

The clinical significance of antenatal pathological Doppler findings in fetal middle cerebral artery compared to umbilical artery and fetal aorta

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Summary

Purpose: To compare the diagnostic capacity of fetal Doppler velocimetry in fetal middle cerebral artery to umbilical artery and fetal aorta to the prediction of fetal outcome.

Methods: 229 patients between 28 weeks of gestation (weeks) and 40 weeks were examined by Doppler ultrasound in relationship to complications in gestation and labor, and fetal outcome. One thousand two hundred and seventy doppler blood flow velocity waveforms in the middle cerebral artery, umbilical artery and fetal aorta were recorded. Sensitivity of these vessels with regard to the prediction of intrauterine growth retardation, rate of cesarean section, preterm delivery and new-born depression was calculated. In all Doppler measurements there were no cases with absence of end-diastolic flow.

Results: The differences between pathological fetal outcome were not statistically significant, but diagnostic capacity of the middle cerebral artery velocimetry with regard to the prediction of pathological fetal outcome was on average 11% below the diagnostic capacity of the fetal aorta and umbilical artery.

Conclusion: There is no benefit in examining fetal middle cerebral artery Doppler measurements in clinical routine in patients with normal velocity waveforms in the umbilical artery and fetal aorta.

Key words: Doppler measurements; Fetal middle cerebral artery; Umbilical artery.

Introduction

The objective of fetal Doppler velocimetry is to detect at an early stage any hemodynamic changes that allow us to identify and quantify a placental dysfunction with associated fetal distress. Cerebral blood flow changes in relation to hypoxia and fetal distress continue to be one of the most interesting areas of investigation. Many studies have demonstrated positive correlations between cerebral Doppler data and fetal hypoxia or fetal well-being in cases of absent end-diastolic flow in the fetal aorta or umbilical artery [1-5].

The purpose of this paper was to examine the clinical significance of antenatal pathological Doppler findings in the fetal middle cerebral artery in cases of normal Doppler velocity waveforms at the peripheral vessels compared to the umbilical artery and fetal aorta.

Material and Methods

Two hundred and twenty-nine patients between 28 weeks and 40 weeks of gestation have been examined by Doppler ultrasound in relationship to complications in gestation, labor, and fetal outcome. Doppler blood flow velocity waveforms, (1,270 in total) in the middle cerebral artery, umbilical artery and fetal aorta were recorded. S/D ratios below the 10th percentile of our own reference ranges were defined as pathological in the middle cerebral artery. A 3.5-Mhz pulsed waved duplex colour Doppler ultrasound instrument was used (Combison 530, Kretz Technic).

Four groups were compared: 118 patients with normal velocity waveforms in all arteries (group I); 26 patients with pathological Doppler blood flow velocity waveforms in the middle cerebral artery (group II); 41 patients with pathological measurements in the umbilical artery (group III); 44 patients with pathological measurements in the fetal aorta (group IV). Sensitivity of single vessels with regard to the prediction of intrauterine growth retardation, cesarean section, preterm delivery and new-born depression was calculated and compared.

Results

In group II, 50% of the patients were delivered by caesarean section in case of pathological fetal heart monitoring (CTG) (18% in group I, Figure 1), 69% of new-born babies showed a birthweight below the 10th percentile, 46% weighed less than the 5th percentile (18% and 7% in group I). The average birthweight was 2480g (range 1060g - 3650g), 25% of new-born babies weighed less than 1880g (3073g, 1350g - 4160g, 2750g in group I). In group II, 62% of the babies were premature (13% in group I, Figure 2). In group II, an arterial umbilical-cord-pH < 7.2 and/or Apgar-score after one minute < 7 were diagnosed in 38% of the new-born babies (7.5% in group I).

The differences between pathological fetal outcome in group II, group III, and group IV were not statistically significant, but diagnostic capacity of the middle cerebral artery velocimetry with regard to the prediction of pathological fetal outcome was on average 11% below the diagnostic capacity of the fetal aorta and the umbilical artery.

Revised manuscript accepted for publication May 8, 2000

The sensitivity of a single vessels is shown in Figure 3 and the diagnostic capacity in Table 1.

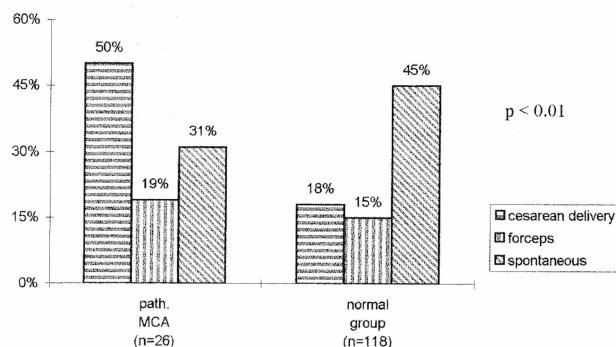


Figure 1. — Mode of delivery in cases of normal Doppler measurements (normal group) and pathological Doppler findings in the fetal middle cerebral artery (path. MCA).

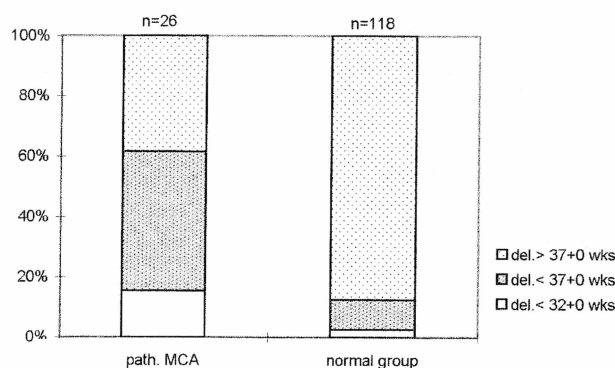


Figure 2. — Date of delivery (del.) in cases of normal Doppler measurements (normal group) and pathological Doppler findings in the fetal middle cerebral artery (path. MCA), (wks = weeks of gestation).

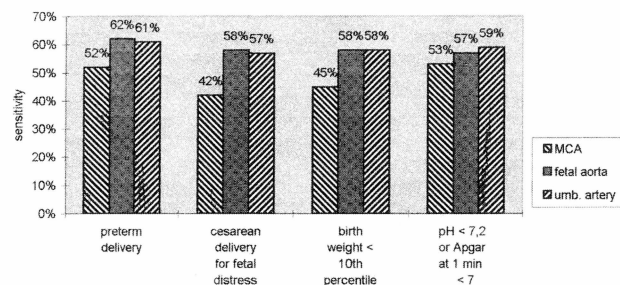


Figure 3. — Sensitivity of fetal Doppler velocimetry (middle cerebral artery = MCA, fetal aorta, umbilical artery = umb. artery) with regard to the prediction of fetal outcome.

Discussion

The efficacy of fetal Doppler investigations for predicting adverse perinatal outcome in complicated pregnancies has been widely investigated [6, 7, 8]. Most studies indicated that the Doppler results were efficacious for

identifying the fetus at risk in complicated pregnancies or in pregnancies with absent end-diastolic flow in the fetal aorta or umbilical artery [9, 10, 11]. There are, however, wide variations in the performance of the technique, with the sensitivity ranging from 20% to more than 90% and the specificity from 60 to 97% [12]. The studies were heterogeneous in several ways, including the population selection criteria, the method of using Doppler surveillance, the diagnostic vessels, and the outcome parameters.

The purpose of this paper was to examine the benefit of antenatal pathological Doppler measurements in the fetal middle cerebral artery (MCA) in clinical routine in cases of normal Doppler velocity waveforms at the peripheral vessels.

The Doppler measurements of the middle cerebral artery are sensitive to any vasoconstriction or vasodilatation of the brain vessels [13]. An increase in diastolic cerebral flow is interpreted as a vasodilatation to hypoxia [14]. Comparisons between the cerebral Doppler index and the measurement of PO_2 , PCO_2 , pH, and O_2 content by cordocentesis have demonstrated a good correlation between blood gas values and the cerebral Doppler index in cases of severe hypoxia [15, 16]. In our study the PCO_2 measured in the umbilical cord after delivery was significantly higher in the group with pathological Doppler blood flow velocity waveforms in the middle cerebral artery ($p < 0.05$). There were no differences in the PO_2 or PCO_2 values between the other groups, but the average weight of the placenta was 200g lower in the group with pathological Doppler flow measurements in the fetal aorta compared with the other groups ($p < 0.001$). These findings are concordant with the results of other reports. In a study by Laurini *et al.* which evaluated placental morphology in relation to Doppler flow measurements, the presence of placental infarction was significantly associated only with abnormal flow velocity findings in the fetal descending aorta [17].

Gramellini *et al.* studied 45 growth-retarded fetuses and found a sensitivity of 78% for the MCA and 83% for the umbilical artery when these parameters were used as predictors of poor perinatal outcome [18]. In their study the parameters taken into account to evaluate fetal well-being were fetal heart rate, gestational age, birth weight, cesarean section rate, umbilical vein pH, 5 minute Apgar score, incidence of admission to the neonatal intensive care unit, and neonatal complications. Most studies have shown similar results in high risk pregnancies. The Doppler indices of the umbilical artery and the fetal aorta were significantly higher than the indices of the MCA. Abnormal Doppler indices measured in the peripheral vessels are strong predictors of intrauterine growth retardation and adverse perinatal outcome. The MCA Doppler indices alone are not a reliable indicator [19, 20, 21].

In the present study the predictive value of the Doppler values of the umbilical artery and the fetal aorta were found to be a better predictor of fetal outcome than the Doppler measurements of the MCA. The lower sensitivity is based on the group with unselective pregnancies.

The diagnostic efficacy of the Doppler method in a low risk population or unselective pregnancies is disappointing, as indicated by several studies summarized below [22-24].

Sijmons and colleagues conducted a prospective blind assessment of the efficacy of Doppler parameter screening for predicting small-for-gestational-age infants and a low ponderal index. The population consisted of 400 women between 28 and 34 weeks of gestation. The prevalence of the outcome varied between 3.3% and 22%. For the different outcome parameters, the test sensitivity ranged from 7% to 41%, the specificity from 91% to 99%, the positive predictive value from 10% to 53% and the negative predictive value from 79% to 97%.

In conclusion this study shows no benefit in measurements of Doppler velocity waveforms in the fetal middle cerebral artery per se. The efficacy of cerebral Doppler investigation should therefore be appraised according to the risk category of the study population.

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