Original Article

Cranial Magnetic Resonance Imaging Examination of Normal Term Neonates: A Pilot Study

Kenton R. Holden, MD; M. Olivia Titus, BA; Pamela Van Tassel, MD

ABSTRACT

This pilot study's aim was to determine, using magnetic resonance imaging (MRI), if and to what extent asymptomatic intracranial hemorrhage occurs in normal term neonates after uncomplicated vaginal deliveries. Eight normal, term, vaginally delivered infants and three cesarean-section deliveries used as controls underwent cranial MRI. No sedation was administered. Small subdural hematomas of the falx cerebri or tentorium cerebelli were found in half of those with an uneventful vaginal delivery. Pediatric follow-up, on average 3.9 years after the MRI study was performed, demonstrated normal growth and development. It appears that more data is needed to confirm the observation that the intracranial hemorrhages described should not be considered the etiology for neurologic abnormalities present in symptomatic neonates. (*J Child Neurol* 1999;14:708–710).

Intracranial hemorrhage is a leading cause of neurologic problems in neonates. Subdural hemorrhage is most frequently found in term infants secondary to perinatal trauma.[1] Perinatal trauma is associated with large infant size, precipitous or prolonged labor, difficult extraction, or fetal malpresentation. The clinical consequences of subdural hematomas vary depending on location and size, causing nonspecific irritability, seizures, focal neurologic deficit, and even death.[1] Imaging is commonly used to investigate an etiology for clinical findings. If hemorrhage is noted it is frequently cited as the cause of the neurologic abnormality. However, the incidence of subclinical intracranial hemorrhage in the normal term neonate as a consequence of passing through the birth canal is not known. This pilot study was designed to help clarify the incidence, extent, and clinical significance of intracranial hemorrhage found by magnetic resonance imaging (MRI) of asymptomatic, term neonates following normal vaginal deliveries.

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From the Departments of Neurology, Division of Pediatric Neurology (Dr Holden and Ms Titus) and Radiology (Dr Van Tassel), Medical University of South Carolina, Charleston, SC.

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Address correspondence to Dr Kenton R. Holden, PO Box 959, Charleston, SC 29402. Tel: 843-792-3307; fax: 843-792-3220.

METHODS

Eligible patients were normal term infants of normal primigravida mothers (between 15 and 36 years of age) with a gestational age between 36 and 42 weeks by obstetric estimate, born at an urban university medical center, and without history of maternal obstetric or intrapartum complications. All vaginal deliveries had to be cephalic presentation; augmentation with oxytocin was allowed. No forceps, vacuum, or other instrumentation was used. Elective cesarean-section deliveries were used as controls. Initial hospital physical and neurologic examinations of the infants performed by neonatologists were normal. Following investigational review board approval and parental consent, all infants were enrolled and scanned during the first 4 days of life, most on the second day. Infants were selected in a consecutive, nonrandomized fashion consistent with a case-series, observational clinical trial.

No sedative agents or other pharmacologic intervention was administered to the neonates for the MRI study. The infants were fed prior to the MRI in the usual fashion and the scan was performed soon after the feeding to take advantage of postprandial drowsiness. MRI was used because it is more sensitive for the detection of small amounts of hemorrhage[2] and does not use ionizing radiation as does computed tomography (CT).

The scans were performed on a GE Signa 1.5-Telsa scanner. In each subject, three MRI pulse sequences were performed for evaluation of the anatomy of the intracranial contents and for maximum sensitivity to edema and blood products. These sequences were (1) sagittal T_1-weighted spin echo, (2) axial T_2-weighted fast spin echo, and (3) axial T_2^*-weighted gradient echo images. Soft foam rubber sponges were placed at the sides of the infants' heads to

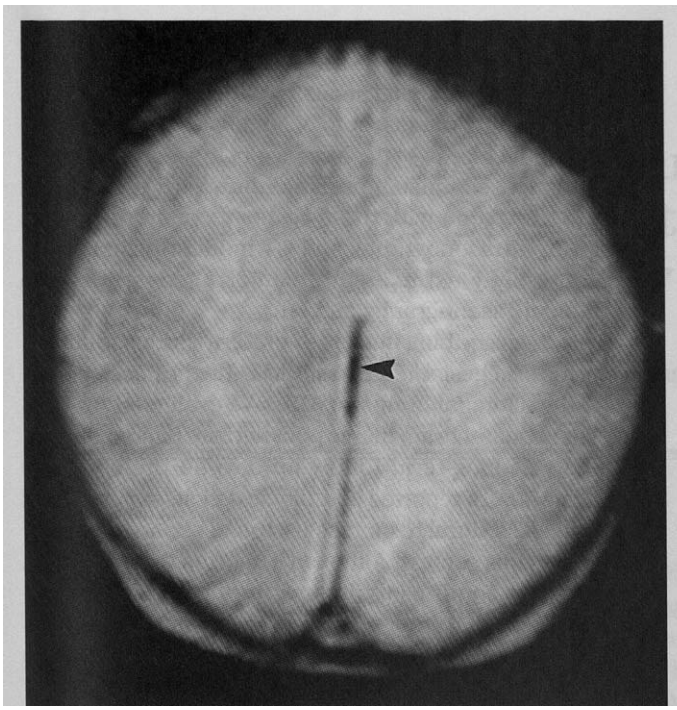

Figure 1. Axial gradient echo T_2^*-weighted image shows focal hypointensity along the midportion of the falx (arrowhead), consistent with a nondisplacing collection of subdural blood.

Figure 2. Axial T_2^*-weighted gradient echo image shows asymmetric irregular thickening and hypointensity of the left side of the tentorial notch (arrowhead), indicating a subdural hematoma.

muffle the noise from the rapid switching of the gradient coils and to minimize head motion. The MRI scanning required the infants to be in the scanner for 15 to 20 minutes.

Long-term follow-up information about the participants was obtained during telephone interviews with the patients' parents and medical caregivers and the responses were evaluated for any suggestion of neurodevelopmental problems. Medical follow-up was offered and available for any significant concerns.

RESULTS

MRI revealed abnormal intracranial findings in four of eight vaginally delivered infants and in none of the three cesarean-sectioned infants. Extra-axial hemorrhages along the falx occurred in three infants, one of which is shown in Figure 1, and around the tentorial notch in one infant (Figure 2), best seen on T_2^*-weighted gradient echo images. These hemorrhages were consistent with small subdural hematomas and were not associated with any mass effect. No subdural hemorrhage was seen over the cerebral convexities and no parenchymal brain hemorrhages were identified. Incidental findings included small bilateral parietal subgaleal fluid collections in six of the eight vaginally delivered infants and head moldings in seven of the same eight infants.

MRI quality in the unsedated infants was satisfactory overall. Mild motion artifacts occurred in scans of 4 of the 11 neonates, and is evident in Figure 1. Severe artifact was seen in one case. No infants were unable to be imaged because of lack of sedation. There was no change in the clinical status of the infants during the imaging and their nursery discharge examinations were normal.

There were eight female and three male term neonates, nine black and two white. Mean birthweight was 3078 grams, length 49.7 cm, and head circumference 32.9 cm. All Apgar scores were normal with a mean 1-minute score of 8.7 and a 5-minute score of 9.1. Their mothers demonstrated normal intelligence and appropriate educational levels with a mean age of 19.2 years and mean gestational age of 38.6 weeks. Labors had a mean duration of 8.3 hours with less than 24 hours of ruptured membranes (mean, 7.0 hours).

The low patient population was the result of difficulties in patient recruitment, in part secondary to the strict criteria for inclusion in the study. All potential study neonates had to be delivered to primigravida mothers who were without any significant past medical history or complications during their pregnancy. In addition, the neonates had to have normal spontaneous vaginal deliveries uncomplicated by assistance with vacuum, forceps, or cesarean section. Inherent difficulties in obtaining permission from parents to allow their normal neonates to undergo MRI scans also contributed to the small patient sample.

Follow-up information obtained from the parents and medical caregivers of seven vaginally delivered infants and one cesarean-sectioned infant (73% total follow-up) on average 3.9 years after their MRI scans demonstrated normal child growth (height, weight, and head circumference) and

general psychomotor development. The participants not interviewed were lost to follow-up, including one of the normal, vaginally delivered newborns with an intracranial hemorrhage along the falx as seen on MRI scan.

DISCUSSION

Evidence suggests that spontaneous vaginal deliveries can be traumatic to the normal term newborn. Retinal hemorrhages have been observed in 20% to 40% of newborns without obvious perinatal difficulties or neurologic injury, and a relationship to vaginal deliveries is apparent.[1] Although the absence of red cells is considered normal, a mean of 120 red cells/μL has been reported after examination of cerebrospinal fluid of term newborns.[3] Although cranial molding is viewed as a natural part of parturition, excessive molding appears to create shearing forces on the tentorium cerebelli and falx cerebri leading to tearing of the dural structures and vein lacerations.[4]

Koch et al[5] reported that intrapartum and obstetric complications causing intracranial hemorrhage led to significant depression at birth and a spectrum of neurologic presentations including irritability, hypotonia, and seizures. Cartwright et al[6] used CT scans to demonstrate the presence of intracranial hemorrhage in term neonates. They concluded that term infants with a diagnosis of intracranial hemorrhage who had had nontraumatic deliveries, present with seizures, and survive.

In 1980, Ludwig et al[7] investigated the frequency of intracranial hemorrhage in full-term neonates using CT imaging. Their newborn population, drawn from two hospitals, included 33 term neonates determined to be normal at initial clinical examination, and 117 term neonates with slight or severe clinical findings including gross neurologic signs. CT scans demonstrated subdural hematomas in 27 of 150 term newborns. On repeat clinical and neurologic examinations after the CT scan, only 2 of 27 term newborns with subdural bleeding were normal. They concluded that clinically silent hemorrhage was rare. Our pilot study identified small falcine and tentorial hematomas in four of eight asymptomatic, vaginally delivered, term neonates of primigravida mothers. These neonates continued to have a normal neonatal course, as well as subsequent normal growth and development.

The examination of full-term newborns by CT in the study by Ludwig et al[7] was accomplished by sedation of the newborns with chloral hydrate. Our investigation showed that it is possible to perform successful modified cranial MRI on unsedated postprandial neonates with limited sequences and incorporating the fast spin echo pulse sequence in the protocol. Avoidance of both pharmacologic sedation and ionizing radiation eliminates possible untoward effects that could be associated with these agents. In addition, MRI is superior to ultrasonography and CT in identifying hemorrhage, especially extracerebral hemorrhages, which are missed on ultrasonography and CT.[2]

Reports describing images of preterm brains followed serially to term gestation characterize the normal appearance of the neonatal brain on MRI.[8] We evaluated the normal term neonatal brain in our pilot series of neonates and obtained 73% long-term follow-up beyond the newborn period. The lack of reported neurologic deficits suggests that the neonatal subdural hemorrhages found are not clinically significant in this context. Although it appears that more data is necessary to confirm our findings, we propose that there could be alternative etiologies to explain neurologic abnormalities in symptomatic, vaginally delivered term neonates other than their intracranial hemorrhage as seen on MRI.

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