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Renal Artery Doppler Findings in the Patients with Polyhydramnios before and after the Conservative Treatment

Polihidramniyoslu Hastalarda Konservatif Tedavi Öncesi ve Sonrası Fetal Renal Arter Doppler Bulguları

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Abstract

Objective: The aim of this study was to evaluate the foetal renal blood flow with colour Doppler ultrasonography. Patients with polyhydramnios were investigated for the foetal renal artery pulsatility index (PI) at the beginning of the treatment, and after the conservative treatment in those who reached the normal amniotic fluid index.

Materials and Methods: In this prospective study, 39 foetuses with polyhydramnios were evaluated at gestational weeks 26 to 36. The foetal development parameters, right and left foetal renal artery PIs, and amniotic fluid index were measured at the beginning of the treatment in all of these patients. Of these patients, 19 who responded to the conservative treatment were also revaluated when their amniotic fluid index reached normal levels, and statistical analyses were performed for the renal artery PIs before and after the treatment.

Results: In this study, 19 patients fulfilled the inclusion criteria as patients with polyhydramnios who responded to conservative treatment. For these patients, the mean foetal renal artery PI was 2.08 (range 1.5-3.0) at the first sonographic examination, and the mean foetal renal artery PI was 1.94 (range 1.53-2.69) after the conservative treatment. However, there was no statistically significant difference between these two groups (p=0.117).

Conclusion: In this study, no statistically significant difference was found in the foetal renal artery PIs of the patients with polyhydramnios before and after the conservative treatment. These results suggest that the renal artery blood flow may not have any effect on the renal artery PI; therefore, these findings indicate that the renal artery PI cannot be used as a marker in the evaluation of polyhydramnios.

Keywords: Doppler ultrasonography, foetal renal artery, polyhydramnios, pulsatility index

Özet

Amaç: Bu çalışmanın amacı fetal renal arter kan akımını renkli Doppler ultrasonografi ile değerlendirmek olup polihidramniyos saptanan tüm fetuslarda konservatif tedavi öncesinde ve sonrasında fetal renal arter pulsatilite indeksleri ölçüldü. Konservatif tedavi sonrası amniyotik sıvı indeksi normale dönen fetuslarda renal arter pulsatilite indeksi yeniden ölçüldü.

Gereç ve Yöntem: Bu prospektif çalışmaya 26-36. gestasyonel haftalar arasında polihidramniyosu olan 39 fetus dahil edildi. Tüm fetusların tedavi öncesinde fetal gelişim parametreleri, sağ ve sol renal arter pulsatilite indeksleri ve amniyotik sıvı indeksi ölçüldü. Bu hastaların 19'u konservatif tedaviye yanıt vermiş olup tedavi sonrası amniyotik sıvı indeksi normale döndü. Bu 19 fetusun renal arter pulsatilite indeksi tedavi öncesi ve sonrasında istatistiksel olarak değerlendirilmiştir.

Bulgular: Çalışmaya polihidramniyosu olup konservatif tedavi sonrası tedaviye yanıt veren 19 hasta ile devam edildi. Bu fetuslarda mean fetal renal arter pulsatilite indeksi ilk sonografik incelemede 2,08 (range 1,5-3,0) ölçülmüş olup tedavi sonrasında 1,94 (range 1,53-2,69) olarak saptandı. Ancak bu iki grup arasında istatistiksel olarak anlamlı fark saptanmadı (p=0,117).

Sonuç: Çalışmamızda polihidramniyosu olan hastalarda tedavi öncesi ve tedavi sonrasında fetal renal arter pulsatilite indeksi arasında anlamlı fark saptanmadı. Bu da bize renal arter kan akımının renal arter pulsatilite indeksi üzerinde etkisi olmayabileceğini gösterdi. Dolayısıyla renal arter pulsatilite indeksini polihidramniyos değerlendirilmesinde bir belirteç olarak kullanmak çok doğru değildir.

Anahtar Kelimeler: Doppler ultrasonografi, fetal renal arter, polihidramniyos, pulsatilite indeksi

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Introduction

Amniotic fluid is essential for maintaining the life of the foetus during the prenatal period. It protects against physical trauma and ascending infections, and contributes to the development of the foetal lungs. Foetal resorption and secretion should be in balance for the normal amniotic fluid index (AFI). The amniotic fluid is produced mainly by the placenta and amniotic membrane during the first trimester, and the main source of the amniotic fluid is foetal urine during the second trimester. The foetal urogenital and pulmonary systems contribute to the amniotic fluid balance in the later stages of the pregnancy. Increased amniotic fluid is associated with diminished swallowing or increased foetal excretion [1], and minor changes in the foetal urine production or absorption may cause substantial alterations in the AFI. If the value of the amniotic fluid is between 80-99 mm, it is defined as mild polyhydramnios, and 100-120 mm is considered to be medium polyhydramnios. A value for amniotic fluid >120 mm is accepted as severe polyhydramnios [1].

The etiology of polyhydramnios includes maternal, foetal, and placental abnormalities; additionally, 60% of the cases are idiopathic [1, 2]. Maternal reasons for polyhydramnios are diabetes mellitus (DM) and infections such as TORCH, and the incidence of occurrence with DM was 7.5% in 2004. Foetal causes of polyhydramnios are foetal malformations and tumours, musculoskeletal disorders, chromosomal disorders, immunological and non-immunological hydrops fetalis, and multiple gestations. The incidence of foetal malformations was 24.1% in 2004, and included cerebral, pulmonary, gastrointestinal, cardiac, and urogenital system malformations. Foetal urogenital malformations include increased urine production, diminished urine concentration, and renal tumours [1, 3]. The degree of polyhydramnios is associated with foetal morbidity and mortality, and severe polyhydramnios may cause poor foetal and neonatal prognoses, with a mortality ratio of up to 30% [1, 4].

In this study, we evaluated the foetal renal blood flow, which can affect the production of foetal urine, with colour Doppler ultrasonography (US). Patients with polyhydramnios were investigated for the foetal renal artery pulsatility index (PI) at the beginning of the treatment, and after the conservative treatment in those who reached a normal AFI. Also, statistically significant differences between the values of the foetal renal artery PIs were investigated.

Materials and Methods

This prospective study was conducted in our clinic between the gestational weeks 26-36. As a result of all sonographic examinations, 39 patients with polyhydramnios were included in this study. Inclusion criteria were singleton pregnancies between the gestational weeks 26-36 who accepted the conservative treatment. Patients with multiple gestations or any medical disorders complicating the pregnancy, and foetuses with abnormal renal morphology or poorly visualized kidneys were excluded from the study. Hospital ethics committee approval was obtained for this study and additional informed consents were obtained from all patients.

Routine antenatal and colour Doppler US were done for all patients included in this study. All ultrasound examinations were performed with a GE Logic 9 (Milwaukee, USA) ultrasound machine using a 3.5 to 5 MHz multi-frequency convex probe, by a specialist experienced in obstetric US (AI, 18 years of experience). All patients were examined in the supine and mild left decubitus position during the sonographic examinations.

Thirty-nine patients with polyhydramnios were evaluated by the Obstetrics and Gynaecology clinic. Head circumference, abdominal circumference, femur length, AFI, and foetal renal artery PI were measured between the gestational weeks 26-36. The patients whose AFIs did not return to normal levels were examined before the conservative treatment, whereas 19 patients, whose AFIs returned to normal values at the weekly controls, were examined initially and after the conservative treatment. Patients who responded to the conservative treatment and whose AFIs came under 20 cm were examined, and their foetal renal artery Doppler PIs were compared.

The right and left renal artery PIs (Figure 1, 2) were measured at the beginning of the study for all patients. In the second sonographic examination, the right and left renal arteries were measured in those patients whose AFIs were under 20 cm after the treatment. In the patients who responded to conservative treatment, the statistical analysis was not significant for the right and left renal artery PIs in the first examination. Therefore, the mean right and left renal artery PI, before and after the treatment, was used to compare the foetuses with polyhydramnios who responded to the treatment. Haugen and colleagues showed that the right and left foetal renal artery PI and resistive index (RI) values were the same in their study, when they measured the proximal and distal segments [5].

Restricted fluid intake is a conservative treatment, limited to not more than 2 litres per day. Foetal renal artery Doppler US was done before and after the approximately 3-week treatment, when the AFI returned to the normal level.

During the foetal renal artery US, after the foetal body's sagittal image was taken, the US probe was directed to the vertebrae laterally, and the coronal image of the foetal body was taken. The descending aorta and coronal image of the kidneys were demonstrated by moving the transducer ante-

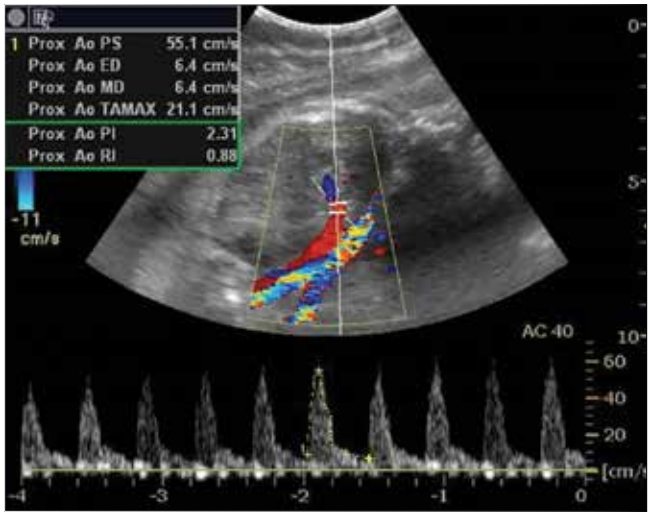

Figure 1. *Colour Doppler ultrasonographic appearance of the right foetal renal artery.*

Figure 2. *Colour Doppler ultrasonographic appearance of the left foetal renal artery.*

riorly. The examination was made by positioning the sample volume over the renal artery, adjacent to the aorta, just after it originated from the descending aorta, when the foetus was immobile in respiratory apnoea. Similar flow spectrums that had at least three cardiac cycles were assessed. The examination was done from both renal arteries and the mean renal artery PI was taken.

The measurement of the AFI, by using colour Doppler when the patient was in the supine position, as Phelan and colleagues had previously described, was calculated by the summation of the widest vertical diameters of the pouches in 4 quadrants which did not contain the umbilical cord. The AFI values measured at 20 cm or above were accepted as polyhydramnios [6].

Table 1. Comparison of the right and left foetal renal artery PIs before the treatment in the group who responded to conservative treatment

Group	N	PI	Standart deviation	Minimum	Maximum
Right RA before CT	19	2.0505	0.38158	1.46	2.80
Left RA before CT	19	2.1316	0.53333	1.48	3.67

CT: conservative treatment; RA: renal artery; PI: pulsatility index

Statistical Analysis

The statistical analyses were done by using the SPSS (Version 11.0, SPSS; Chicago, IL, USA) licensed program. The t-test and Wilcoxon signed rank test were used while comparing the groups.

Results

Thirty-nine patients with polyhydramnios were evaluated in this study. All patients received conservative treatments, but only 19 of them responded to the treatment with amniotic fluid values that returned to normal levels. Those 19 patients were included in the study.

The age, gestational week, and AFI were statistically meaningless between the patients who responded to the conservative treatment and those who did not. The mean gestational week of the patients was 31 (range 26-39), and the mean age of all patients included in the study was 27 (range 18-41). The mean age of the patients who did not respond to treatment was 28 (range 18-41), and the mean age of the patients who responded to treatment was 25 (range 18-39). There was no statistically significant correlation between the ages.

The mean AFI was 25.3 cm (range 21-32 cm) at the beginning of the study in the group which did not respond to the conservative treatment. At the beginning of the study, the mean AFI was 23.7 cm (range 21-32 cm) in the group that responded to conservative treatment.

In the first sonography of the patients that responded to conservative treatment, the mean right renal artery PI was 2.05 (range 1.4-2.8) and mean left renal artery PI was 2.1 (range 1.4-3.6). There was no statistically significant difference between the right and left renal artery PIs (p=0.420) (Table 1).

The mean foetal renal artery PI was 2.08 (range 1.5-3.0) at the first sonography in the patients with polyhydramnios who responded to conservative treatment. In the patients with polyhydramnios who did not respond to conservative treatment, the mean foetal renal artery PI was 2.03 at the first

Table 2. Comparison of the mean foetal renal artery PIs before the treatment in the groups who responded and did not respond to conservative treatment

Group	N	Mean RA PI before CT	Standart deviation	Minimum	Maximum
Respond to CT	19	2.0895	0.40721	1.54	3.04
No respond to CT	20	2.0325	0.35449	1.42	2.88

CT: conservative treatment; RA: renal artery; PI: pulsatility index

Table 3. Comparison of the foetal renal artery PIs before and after the treatment in the group who responded to conservative treatment

Group	N	Mean PI	Standart deviation	Minimum	Maximum
RA before the CT	19	2.0895	0.40721	1.54	3.04
RA after the CT	19	1.9463	0.33478	1.53	2.69

CT: conservative treatment; RA: renal artery; PI: pulsatility index

sonography. There was no statistically significant difference between these two groups (p=0.643) (Table 2).

In the patients with polyhydramnios who responded to conservative treatment, the mean foetal renal artery PI was 2.08 (range 1.5-3.0) at the first sonography, and the mean foetal renal artery PI was 1.94 (range 1.53-2.69) after conservative treatment. There was no statistically significant difference between these two groups (p=0.117) (Table 3).

Discussion

The biparietal diameter (BPD), abdominal circumference (AC), femur length (FL), AFI, maturation of the placenta, umbilical, renal, and uterine artery colour Doppler parameters can play significant roles when evaluating the foetal development by sonography [7, 8].

The main source of the amniotic fluid is foetal urine in the second trimester, so foetal renal perfusion plays a significant role in the amniotic fluid regulation [9]. In the previous studies, an association between the foetal renal artery PI and oligohydramnios was present. However, there are few studies in the literature which evaluate the association between the foetal renal artery PI and polyhydramnios, and the effects of the foetal survey. Our aim was to investigate the significance of the foetal renal artery PI before and after the conservative treatment for patients with polyhydramnios, and evaluate the effects of the foetal prognosis.

The umbilical and renal arteries were evaluated with colour Doppler sonography in 100 normal foetuses and 39 growth restricted foetuses, and the renal artery PIs and AFIs were compared by Yoshimura et al. [10]. They reported that the renal and umbilical artery PIs were significantly higher in the growth restricted foetuses with oligohydramnios than the normal foetuses with normal AFIs. Also, they detected a statically significant negative correlation between the renal artery PI and AFI in growth restricted foetuses [10].

Scott et al. [11] revealed that renal artery PIs were higher in normally growing foetuses with oligohydramnios than in normally growing foetuses with normal AFIs. These findings also support the literature. In another study, Silver et al. [12] reported that there was a statically significant correlation between the intrauterine growth restriction (IUGR) and foetal renal volume. This may be because the number of nephrons is probably an indicator of the renal volume. Additionally, this study supported the hypothesis that IUGR might be associated with congenital oligonephropathy, hypertension, and other vascular diseases [12].

One-hundred foetuses were evaluated by Behery and colleagues [13] with colour Doppler US between the gestational weeks 26-34, and forty-three of them had growth retardation. Renal artery PIs were detected at 0.79 and 1.75, respectively, in normally growing foetuses and growth restricted foetuses, and there were statically significant correlations between these two groups [13]. Also, there were significantly negative correlations between the foetal arterial pO_2 and AFI. Renal resistance and renal artery PI increased because of the reduced foetal arterial pO_2 and AFI.

Foetal cardiac and renal blood flows were evaluated by Rosnes et al. [14] between the foetuses with normal AFIs and idiopathic polyhydramnios. The total cardiac output, right ventricular output, renal blood flow, and renal artery diameter were lower in the foetuses with idiopathic polyhydramnios than in the foetuses with normal AFIs. Accordingly, diminished renal perfusion was detected in the foetuses with idiopathic polyhydramnios when compared to the foetuses with normal AFIs.

Behery et al. [13] evaluated 110 patients with colour Doppler US, and 43 of them had IUGRs between gestational weeks 26-34. The renal artery PI was 0.79 and 1.75, respectively, in normally growing foetuses and growth restricted foetuses; and there was a statically significant correlation between these two groups [13]. They also detected a negative correlation between the foetal arterial pO2 and AFI. A reduction in the foetal arterial pO2 or AFI caused increased resistance in the renal arterial PI.

Rosnes et al. [14] compared the foetal cardiac and renal blood flows between the foetuses with normal AFIs and polyhydramnios in their study. They found that the total cardiac

output, right ventricular output, renal blood flow, and renal artery diameter were lower in the foetuses with polyhydramnios than in normally growing foetuses without polyhydramnios. Additionally, the renal perfusion was low [14].

In the first control of our study, the mean renal artery PI was 2.08 (range 1.5-3.0) in the patients with polyhydramnios who responded to conservative treatment. The mean renal artery PI was 2.03 (range 1.4-2.8) in those patients who did not respond to conservative treatment; however, there were no statically significant correlations between these two groups. Additionally, the mean renal artery PIs were 2.08 (range 1.5-3.0) and 1.94 (range 1.5-2.69), respectively, before and after the treatment, in those patients who responded to conservative treatment. However, there were no statistically significant correlations between these two groups.

Various treatment options for polyhydramnios may be considered with the presence of complications and preterm labour or severely disturbed patients [1]. These treatment options include drainage of the amniotic fluid or prostaglandin synthesis inhibitors to decrease the amniotic fluid, and prolongation of the pregnancy. Additionally, fluid restriction may be recommended. Drainage of the amniotic fluid is used in very serious cases of polyhydramnios, and is performed until the normalization of the AFI. Additionally, no more than 5 litres of amniotic fluid should be drained at one time [1]. Inhibitors of prostaglandin synthesis are an alternative method for this treatment, and indomethacin is often used for this purpose. Indomethacin reduces the amniotic fluid by inhibiting the prostaglandin synthesis in the myometrium, chorion, and decidua; however, one must be careful of the side effects that may occur during the use of this drug [1]. Indomethacin does not lead to changes in the uteroplacental blood flow; it just reduces the foetal renal blood flow and raises the renal vascular resistance [14]. As a result, foetal urine production decreases and foetal absorption increases, which contribute to the lowering of the AFI. However, we did not use indomethacin in our study [15]. We only restricted the fluid uptake to no more than 2 litres per day, and as a result of the fluid restriction, only 19 patients reached the normal AFIs.

In the evaluation of renal perfusion, renal artery PI is considered for the patients with oligohydramnios. In our study, we found that renal artery PI was not statically significant for the foetuses with polyhydramnios, and did not contribute to the foetal outcome. Mari et al. [16] detected that there were no alterations in the renal artery PI after indomethacin treatment in the foetuses with polyhydramnios. Additionally, we did not determine any alterations in the renal artery PIs after the fluid restriction in the foetuses with polyhydramnios in our study.

As a result, we suggest that renal artery blood flow alterations cannot affect the renal artery PIs. Also, the renal artery PI should not be used as a marker for the foetuses with polyhydramnios. The limited number of patients who accepted the conservative treatment was one limitation of this study. Therefore, new studies with extensive groups will further contribute to the literature.

Ethics Committee Approval: Ethics committee approval was received for this study.

Informed Consent: Written informed consent was obtained from patients who participated in this study.

Peer-review: Externally peer-reviewed.

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