

The effect of genetic amniocentesis on Doppler measurements of utero-placental and feto-placental circulations

Efecto de la amniocentesis genética en las mediciones Doppler de las circulaciones útero-placentaria y feto-placentaria

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Abstract

Objective: The objective of this study was to determine whether there is a change in feto-maternal circulation after amniocentesis (AS) using Doppler ultrasonography. **Methods:** In this prospectively designed study, fetuses with singleton pregnancies between 16 and 22 weeks of gestational age with an indication for invasive testing and a healthy AS result were included. Twin pregnancies, fetuses with major anomalies as determined by ultrasound evaluation, and fetuses with chromosomal or genetic diseases resulting from AS were excluded from the study. **Results:** A total of 73 patients who underwent AS according to the risky screening result were included in the study. Fetal Doppler measurements were performed at three different time periods. The parameters that were analyzed included the fetal umbilical artery, the ductus venosus, and the maternal right and left uterine arteries. The analysis revealed no statistically significant differences between the measurements. **Conclusions:** It has been observed that AS, the most commonly used invasive diagnostic procedure in clinical practice, does not affect feto-maternal circulation and fetal heart function.

Keywords: Amniocentesis. Doppler ultrasonography. Placental circulation.

Resumen

Objetivo: Determinar si existe un cambio en la circulación feto-materna tras la amniocentesis mediante ultrasonografía Doppler. **Métodos:** Estudio de diseño prospectivo en el que se incluyeron fetos de embarazos únicos de entre 16 y 22 semanas de edad gestacional con indicación de pruebas invasivas y un resultado sano de la amniocentesis. Se excluyeron del estudio los embarazos gemelares, los fetos con anomalías importantes determinadas mediante ecografía y los fetos con enfermedades cromosómicas o genéticas derivadas de la amniocentesis. **Resultados:** Se incluyeron en el estudio 73 pacientes que se sometieron a amniocentesis según el resultado del cribado de riesgo. Se realizaron mediciones de Doppler fetal en tres periodos de tiempo diferentes. Los parámetros analizados fueron la arteria umbilical fetal, el conducto venoso y las arterias uterinas derecha e izquierda de la madre. El análisis no reveló diferencias estadísticamente significativas entre las mediciones. **Conclusiones:** Se ha observado que la amniocentesis, el procedimiento diagnóstico invasivo más utilizado en la práctica clínica, no afecta a la circulación feto-materna ni a la función cardíaca fetal.

Palabras clave: Amniocentesis. Ultrasonografía Doppler. Circulación placentaria.

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Introduction

Prenatal diagnosis is a medical procedure used to identify fetal chromosomal abnormalities, single-gene disorders, and congenital infections in the antenatal period. Invasive prenatal diagnostic tests include amniocentesis (AS), chorionic villus sampling, and cordocentesis^{1,2}. AS is an invasive procedure in which amniotic fluid is obtained using a 20-22-gauge spinal needle under ultrasonography (USG) guidance through a transabdominal approach². The first documented case of AS was performed by Fuchs and Riis in 1956 with the objective of determining antenatal sex chromosomes³. AS, when performed by experienced clinicians under outpatient clinic conditions, can be utilized not only for prenatal diagnosis but also for treatment in certain cases^{4,5}. The advent of advanced technology has led to a substantial decrease in the incidence of complications associated with the AS procedure. While transient vaginal bleeding and amniotic fluid leakage may occur in some cases, the risk of miscarriage, the most serious complication, has been reported to be approximately 0.2%^{6,7}.

The potential hemodynamic changes in the fetomaternal circulation following AS are a source of concern. Doppler USG can be used safely as a non-invasive method to detect these changes. The findings from Doppler USG of the fetal umbilical artery, ductus venosus (DV), middle cerebral artery, and maternal uterine artery can provide crucial insights into placental perfusion⁸.

There are very few studies on maternal and fetal perfusion after AS. Previous studies on this subject have reported that fetal circulation was not affected after the procedure^{9,10}. In this study, we tried to investigate whether there is a change in fetomaternal circulation after AS procedure using Doppler USG.

Methods

This prospective study was conducted in the Department of Obstetrics and Gynecology between June 2022 and January 2025. The study was planned in accordance with the principles of the Declaration of Helsinki. Approval was obtained from the Local Ethics Committee of (Ethics Committee number: 2022/309) before the study. Written informed consent was obtained from all patients included in the study.

A total of 73 patients with singleton pregnancies between 16 and 22 weeks of gestation were included

in the study. Fetuses with an indication for invasive testing and a healthy AS result were included in the study. Twin pregnancies, fetuses with major anomalies on USG evaluation, and fetuses with AS results of chromosomal or genetic disorders were excluded from the study.

All procedures were carried out by clinicians specializing in perinatology, utilizing a Voluson E6 (GE Medical Systems, Milwaukee, WI) equipped with a transabdominal 2D convex probe. Fetal Doppler measurements were obtained at three distinct time points: before AS (1st measurement), immediately after AS (2nd measurement), and 1 h after AS (3rd measurement). The parameters that were analyzed included the fetal umbilical artery, the DV, and the maternal right/left uterine artery. The recorded values were then subjected to statistical analysis to determine the presence of any significant differences between them.

Statistical analysis

The analyses were evaluated in Statistical Package for Social Sciences (SPSS) (SPSS Inc., Chicago, IL) 22. Descriptive data were presented as n and % values for categorical data and mean $\pm$ standard deviation (mean $\pm$ standard deviation) and median (minimum-maximum) values for continuous data. The Kolmogorov–Smirnov test was used to assess the normal distribution of continuous variables. For comparison between measurements, the Wilcoxon analysis was employed for paired comparisons, and the Friedman analysis was used for comparisons involving three measurements. The statistical significance level was set at $p < 0.05$.

Results

A total of 73 patients who underwent AS according to high-risk screening results ($n = 57$; 78%), minor soft markers (hyper echogenic cardiac focus, hyperechogenic bowel, nuchal fold thickness, pelviectasia) ($n = 9$; 12%), and advanced maternal age ($n = 7$; 10%) were included in the study. The mean maternal age was 31.9 ± 6.1 (min 21-max 38), and the mean maternal body mass index was 28.0 ± 5.5 kg/m² (min 23-max 33). The mean gestational week at which AS was performed was 18.4 ± 2.0 (min 16-max 22), while the mean estimated fetal weight of the fetuses was 273.8 ± 134.0 g (min 168-max 420).

The first and second Doppler measurements of the umbilical artery, DV, and right and left uterine artery

Table 1. Comparison of first and second Doppler measurements

Doppler measurements	1 st	2 nd	p*
	Mean ± SD	Mean ± SD	
Umbilical artery	3.71 ± 1.13	3.90 ± 1.32	0.360
S/D	1.32 ± 0.47	1.39 ± 0.54	0.510
PI	0.75 ± 0.20	0.78 ± 0.21	0.405
RI			
Right uterine artery			
S/D	3.20 ± 1.26	3.05 ± 1.30	0.220
PI	1.32 ± 0.66	1.23 ± 0.50	0.843
RI	0.65 ± 0.18	0.64 ± 0.17	0.998
Left uterine artery			
S/D	3.00 ± 0.97	3.12 ± 1.29	0.997
PI	1.25 ± 0.58	1.28 ± 0.65	0.999
RI	0.66 ± 0.22	0.65 ± 0.23	0.987
DV			
PI	0.77 ± 0.32	0.78 ± 0.32	0.998

*Wilcoxon analysis was applied.

S/D: systolic/diastolic; PI: pulsatility index; RI: resistance index; DV: ductus venosus; SD: standard deviation.

are shown in table 1. There was no statistically significant difference in the Doppler parameters before and immediately after AS ($p > 0.05$ for all).

The data regarding the first and third Doppler measurements of the umbilical artery, DV, and right and left uterine artery are shown in table 2. There was no statistically significant difference in Doppler parameters before and 1 h after the procedure ($p > 0.05$) ($p > 0.05$) (Table 2).

The first, second, and third Doppler measurements of the umbilical artery, DV, right, and left uterine artery are shown in table 3. The umbilical artery systolic/diastolic ratio and pulsatility index (PI) value increased immediately after the procedure and returned to the pre-procedure level at 1 h. However, these findings were not statistically significant.

Discussion

AS is the most commonly performed prenatal invasive diagnostic test, and the incidence of associated complications is very rare when performed by experienced clinicians with superior equipment. However, our understanding of the short-term effects of AS on the fetomaternal circulation and their implications for the fetus remains limited. While numerous studies have examined the indications and complications of AS¹¹⁻¹⁴, there is a paucity of research investigating the potential changes in the fetomaternal circulation

Table 2. Comparison of the first and third Doppler measurements of the patients

Doppler measurements	1 st	3 rd	p*
	Mean ± SD	Mean ± SD	
Umbilical artery			
S/D	3.71 ± 1.13	3.65 ± 0.76	0.998
PI	1.32 ± 0.47	1.36 ± 0.51	0.936
RI	0.75 ± 0.20	0.77 ± 0.26	0.684
Right uterine artery			
S/D	3.20 ± 1.26	3.07 ± 0.97	0.998
PI	1.32 ± 0.66	1.25 ± 0.51	0.999
RI	0.65 ± 0.18	0.67 ± 0.20	0.987
Left uterine artery			
S/D	3.00 ± 0.97	3.37 ± 1.32	0.099
PI	1.25 ± 0.58	1.31 ± 0.52	0.819
RI	0.66 ± 0.22	0.68 ± 0.18	0.237
DV			
PI	0.77 ± 0.32	0.73 ± 0.18	0.887

*Wilcoxon analysis was applied.

S/D: systolic/diastolic; PI: pulsatility index; RI: resistance index; DV: ductus venosus; SD: standard deviation.

Table 3. Comparison of three different Doppler measurements of the cases

Doppler measurements	1 st	2 nd	3 rd	p*
	Mean ± SD	Mean ± SD	Mean ± SD	
Umbilical artery				
S/D				
PI	3.71 ± 1.13	3.90 ± 1.32	3.65 ± 0.76	0.397
RI	1.32 ± 0.47	1.39 ± 0.54	1.36 ± 0.51	0.286
	0.75 ± 0.20	0.78 ± 0.21	0.77 ± 0.26	0.206
Right uterine artery				
S/D				
PI	3.20 ± 1.26	3.05 ± 1.30	3.07 ± 0.97	0.287
RI	1.32 ± 0.66	1.23 ± 0.50	1.25 ± 0.51	0.805
	0.65 ± 0.18	0.64 ± 0.17	0.67 ± 0.20	0.494
Left uterine artery				
S/D				
PI	3.00 ± 0.97	3.12 ± 1.29	3.37 ± 1.32	0.132
RI	1.25 ± 0.58	1.28 ± 0.65	1.31 ± 0.52	0.463
	0.66 ± 0.22	0.65 ± 0.23	0.68 ± 0.18	0.133
DV				
PI	0.77 ± 0.32	0.78 ± 0.32	0.73 ± 0.18	0.805

*Friedman analysis was applied.

S/D: systolic/diastolic; PI: pulsatility index; RI: resistance index; DV: ductus venosus; SD: standard deviation.

resulting from AS procedures^{9,10}. Consequently, we sought to elucidate the effects of AS on fetomaternal circulation by employing Doppler USG, a non-invasive methodology.

DV is one of the shunt mechanisms that provide oxygen-rich blood to the fetus in intrauterine life, which makes fetal life different from adult life. The DV carries a substantial proportion of the blood flow from the umbilical vein directly to the inferior vena cava, thereby ensuring the delivery of oxygenated blood to the fetal body, particularly the fetal heart and brain¹⁵. Consequently, DV assumes a pivotal role in the assessment of fetal heart function^{16,17}. To date, only two studies have examined the relationship between DV Doppler parameters and AS. One of these studies was conducted by Helbig and Haugen, who evaluated 99 patients who underwent AS for genetic diagnosis. The pre-procedure DV PI measurements of the fetuses were calculated as mean:1.07; min 0.54-max 2.42, and the post-procedure DV PI measurements were calculated as mean:1.03; min 0.51-max 3.27. No significant difference was observed between the two measurements¹⁰. In a subsequent study, DV PI parameters were examined immediately before and after the AS procedure, and the mean and mean values were calculated as 1.050 and 1.050, respectively. 1.050 and 0.930, respectively, and no statistically significant difference was found between these two values. The findings of the present study are consistent with the extant literature; the mean DV PI measurements before AS were 0.77 ± 0.32 , immediately after AS were 0.78 ± 0.32 , and 1 h after AS were 0.73 ± 0.18 . The results were analogous, and no statistically significant difference was identified between them.

In their study, Ulkumen et al. compared the Doppler USG parameters of the umbilical artery, middle cerebral artery, right uterine artery, and left uterine artery before and after the procedure in 56 patients who underwent AS in their clinic. The researchers reported that the results of all parameters before and after the procedure were similar⁹. In a related study, 200 patients who underwent AS for genetic diagnosis were examined, and the patient group who underwent transplacental AS during the procedure and the patient group who did not undergo transplacental needle passage were compared. The umbilical artery Doppler parameters and fetal heart rate were compared between these two groups before and after the procedure. The results showed that both measurements were similar in both groups¹⁸. In a subsequent study by Iskender et al., the Doppler parameters of the middle cerebral artery and umbilical artery were compared before and after the procedure in patients with bleeding into the amniotic fluid during the AS procedure and in patients without such bleeding. The study revealed that the

Doppler parameter measurements were comparable between the two groups¹⁹. The present study involved the performance of uterine artery, umbilical artery, and DV Doppler flow examinations on 73 patients before, immediately following, and 1 h after the AS procedure. The results of the present study corroborate the extant literature, and no statistically significant difference was observed between the groups in Doppler USG parameters evaluating fetomaternal circulation and fetal cardiac function.

The strengths of this study are its prospective design, the expertise of the clinicians, the utilization of advanced technological devices, and the inclusion of only live, healthy fetuses. The limitations of the study are its single-center design and the limited number of patients.

Conclusion

In this research, it was observed that AS, the most commonly used invasive diagnostic procedure in clinical practice, does not affect fetomaternal circulation and fetal cardiac function. Therefore, AS can be safely recommended by experienced clinicians under appropriate conditions.

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Conflicts of interest

The authors declare no conflicts of interest.

Ethical considerations

Protection of humans and animals. The authors declare that the procedures followed complied with the ethical standards of the responsible human experimentation committee and adhered to the World Medical Association and the Declaration of Helsinki. The procedures were approved by the institutional Ethics Committee.

Confidentiality, informed consent, and ethical approval. The authors have followed their institution's confidentiality protocols, obtained informed consent from patients, and received approval from the Ethics Committee. The SAGER guidelines were followed according to the nature of the study.

Declaration on the use of artificial intelligence.

The authors declare that no generative artificial intelligence was used in the writing of this manuscript.

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