

Accurate neurosonographic prediction of brain injury in the surviving fetus after the death of a monochorionic cotwin

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ABSTRACT

Objective To assess the feasibility of the prenatal diagnosis using fetal neurosonography of brain injuries in the surviving fetus after the demise of a monochorionic cotwin.

Methods This was a retrospective observational study in the period 1990–2004 of monochorionic twin pregnancies with a single fetal demise. A detailed sonographic evaluation of the intracranial anatomy of the surviving twin had been performed whenever possible using a multiplanar approach and from 1999, fetal magnetic resonance imaging was offered as well. Postnatal follow-up was obtained in all cases.

Results In six of nine cases, abnormal neurosonographic findings were identified including intracranial hemorrhage, brain atrophy, porencephaly and periventricular echogenicities evolving into polymicrogyria. Prenatal diagnosis of brain lesions was confirmed postnatally and all affected infants who survived had severe neurological sequelae. Two fetuses had normal cerebral structures both on the prenatal neurosonogram and on postnatal imaging and were following normal developmental milestones, one at 1 and the other at 5 years of age. In one case the neurosonographic examination was suboptimal and the infant was found at birth to have a porencephalic cyst. Fetal magnetic resonance imaging was performed in two cases and confirmed the ultrasound diagnosis.

Conclusions Prenatal neurosonography is a valuable tool for the prediction of neurological outcome in fetuses surviving after the intrauterine death of a monochorionic cotwin. Although our experience is limited, we suggest that magnetic resonance imaging should also be offered. Copyright © 2006 ISUOG. Published by John Wiley & Sons, Ltd.

INTRODUCTION

The intrauterine death of one twin in monochorionic twin pregnancies is associated with increased risk of perinatal mortality and long-term morbidity for the surviving fetus, with perinatal loss in up to 40% of cases and intracranial lesions at birth in up to 46% of survivors^{1–3}. The cause of damage is probably acute blood loss into the vascular system of the dying twin through placental anastomoses just before or at the time of death, leading to varying degrees of acute anemia and hypovolemia in the survivor^{2–4}.

Fetal neurosonography is a well-established tool for the assessment of brain lesions with different etiologies^{5–8}. The aim of our study was to assess the feasibility of this technique for the diagnosis of the cerebral injuries associated with intrauterine demise of one fetus in monochorionic twins.

METHODS

We reviewed retrospectively the archives of our ultrasound laboratory in the period 1990–2004 for cases of monochorionic twins with a single fetal demise. A detailed evaluation of the intracranial anatomy of the surviving twin had been performed whenever possible using a multiplanar approach as previously suggested⁹. When permitted by a low position of the fetal head, the examination was performed transvaginally using 5–10-MHz transducers. The diagnosis of twin–twin transfusion syndrome was based upon criteria suggested in previous reports¹⁰. Starting from 1999, fetal magnetic resonance imaging (MRI) was offered to the patients in addition to neurosonography. During the period of this study, MRI was being scheduled at 30–34 weeks to better evaluate

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cortical development. Postnatal follow-up was obtained in all cases by reviewing medical records and/or telephone interviews with the physicians and/or parents of the affected infants.

RESULTS

We identified 12 cases in the period 1990–2004 of monochorionic twin pregnancies with a single fetal demise. Three cases were excluded because delivery was expedited soon after the death of the cotwin and neurosonography of the surviving fetus was not performed. For the remaining nine cases, the gestational age at the time of diagnosis of intrauterine death ranged between 20 and 28 gestational weeks. Six cases were associated with twin–twin transfusion syndrome, one with multiple anomalies and in two we failed to identify the etiology for the intrauterine death. The main clinical data of the pregnancies are summarized in Table 1. Three of these cases have been reported previously^{5,6}.

In one case neurosonography was performed with suboptimal results because the position of the surviving fetus was unfavorable. Only transabdominal axial scans of low quality were obtained. The surviving infant was diagnosed with a porencephalic cyst at birth. At 6 years the intelligence of this infant was normal, but a severe motor deficit was present.

In six of the remaining eight cases neurosonography disclosed abnormal findings, including one case each of porencephaly, subdural hematoma, Grade IV hemorrhage, brain atrophy (Figure 1), unilateral hyperechogenicity evolving into multicystic encephalomalacia (Figure 2), and bilateral hyperechogenicity of the parietal lobes evolving into polymicrogyria and microcephaly (Figure 3). Four pregnancies were terminated at the request of the parents. In three of these cases an autopsy

was performed which confirmed the prenatal diagnosis. In the two remaining pregnancies with brain lesions on the neurosonogram, the parents opted to continue the pregnancy. The prenatal diagnosis of cerebral injury was confirmed at birth and both infants had severe neurological sequelae. The fetus with Grade IV hemorrhage diagnosed at 24 weeks developed severe hydrocephalus requiring a ventricular shunt after birth. The surviving twin with periventricular diffuse echogenicities evolving into a cortical abnormality (Figure 3) was delivered at 31 weeks because of severe growth restriction with absent end-diastolic velocities in the umbilical artery. At 2 years of age the infant was affected by severe neurodevelopmental delay and cerebral palsy.

Two fetuses had normal cerebral structures on the prenatal neurosonogram, which was confirmed postnatally by both sonography and MRI; these were following normal developmental milestones at 1 and 5 years of age.

Intrauterine MRI was performed in two fetuses, one with sonographic evidence of brain lesions (Figure 3) and one with a normal sonogram at 31 and 35 weeks, and this confirmed the sonographic findings.

Overall, brain injuries were present in seven of nine fetuses. In one of the six cases that were diagnosed prenatally the patient was first seen only after the death of the cotwin. Of the remaining five cases, in two the abnormal findings were identified within 1 day from the death of the cotwin (in one of these cases a few hours before the disappearance of cardiac activity), while in three they appeared only after 1–2 weeks.

DISCUSSION

In 1990 Fusi and Gordon¹ reported that the neurological damage in fetuses surviving after the death of a

Table 1 Main clinical data and sonographic diagnosis in nine monozygotic twin pregnancies with a single fetal death

Case	GA at diagnosis (weeks)	Clinical findings	Prenatal neurosonogram	Outcome of surviving fetus
1	24	Twin transfusion	Cerebral atrophy, porencephaly*	Termination of pregnancy
2	27	Twin transfusion	Normal†	Delivery at 34 weeks, normal at 5 years
3	20	None	Cerebral atrophy‡	Termination of pregnancy
4	21	Twin transfusion	Hyperechogenicity, multicystic encephalomalacia§	Termination of pregnancy
5	20	None	Subdural hematoma*	Termination of pregnancy
6	28	Multiple anomalies and selective growth restriction in dead twin	Suboptimal due to fetal position	Porencephalic cyst, normal intelligence, motor ability deficit at 6 years
7	24	Twin transfusion	Grade IV hemorrhage§	Delivery at 34 weeks, severe hydrocephalus, shunt
8	27	Twin transfusion	Normal	Delivery at 35 weeks, normal at 1 year
9	24	Twin transfusion	Hyperechogenicity of the cortex, microcephaly*†	Growth restriction, delivery at 31 weeks, polymicrogyria, microcephaly, severe developmental delay and cerebral palsy at 2 years

Cases 1, 5 and 7 have been reported previously^{5,6}. *Brain lesions appeared 1–2 weeks after the demise. †Fetal magnetic resonance imaging was performed and confirmed the neurosonographic diagnosis. ‡Interval between death and sonographic demonstration of brain lesions unknown. §Brain lesions appeared within 1 day from the demise. GA, gestational age.



Figure 1 Case 3. (a) Transabdominal sonogram of the surviving twin obtained along the axial plane showing increased echogenicity and thinning of the cerebral cortex with increased extracerebral fluid (arrows). (b) Transvaginal coronal sonogram; as biometry of the fetal head was within normal limits, the increased amount of fluid into the cisterns above the cerebral convexity and the small volume of the cortex suggest complete cerebral collapse presumably secondary to an acute hypoxic event. Echogenic spots are sparse in the cortex. The dead fetus is also visible. (c) Transvaginal oblique scan confirming the very thin parietal and occipital cortex (arrow).



Figure 2 Case 4. (a, b) In this pregnancy complicated by severe twin–twin transfusion soon after the first amniocentesis, a hyperechogenic area (arrow) was noted within the cortex of the recipient twin; the donor twin died the night following the procedure. (c) Ten days later, multiple cystic areas were seen bilaterally in the subcortical cerebral parenchyma (arrows) suggesting multicystic encephalomalacia, which was confirmed after termination of the pregnancy.

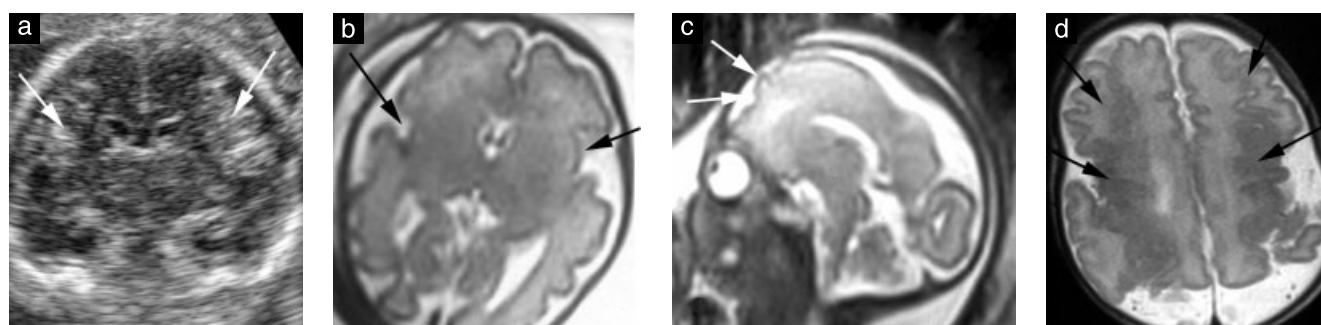


Figure 3 Case 9. (a) Transabdominal coronal sonogram of the brain of the surviving twin 1 week after the death of the cotwin demonstrates bilateral hyperechogenicity of the parietal cortex (arrows). (b, c) Magnetic resonance imaging at 30 weeks' gestation: the sylvian fossa is widely open, and the contour of the frontal lobe is irregular with the impression of a reduction in the thickness of the underlying white matter (arrows). (d) Magnetic resonance obtained after birth demonstrates polymicrogyria with thickening of the cortical plate and an irregular demarcation line between the white and gray matter (arrows).

monochorionic twin could not be predicted prenatally. Similar to one previous report¹¹ our experience does suggest, however, that early sonographic diagnosis *in utero* is possible.

We believe that the most interesting aspect of our experience is the high degree of accuracy of fetal neurosonography in the prediction of brain injuries in the

surviving cotwin. The brain examination was performed successfully in all but one of the cases in which it was attempted, and was proved correct by postnatal follow-up examinations. Demonstration of abnormal cerebral findings was associated with severe cerebral lesions and adverse outcome. Conversely, a normal brain scan was associated with a good outcome.

The ultrasound appearance of the brain lesions was variable, and included both hemorrhagic and hypoxic-ischemic lesions. Similar to another recent case, hyperechogenicity of the cerebral cortex was the harbinger of the subsequent development of a cortical abnormality, polymicrogyria¹². There was frequently a latency between the time of fetal death and the development of abnormal sonographic findings in the survivor. In three of our cases the lesions were established only after 1–2 weeks from the death of the cotwin.

In our series the frequency of cerebral lesions was particularly high (7/9 fetuses surviving the death of the cotwin). This may be due to the inclusion of many cases with twin–twin transfusion syndrome, a condition which is characterized by large placental anastomoses between the two fetal circulations and by unstable hemodynamics, which probably predispose to acute blood transfusion.

We acknowledge that our study had several limitations. The number of cases was relatively small, the cerebral lesions were in general very severe, and only a few cases were evaluated with fetal MRI. Our experience does not allow us to establish clearly the best time for scanning the brain of the surviving twin. However, in several cases brain lesions were detected within hours after the death of the cotwin and in all cases they were obvious by 2 weeks. This correlates well with postnatal neurosonographic studies of infants with severe hypoxic-ischemic insults¹³. We suggest, therefore, that a scan may be performed as soon as the death of the cotwin is recognized, but that a follow-up examination should be scheduled 2 weeks later.

Similarly, more experience is needed to establish whether MRI should be performed in all cases, and when. The relative value of fetal expert neurosonography and MRI is currently under debate^{14,15}. The prenatal diagnosis of intracranial hemorrhage with ultrasound is well established and although the interpretation of the findings is not always immediate, ultrasound is usually accurate⁶. Experience with the prenatal diagnosis of ischemic lesions that are not associated with hemorrhage is more limited. Postnatal studies do suggest that in such cases not only is MRI more accurate but it also allows a much earlier diagnosis of hypoxic-ischemic lesions than does ultrasound¹⁶. Indeed, in one of our cases, a brain lesion was suspected on ultrasound but MRI provided a better demonstration of the severe cortical abnormality. At present, we agree with others that MRI is advisable in the setting of single fetal death in monochorionic twins^{12,17}. The optimal time to perform the MRI is uncertain. The period between 30 and 34 weeks is probably ideal to evaluate cortical development, which is frequently affected in fetuses surviving after the death of a cotwin^{12,17}. This would seem particularly convenient in countries where late termination of pregnancy is possible.

Management of monochorionic pregnancies after a single fetal death is controversial, and the interested reader is referred to specific studies on this subject^{18,19}.

Our experience confirms that brain lesions are established immediately after or even before fetal death and suggests it is unlikely that there is any benefit from anticipation of delivery.

In conclusion, prenatal neurosonography is a valuable tool for the prediction of the neurological outcome in fetuses surviving after the intrauterine death of a monochorionic cotwin. Although our experience is limited, we suggest that MRI should also be offered.

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