript. All authors read and approved the final manuscript.*

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## ABSTRACT

**Background:** Because advance knowledge of fetal sex can satisfy parental curiosity and allay anxiety, attempts at its determination prior to birth have a long history. There may also be reason to determine fetal sex when sex-specific genetic disorders are suspected. The aim of this study was to investigate the association between gestational sac (GS) location and fetal sex.

**Materials and Methods:** This cross-sectional study was conducted on 751 pregnant women. Transvaginal ultrasound was performed during 7-8 weeks of gestation for prenatal care and assessment of pregnancy sac and GS location. Age, parity, gravidity and GS location were recorded. Abdominal ultrasound was performed at 16-20 weeks of gestation to determine fetal health and sex and finally data was analyzed and compared to sex of the fetus after birth using SPSS software version 21.

**Results:** There was a significant relationship between GS location and fetal sex ($P<0.0001$).

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However, pregnancy outcomes (male or female) and GS location (anterior or posterior) were not significant correlated (P= 0.290). There was, on the other hand, a significant relationship between outcomes and GS location (right or left) (P<0.0001).

**Conclusion:** Maybe GS location could be considered as a helpful method for earlier fetal sex determination.

*Keywords: Sex; gestational sac location; placental location; ultrasound; fetus.*

## 1. INTRODUCTION

The determination of fetal sex is carried out for a variety of reasons, including medical reasons (diagnosis of diseases), convenience reasons (knowing what clothes and colours to purchas in advance) [1,2]. Furthermore, early detection of fetal sex is important for researchers and parents. Some fetal diseases are sex dependent and if one of the parents or both had specific diseases, early detection can help families receive on time genetic consultations. They can consequently decide on whether or not to continue the pregnancy [3]. Fetal sex determination can also be requested by parents for unethical reasons e.g. to determine whether fetuses, if they are female, are worth keeping. This unlawful practice is carried out in many regions of the world, fetal sex can be determined by different methods, including Chorionic villus sampling (at 10-11 weeks of gestation) and amniocentesis (at 15-16 weeks of gestation). These methods are invasive and sometimes fail [4-6]. Commonly, clinicians determine fetal sex by ultrasound, which is a noninvasive and cost effective method compared to other methods [4,7]. Ultrasound has been the key technology for assessing fetal disease during the late 3 decades [8,9]. Recently, clinicians use ultrasound as an alternative screening method to determine fetal abnormalities, fetal growth disorders, GS location and gestational age; it is widely applied during pregnancy [10-12].

Fetal sex determination can reveal important information regarding fetal health. It can be helpful for deciding on the necessity for invasive methods in patients with family history of sex dependent abnormalities, including hemophilia and Duchenne's muscular dystrophy. Ultrasound can facilitate the diagnosis of fetal anomalies, including posterior urethral valve in male fetuses and Turner syndrome in female fetuses, dichorionic twin pregnancies and hermaphroditism [12].

Furthermore, it has been reported that fetal sex determination could help identify the high risk pregnancies as preeclampsia occurs at higher rates in male fetus pregnancies [13,14]. Fetal sex determination can also help reduce the risk of female masculinization in 21 hydroxylase deficient fetuses by early sex detection and prompt corticosteroid therapy [6].

Previous investigations assessed the effect of placental location on fetal sex and reported inconsistent results. Ismail et al. reported a significant relationship between placental location and fetal sex. They mentioned that male fetuses had right chorionic villi/placenta location [15], However, The et al. observed a weak relationship between placental location and fetal sex [16] and Erdolu et al. [11] noted only a probable effect of fetal sex on placental location.

Fetal sex can be determined with ultrasonography at eleven or twelve weeks of gestation. Otherwise, sex detection is not reliable by ultrasound in earlier gestational ages. Though fetal sex determination is made possible before 14 weeks gestation by 3D ultrasound, the use of three or four-dimensional ultrasounds costs more and may be associated with complications [3,17]. Therefore, there is a need for a low cost and non-invasive diagnostic tool for the determination of embryonic sex in early gestational weeks. It is hypothesized that GS location can help as a predictor of fetal sex by the sixth week of pregnancy. However, this is not actual used in clinically and just we suggest it. As there is no consensus on the effect of GS location on fetal sex and due to the importance of early fetal sex determination in some cases, we aimed to assess the association between GS location (gestational sac) and fetal sex in pregnant women.

## 2. METHODS

### 2.1 Study Population

This analytic cross-sectional study was conducted on pregnant women, who referred to Al-Zahra hospital and Private offices in Rasht, Iran. Sample size was calculated based on the findings of a study by Erdolu et al. [11] using the following equation. The calculated sample size was 800 women.

$$\frac{(z_{1-\alpha/2}+z_{1-\beta})^2[P_1(1-P_1)+P_2(1-P_2)]}{(P_1-P_2)^2}$$

$Z_1\text{-}{}^{\alpha}/_{2} = 1.96$
$z_{1-\beta}=Z_{80}= 0.84$
$P_1= 0.62$
$P_2=0.481$

## 2.2 Inclusion and Exclusion Criteria

The inclusion criteria were age between 20 and 31 years old, no previous history of diseases including chronic hypertension, diabetes mellitus, chronic renal disease, cigarette smoking or alcohol consumption, as well as no history of diseases known to affect fetal growth, including early miscarriage and assisted conception, and determined normal uterus. Exclusion criteria were twin pregnancy, ectopic pregnancy, fetal death, abortion, polyhydramnios or oligohydramnios, as well as existence of congenital anomalies.

## 2.3 Data Collection

Pregnant women at their $8^{th}$ week of gestation underwent transvaginal ultrasound by a single radiologist in a single radiology center. Transvaginal ultrasound was performed as a component of prenatal care with the aim of observing the location of the gestational sac and the placental location (anterior- posterior, right-left).

Data (age graviity, parity) were gathered through interviews At 16-20 weeks of gestation, routine transabdominal ultrasound was performed to assess fetal health and sex determination. After birth, the investigators confirmed the neonatal sex through phone call and matched the actual sex with the transabdominal ultrasound result. A single radiologist performed the ultrasound - coronal and sagittal planes. (Medison V 20 and 3- 7 MHz).

## 2.4 Statistical Analysis

Data were collected and analyzed by SPSS v.21. The chi square test was used to assess the relationship between the frequency distribution of sex and placental location. The relation between sex and placental location based on age, gravidity and parity were assessed by logistic regression. P<0.05 was considered as statistical significance and 95% confidence interval was used.

# 3. RESULTS

A total of 800 pregnant women enrolled in this study. Forty-nine women were excluded (8 twin pregnancy, 26 abortion, 5 fetal death and 10 unwilling to participate) resulting in the final 751 pregnant women. The mean age of pregnant women was 28.56±5.51 years. The mean gravidity and parity were 1.6±0.79 and 0.56±0.42 respectively. The pregnancies resulted in 380 boys (50.6%) and 371 girls (49.4%).

Assessing the pregnancy outcomes regarding placental location revealed a significant difference between sexes (p = 0.0001). However, no significant difference was noted between pregnancy outcomes regarding anterior or posterior placental location (p = 0.290) (Table 1).

There was a significantly relationship between maternal age groups (26-35 years old) and placental location (p<0.05) (Table 2). The relationship between frequency distribution of pregnancy outcomes in primigravida mothers and gravida are shown in Table 3. Relation between frequency distribution of pregnancy outcomes and right and left placental location in nuliparus and primiparus mothers are shown in Table 4.

Multivariate analysis assessed the relation between placental location and the probability of male and female birth using backward conditional regression logistic (LR). After controlling for maternal age, parity and gravidity, no significant difference was observed between left anterior and left posterior (reference group) placental location and fetal sex (P=0.291). After controlling for maternal age, parity and gravidity, it was found that the chance of female birth was significantly related to left posterior placental location (p<0.0001) and the prevalence of left anterior placenta (p=0.002) were significantly higher than right anterior placenta (reference group).

Whereas, the chance of female birth in left posterior placenta was 2.4 fold higher than right anterior placenta. (OR = 2.42, 95% CI: 1.54-3.79). Furthermore, the chance of female birth in left posterior placenta was 1.88 fold higher than right posterior (reference group) placenta (OR = 1.88, 95% CI: 1.23-2.87). There was no significant difference between right posterior and right anterior (reference group) placental location regarding the chance of female birth (P=0.205).

## 4. DISCUSSION

The results of this study showed that the most frequent pregnancy outcomes in right anterior placenta were male and in left posterior placenta were female. There was no significant difference between sexes regarding anterior and posterior placental location as well as right and left placental position, whereas most of the fetuses in right and left placental location were male and female respectively.

To the best of our knowledge, the relationship between fetal sex and anterior-posterior, right left placental location has not been assessed before.

A study on 5376 pregnant women revealed that location of placenta in the first trimester of pregnancy could predict of 97.97% of female cases and 97.92% of male cases. They concluded that there is a more tendency toward right placement of placenta in male pregnancies while the tendency is toward left placement in female pregnancies [18]. In the current study, in most female cases, the placenta was located anteriorly, the placental position was located posteriorly in male pregnancies.

Erdolu et al. [11] found that 62% of female fetuses had an anterior placenta and 51.9% of male fetuses had posterior placenta which was similar to the results of our study. Similarly, the results of  a study by Jafari et al. [19] were also in line with the findings of our study.

Hwida et al. reported opposite results compared to the findings of our study. They found that most placental positions among female and male fetuses were anterior and posterior respectively [20] But, in this study, results demonstrated no significant difference between anterior- posterior placenta between fetal sexes. This difference between study findings might be due to heterogeneous samples and the effect of demographic factors.

Assessing the relation between right- left position of placenta and fetal sexes:

Ismail et al. noted that the placental position was on the right side among most male fetuses [15], which was similar to the findings of our study. The et al., however, assessed 227 pregnant women and reported that 51% of male fetuses had a right placenta while 57% of female fetuses had a left placenta which was not significantly different. They indicated that genital tubercle ultrasound was a more effective tool for fetal sex prediction [16]. The difference between the findings of our study and The et al. might be due to our sample size beingtoo small.

It seems that the association between fetal sex and placental location could result from different blood supplies in different sections of the uterus, which depends on the distance between each section and uterine artery. Increased distance might decrease the blood supply, therefore; blood supply in the central section of uterine might be more appropriate than peripheral section. It has been estimated that the lateral placental location in fetuses with intrauterine growth retardation were four fold higher than anterior or posterior locations [21].

In addition, Kavraiskaya et al. noted that blood supply to the right side of uterus was higher than left side [22]. It seems that the difference in blood supply might affect sex determination and each sex might prefer different type of blood supply. A previous study showed that endometrial movement and electrical activity could affect sperm transfer. The polarity of uterine wall and sperm could be indicated as probable causes for different implantation by different sexes [21].

Although, no definite hypothesis for this occurrence has yet been established, it is thought that implantation in the right upper part of uterine commonly occurs 4 days before implantation in left upper quadrant, which could be due to hormonal and temperature differences. The imbalance in sexual hormones has been confirmed previously, excessive estrogen may affect male fetuses and can affect sexual chromosomes. On the other hand, excessive androgen can affect female fetuses. It can be hypothesized that the right side of uterine may allow male hormones to transfer more than the left side. The right side may have a positive polarity in comparison with the negative left uterine side [15].

In this study, variables including maternal age, gravidity and parity were assessed which were not previously evaluated. The results of this study showed that maternal age between 26 and 35 years old, first and second gravidity and first parity were associated with the placental location and fetal sexes. After adjustment for these factors, the only predictive factor was the placental location.

The limitations to this study include relatively a small sample size. It is recommended that future studies be performed on a larger population in a multicenter study. Furthermore, this study was the first study to assess three variables including maternal age, number of pregnancies (gravidity) and parity. It is recommended that future studies should be conducted to assess the role of each of these variables on fetal sex. This study did not investigate abnormalities of uterus. Considering the fact that different blood transfusion exists in different uterine parts, it is recommended that various hypotheses be assessed in future studies. Additional placental locations (lateral, fundal, etc.) could offer more explanations. Geneticists use the X, Y chromosome isolation technique for sex determination that are costly and invasive while past studies along with our study provide a low cost and non-invasive method to help determine the sex.

**Table 1. The frequency distribution of pregnancy outcomes regarding the placental location**

| | **Placental location** | **Boys N (%)** | **Girls N (%)** | **p-value** |
|---|---|---|---|---|
| Placental location | Right Anterior | 112(60.5) | 73(39.5) | 0.0001 |
| | Left anterior | 84(44.7) | 104(55.3) | |
| | Right posterior | 130(54.4) | 109(45.6) | |
| | Left posterior | 54(38.8) | 85(61.2) | |
| Placental location | Anterior | 197(52.5) | 178(47.5) | 0.290 |
| | Posterior | 183(48.7) | 193(51.3) | |
| Placental location | Right | 240(56.5) | 185(43.5) | 0.0001 |
| | Left | 140(42.9) | 186(57.1) | |

**Table 2. The frequency distribution of pregnancy outcomes regarding the placental location in maternal age groups**

| | **<20 years old ) (N=37)** | | **21-25 years old (n=189)** | | **26-35 years old (n=456)** | | **>36 years old (n=69)** | |
|---|---|---|---|---|---|---|---|---|
| | **Male N(%)** | **Female N(%)** | **Male N(%)** | **Female N(%)** | **Male N(%)** | **Female N(%)** | **Male N(%)** | **Female N(%)** |
| Right anterior | 4(21.1) | 3(16.7) | 26(26.5) | 22(24.2) | 75(32.6) | 40(17.7) | 7(21.2) | 8(22.2) |
| Left anterior | 3(15.8) | 8(44.4) | 25(25.5) | 23(25.3) | 48(20.9) | 60(26.5) | 8(24.2) | 13(36.1) |
| Right posterior | 7(36.8) | 4(22.2) | 31(31.6) | 25(27.5) | 80(34.8) | 71(31.4) | 12(36.4) | 9(25.0) |
| Left posterior | 5(26.3) | 3(16.7) | 16(16.3) | 21(23.1) | 27(11.7) | 55(24.3) | 6(18.2) | 6(16.7) |
| P -value | 0.295 | | 0.687 | | 0.0001 | | 0.669 | |
| Anterior | 7(36.8) | 11(61.1) | 51(52.0) | 45(49.5) | 124(53.9) | 101(44.7) | 15(45.5) | 21(58.3) |
| Posterior | 12(63.2) | 7(38.9) | 47(48.0) | 46(50.5) | 106(46.1) | 125(55.3) | 18(54.5) | 15(41.7) |
| P -value | 0.140 | | 0.722 | | 0.049 | | 0.285 | |
| Right | 11(57.9) | 7(38.9) | 57(58.2) | 48(52.7) | 153(66.5) | 113(50.0) | 19(57.6) | 17(47.2) |
| Left | 8(42.1) | 11(61.1) | 41(41.8) | 43(47.3) | 77(33.5) | 113(50.0) | 14(42.4) | 19(52.8) |
| P -value | 0.248 | | 0.454 | | 0.0001 | | 0.390 | |

**Table 3. The frequency distribution of pregnancy outcomes regarding the placental location and gravidity**

| | Primigravida (n=403) | | Gravida 2 (n-266) | | ≥3 gravida (n=82) | |
|---|---|---|---|---|---|---|
| | Male N (%) | Female N (%) | Male N (%) | Female N (%) | Male N (%) | Female N (%) |
| Right anterior | 60(29.9) | 35(17.3) | 40(30.3) | 32(23.9) | 12(25.5) | 6(17.1) |
| Left anterior | 45(22.4) | 59(29.2) | 30(22.7) | 34(25.4) | 9(19.1) | 11(31.4) |
| Right posterior | 65(32.3) | 62(30.7) | 48(36.4) | 34(25.4) | 17(36.2) | 13(37.1) |
| Left posterior | 31(15.4) | 46(22.8) | 14(10.6) | 34(25.4) | 9(19.1) | 5(14.3) |
| P -value | 0.010 | | 0.008 | | 0.539 | |
| anterior | 106(52.7) | 95(47.0) | 70(53.0) | 66(49.3) | 21(44.7) | 17(48.6) |
| posterior | 95(47.3) | 107(53.0) | 62(47.0) | 68(50.7) | 26(55.3) | 18(51.4) |
| P -value | 0.252 | | 0.538 | | 0.727 | |
| Right | 125(62.2) | 99(49.0) | 88(66.7) | 67(50.0) | 27(57.4) | 19(54.3) |
| Left | 76(37.8) | 103(51.0) | 44(33.3) | 67(50.0) | 20(42.6) | 16(45.7) |
| P -value | 0.008 | | 0.006 | | 0.775 | |

**Table 4. The frequency distribution of pregnancy outcomes regarding the placental location and parity**

| | Nuliparity (n=467) | | Primipara (n=256) | | ≤2 parity (n=28) | |
|---|---|---|---|---|---|---|
| | Male N (%) | Female N (%) | Male N (%) | Female N (%) | Male N (%) | Female N (%) |
| Right anterior | 65(27.9) | 42(17.9) | 41(31.3) | 29(23.2) | 6(37.5) | 2(16.7) |
| Left anterior | 52(22.3) | 64(27.4) | 28(21.4) | 37(29.6) | 4(25.0) | 3(25.0) |
| Right posterior | 81(34.8) | 73(31.2) | 46(35.1) | 31(24.8) | 3(18.8) | 5(41.7) |
| Left posterior | 35(15.0) | 55(23.5) | 16(12.2) | 28(22.4) | 3(18.8) | 2(16.7) |
| P -value | 0.001 | | 0.025 | | 0.509 | |
| anterior | 118(50.6) | 107(45.7) | 69(52.7) | 66(52.8) | 10(62.5) | 5(41.7) |
| posterior | 115(49.4) | 127(54.3) | 62(47.3) | 59(47.2) | 6(37.5) | 7(58.3) |
| P -value | 0.288 | | 0.984 | | 0.274 | |
| Right | 146(62.7) | 117(50.0) | 85(64.9) | 61(48.8) | 9(56.3) | 7(58.3) |
| Left | 87(37.3) | 117(50.0) | 46(35.1) | 64(51.2) | 7(43.8) | 5(41.7) |
| P -value | 0.006 | | 0.009 | | 0.912 | |

## 5. CONCLUSIONS

We here demonstrated that male and female fetuses are more likely to have right anterior and left posterior placentas, respectively. Although this study was based on a small population, this may provide a fundamental data for the future study to associate fetal gender and the placental location.

## CONSENT

A written consent was obtained from each participant.

## ETHICAL APPROVAL

Ethical approval was obtained from the Ethics Committee of the Guilan University of

Medical Sciences (Registration Number: 1393014414).


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## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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