Neuroendocrinology Letters Volume 44 No. 1 2023
ISSN: 0172-780X; ISSN-L: 0172-780X; Electronic/Online ISSN: 2354-4716
Web of Knowledge / Web of Science: Neuroendocrinol Lett
Pub Med / Medline: Neuro Endocrinol Lett

Cerebral artery reverse flow as an indicator of critical intracranial hypertension in fetal intracranial hemorrhage: Case report

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Submitted: 2022-01-21 Accepted: 2023-02-02 Published online: 2023-02-02

Key words: **intracranial hemorrhage; middle cerebral artery reverse flow; intracranial hypertension; cerebral circulation; fetal death**

Neuroendocrinol Lett 2023; **44**(1):1–4 **PMID:** 36931221 NEL440123C02

Abstract

Intracranial hemorrhage (ICH) is a rare serious fetal event. It manifests via non-specific sonographic findings such as: ventriculomegaly, increased periventricular echogenity, hyperechogenic ependyma and presence of avascular intracranial masses. Severe ICH causes an increase in fetal intracranial pressure, which can be quantified in utero by the presence of reverse flow in the middle cerebral artery (MCA-REDF). Retrograde flow in the middle cerebral artery indicates already deteriorating circulatory conditions in the fetal brain with loss of autoregulatory mechanisms and critical damage to the vascular supply. Detection of this finding allows to improve the diagnosis of ICH and also affects the prognosis and management of pregnancy. We report the case of critical intracranial hypertension in fetal intracranial hemorrhage manifested by cerebral artery reverse flow.

CASE REPORT

INTRODUCTION

Intracranial hemorrhage is a rare pathology of the fetus. Sonographic markers such as ventriculomegaly, increased periventricular echogenicity, hyperechogenic nodular ependyma, echogenic avascular intracranial masses are rather non-specific. (Putbrese & Kennedy, 2017) These indicators are also present in other variable fetal brain injuries of various etiologies, e.g. infectious diseases, brain tumors. Some fetal strokes remain stable in the sonographic image, while others lead to rapid progression of the finding with the risk of severe fetal brain damage and intrauterine death. The use of color Doppler with flow measurement in middle cerebral artery (MCA) allows a significant narrowing of the differential diagnosis of non-specific findings and also allows the detection of worsening intracranial hypertension of the fetus. At present, the prognosis of serious fetal intrauterine events is very unfavorable. (Adiego *et al.* 2019) Prompt diagnosis

verifying the exponential deterioration of cerebral circulatory conditions may be key to rapid postnatal intervention and improved neonatal outcomes.

CASE REPORT

A 24 years old woman in her 1st gravidity in the 34th week of pregnancy was sent to our center due to the finding of an abnormality in the central nervous system of the fetus. The patient's family and personal medical history were unremarkable. Previous sonographic examinations were normal. The last ultrasound was performed two weeks before the pathology was detected and no abnormality was reported. Ultrasound examination (GE Healthcare Austria Voluson E10 probe RM6C) at 34 weeks of gestation confirmed fetal growth at the 30th percentile with bilateral ventriculomegaly 22 mm, with an irregular oval structure in the left lateral ventricle, suggestive of an organized coagulum with central hypoechogenicity. A mild dilatation of the 3rd ventricle was present, along with periventricular hyperechogenicity, the fetal cerebellum was without focal changes. (Fig. No. 1 and 2.) By measuring the flow in the middle cerebral artery, reverse flow was confirmed, persisting even when using minimal pressure of the probe on the fetal head and present repeatedly throughout the examination. (Fig. No. 3)

Echocardiographic examination of the fetus did not find any abnormalities. Samples for toxoplasmosis, rubella, cytomegalovirus, and herpes viruses (TORCH) and examination for alloimmune thrombocytopenia were all negative. Due to deteriorating circulatory parameters in the fetal brain, probably due to intracranial hemorrhage and subsequent progressive intracranial hypertension, the pregnancy was terminated by cesarean section. A female fetus weighing 2360 g and 46 cm with an Apgar score of 7/6/9 was born. Postnatally performed neurosonographic examination confirmed progression of intracranial hemorrhage with presence of porencephalic cysts. Flow examinations of the anterior and middle cerebral artery revealed reverse flow with confirmation of intracranial hypertension.

The newborn was admitted to the intensive care unit with supportive care. Neurological status of the child at the age of 8 days described the child as oriented, without tone disorder, rolled to the side, attracted during traction.

On brain ultrasound at the same age, multiple cystic changes in both cerebral hemispheres were found, predominantly in the left hemisphere, cerebral ventricles were wider but without width progression since insertion of the ventriculoperitoneal shunt, third ventricle measuring up to 12 mm, with hyperechogenic areas present at the base of the ventricles. (Fig. No. 4)

DISCUSSION

Intracranial fetal bleeding is a rare fetal event. Intracranial hemorrhage grading corresponds to grading of neonatal hemorrhage. Grade I means subependymal bleeding, bleeding into the germinal matrix. Grade II means bleeding into the lateral ventricles without their dilatation. In grade III, there is intraventricular bleeding associated with ventricular dilatation. In grade IV, the blood already spread to the brain parenchyma. (Putbrese & Kennedy, 2017) Sonographic findings in ICH are nonspecific. Ventriculomegaly is associated with several pathological processes. The presence of a hyperechogenic mass may indicate the presence of a tumor as well as a thrombus. Identification of a porencephalic cyst can

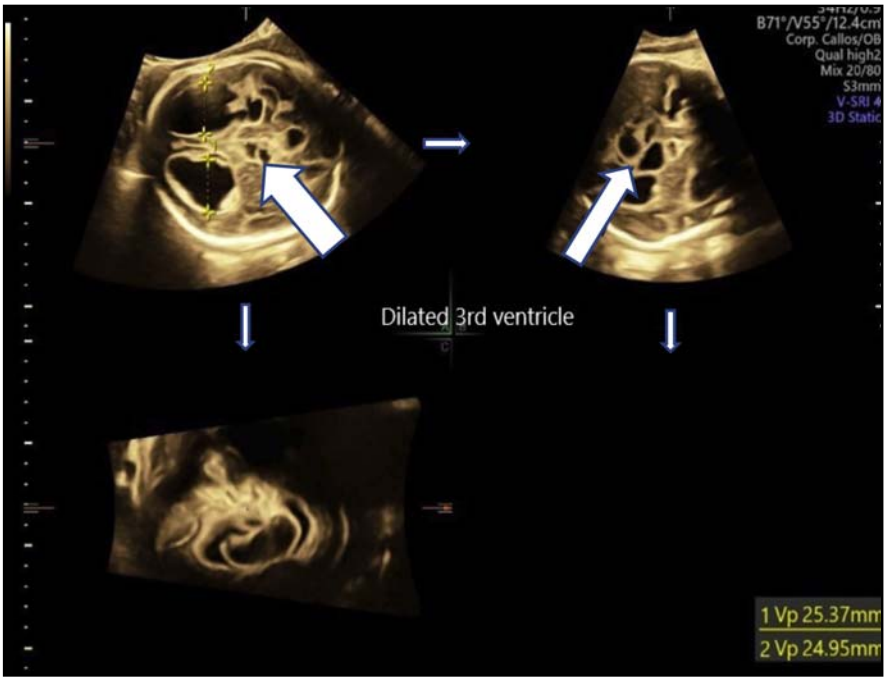

Fig. 1. Multiplanar 3D imaging with lateral and third ventricle ventriculomegaly and periventricular hyperechogenicity.

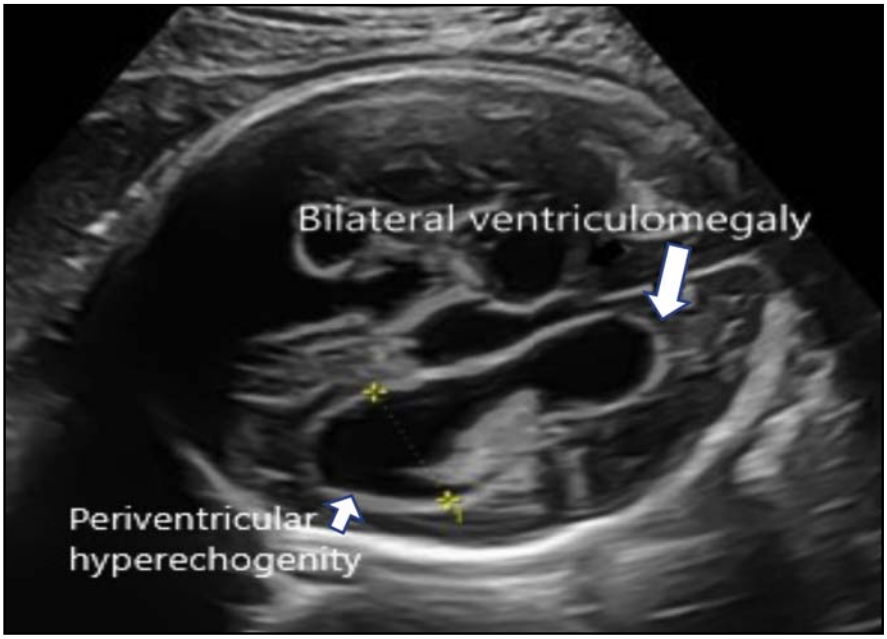

Fig. 2. 2D visualization with detection of severe bilateral ventriculomegaly and third ventricle dilatation

be the result of ICH, but also of destructive processes such as infections or the effects of toxins. The differential diagnosis of these findings is relatively broad. ICH causes intracranial hypertension with a further negative effect on fetal brain circulation. This can be verified by Doppler measurements of the cerebral arteries. (Yoshizuka at al, 2018)

By measuring the flow parameters in the middle cerebral artery, it is possible to quantify several pathological fetal processes. Increased fetal brain flow is a marker of hypoxia, which can be confirmed by a decrease in the pulsative index in MCA. However, any antegrade flow is a feature of functional autoregulatory mechanisms and thus sustainable cerebral hemodynamics. Cerebral autoregulation is a homeostatic process that maintains a constant flow through the brain independent of pressure changes. The primary site of cerebral flow autoregulation are traditonally considered mechanisms involving pericytes. The cells make up the blood barrier, are with contact with endothelial cells and are contractile. As the pregnancy progresses, metabolic demands increases with elevation of cerebrovascular diastolic flow. Steady decline in cerebrovascular resistance coincides with rapid fetal brain development, but remains at higher resistance that tat found in the umbilical arteries. (Leon, et. al. 2022) Any loss of antegrade flow in the MCA is a serious indicator of critically impaired brain circulation. (Armstead, 2016) Such a prenatal sonographic finding has rarely been described in the literature. It is associated with pathophysiological processes such as severe anemia, intracranial hemorrhage, hepatic disorders, severe intrauterine growth restriction. (Brownfoot *et al.* 2015, Hirshberg *et al.* 2013, Kawakita *et al.* 2013) Diagnosis of MCA-REDF requires its repeated detection while adhering to the technical attributes of the measurement. Most

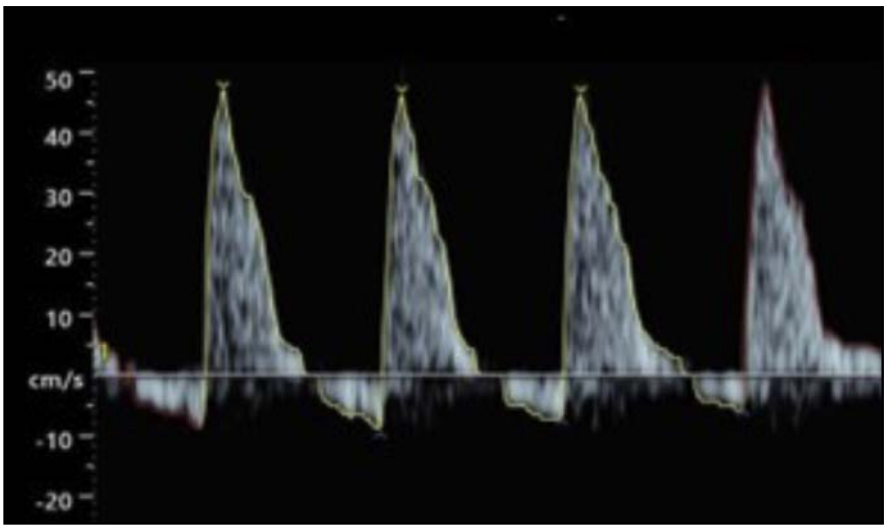

Fig. 3. Doppler examination of the middle cerebral artery with presence of reverse flow

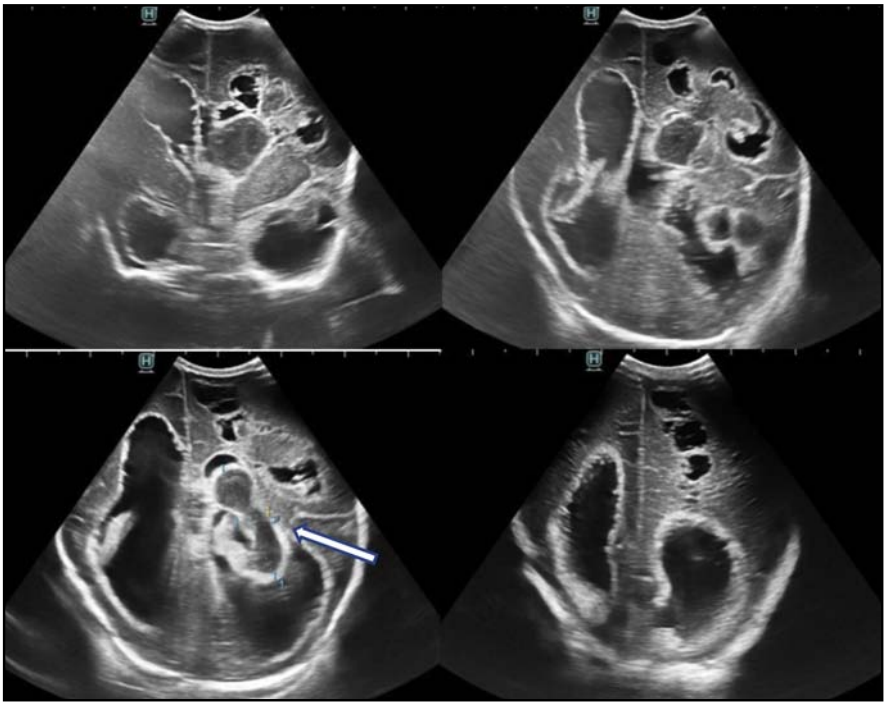

Fig. 4. Neurosonographic postnatal examination on the 8th day after delivery, frontal sections of the right and left lateral ventricles, with a marked hyperechogenic rim, with coagulum and numerous porencephalic cysts in the left hemisphere

commonly it is caused by excessive transducer probe pressure. After readjustment of the probe it quickly resolves. (Respondek *et al.* 1997) The continual presence of MCA-REDF confirms a progressive expansive process leading to fetal intracranial hypertension. The coexistence of non-specific sonographic findings and MCA-REDF led in our case to a preliminary diagnosis of intracranial hemorrhage but also verified critically impaired circulation.

Detection of persistent MCA-REDF increases the risk of very severe postnatal prognosis and intrauterine fetal death. (Brownfoot *et al.* 2015) Similarly, the prognosis of neonates with confirmed reverse flow in MCA is too significantly impaired. (Venkatesh *et al.* 2020) This ominious sign shows critically impaired circulation with loss of antegrade flow and so loss of autoregulation mechanisms.

CONCLUSION

In our case, MCA-REDF was diagnosed by finding non-specific sonographic changes in the fetal brain. The described sonographic findings may be associated with other pathological processes of the central nervous system. It was the finding of MCA-REDF with TORCH negativity and normal peak systolic velocity in MCA that narrowed the diagnostic selection to intracranial hemorrhage. The loss of antegrade flow in the MCA was probably due to increased intracranial pressure that was due to intracranial hemorrhage. Retrograde flow in MCA also indicates markedly deteriorating circulatory conditions in the fetal brain, loss of autoregulatory mechanisms, and critical damage to the vascular supply to the brain.

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