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ORIGINAL RESEARCH
Neonatology

Benefits of adding a routine mastoid fontanel approach to anterior transfontanel ultrasonography in newborns

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ABSTRACT

Objective: We aimed to share the usefulness of adding mastoid fontanelle cranial ultrasonography (MF-CUS) to routine anterior fontanelle US examinations in our neonatal intensive care unit.

Material and Methods: A total of 2400 newborn patients with a gestational age of 28–40 weeks who were hospitalized in the neonatal intensive care unit of our hospital between January 2020 and January 2023 were included in this study. In all patients, US was performed from the anterior fontanelle, and the results were recorded. Then, sonographic evaluation of the mastoid fontanelle was performed blindly. Control MRI was performed in 8 patients. Thus, the contribution of the mastoid fontanelle to the diagnosis was evaluated.

Results: In 48 patients, there were pathological findings that could not be detected by US with an anterior fontanelle approach. The following findings were discovered in the mastoid fontanel US examination performed on the same patients with a blind eye: dilatation and hemorrhagic material in the lateral ventricular occipital horn in 15 patients, isolated cerebellar vermis hypoplasia in 12 patients, cerebellar hematoma in 9 patients, cerebellopontine hypoplasia in 3 patients, fourth ventricular hemorrhage in 3 patients, transverse sinus thrombosis in 1 patient, cerebellar hemispheric hypoplasia in 1 patient, Dandy-Walker malformation in 1 patient, mega cisterna magna in 1 patient, cerebellar vermis hypoplasia (Walker-Warburg syndrome) in 1 patient, and subdural collection in 1 patient. In 8 patients, the findings were checked with MRI.

Conclusion: US examination with only an anterior fontanel approach is insufficient in the evaluation of the posterior fossa, especially in the detection of congenital malformations and cerebellar injuries. Therefore, adding a mastoid fontanel approach to routine transfontanelle US examinations provides important contributions to the diagnosis.

Keywords: Mastoid fontanelle; posterior fossa; newborn; ultrasonography.

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Yenidoğanda anterior fontanel ultrasonografi incelemelerinde rutin mastoid fontanel değerlendirmenin faydaları

ÖZET

Amaç: Yenidoğan yoğun bakım ünitesinde yapılan rutin ön fontanel US tetkiklerine mastoid fontanel kranial ultrasonografi (MF-CUS) incelemesinin de eklenmesinin faydalarını sunmayı amaçladık.

Gereç ve Yöntemler: Ocak 2020–Ocak 2023 tarihleri arasında hastanemiz yenidoğan yoğun bakım ünitesinde yatan gestasyonel yaşı 28–40 hafta aralığında olan toplam 2400 yenidoğan hasta çalışmaya dahil edildi. Tüm hastalara ön fontanelden US yapıldı ve sonuçlar kaydedildi. Daha sonra aynı hastalar kör olarak mastoid fontanel yaklaşımla transfontanel US ile değerlendirildi. Gerekli hastalara kontrol MRG yapıldı. Böylece rutin incelemelerde mastoid fontanel yaklaşımının tanıya katkısı araştırıldı.

Bulgular: Toplamda bakılan 2400 hastanın 48 tanesinde anterior fontanelden yapılan US inceleme ile tespit edilemeyen ancak mastoid fontanelle bakıda tespit edilebilen patolojik bulgular mevcuttu. Mastoid fontanel US ile bu hastaların 15 tanesinde lateral ventriküler oksipital hornunda dilatasyon ve hemorajik materyal, 12 tanesinde izole serebellar vermis hipoplazisi, 9 tanesinde serebellar hematom, 3 tanesinde serebellopontin hipoplazi, 3 tanesinde 4. ventrikül içinde hemorajik materyal, 1 tanesinde transvers sinüs trombozu, 1 tanesinde serebellar hemisferik hipoplazi, 1 tanesinde Dandy walker malformasyonu, 1 tanesinde mega sisterna magna, 1 tanesinde serebeller vermis hipoplazisi (Walker Walburg Syndrome) ve 1 tanesinde subdural koleksiyon saptandı. Bunlardan 8 hastada bulgular MRG ile kontrol edildi.

Tartışma: Başta konjenital malformasyonların ve serebeller hemorajilerin tespiti olmak üzere sadece posterior fossa değerlendirmesinde anterior fontanel yaklaşımla yapılan US incelemeleri yetersiz kalmaktadır. Bu nedenle rutin transfontanel US incelemelerine mastoid fontanel yaklaşım ile değerlendirmesinin de eklenmesi tanıya önemli katkılar sağlamaktadır.

Anahtar Kelimeler: Mastoid fontanel; posterior fossa; ultrasonografi; yenidoğan.

INTRODUCTION

Cranial ultrasonography (CUS) is a safe and first-line imaging method that does not involve ionizing radiation, as in computed tomography (CT), for brain imaging in the neonatal period. It is a practical method, especially in neonatal intensive care units since it can be applied at the bedside and provides real-time images. Also, it is a more practical imaging method than magnetic resonance imaging (MRI), which is more expensive, requires patient transport, and sometimes sedation (1).

Anterior fontanelle (AF) imaging is the main method of routine neonatal CUS. Although supratentorial structures can be evaluated more easily and better with this approach, there are limitations in imaging the posterior fossa due to the large distance between the probe and the examination area. Sonographic evaluations using the posterior fontanelle and mastoid fontanelle (MF) can contribute greatly to the diagnosis. For an experienced sonographer, this requires only a few minutes of additional scanning time.

The posterior fossa cannot be evaluated adequately only from the anterior fontanelle. Especially in term babies, probe insufficiency becomes more evident since the area to be examined is larger, and the fontanelle is narrower compared to premature babies.

Two types of probes are used in transcranial US examination. Although we can evaluate deep distances with lower transducer frequencies, detailed imaging can only be done with higher transducer frequencies. It is not possible to clearly evaluate the posterior fossa with superficial probes placed in the anterior fontanel. Therefore, the anatomical structures of the posterior fossa can be examined in more detail since the distance is reduced in the examination performed with the linear probe through the mastoid window.

MF is located at the junction of the temporal, occipital, and posterior parietal bones (2–4). High-frequency probes are placed closer to the posterior fossa when using the MF as the viewing window. Thus, as the resolution increases, it provides a more advanced viewing opportunity (5). The mastoid fontanel is useful in evaluating the midbrain, perimesencephalic area, basal cisterns, and infratentorial area. The formations in the posterior fossa from the mastoid fontanelle can be evaluated more closely and with a better angle. Thus, artifacts related to the tentorium, which has a highly echogenic structure, are excluded (6). Examinations from the posterior and mastoid fontanelle are useful in detecting clots extending into the occipital horns in the lateral ventricle. In addition, thrombosis can be detected by evaluating the transverse and sigmoid sinuses with color Doppler US. We can also display the Willis polygon with this approach (7).

We aimed to share our results by adding mastoid fontanelle cranial US (MF-CUS), which has many benefits, to routine transfontanelle examinations in our neonatal intensive care unit.

MATERIAL AND METHODS

Between January 2020 and January 2023, a total of 2400 newborn patients, who were hospitalized in the neonatal intensive care unit of our hospital and whose gestational

Table 1. Mastoid fontanelle cranial ultrasonography findings

Mastoid fontanelle US findings	n	%
Dilatation and hemorrhagic material in occipital horn	15	31.3
Isolated cerebellar vermis hypoplasia	12	25
Cerebellar hematoma	9	18.8
Cerebellopontine hypoplasia	3	6.3
Forth ventricular hemorrhage	3	6.3
Transverse sinus thrombosis	1	2.1
Cerebellar hemispheric hypoplasia	1	2.1
Dandy walker malformation	1	2.1
Mega cisterna magna	1	2.1
Cerebellar vermis hypoplasia (Walker Walburg Syndrome)	1	2.1
Subdural collection	1	2.1
Toplam	**48**	**100**

US: Ultrasonography.

age ranged from 28 to 40 weeks, were included in the study. Ultrasonography examinations of all the patients were performed with a portable ultrasonography device (Esaote, Mylab Seven, 201236).

Sonographic evaluations of the anterior fontanelle and mastoid fontanelle were performed while the patients were in the incubator. Both convex (7.5 MHz) and linear probes (13 MHz) were used when evaluating from the anterior fontanelle. Ultrasonography findings from the anterior fontanelle were recorded. A short time later, mastoid fontanel US was performed on the same patients with blind examination, and radiological data were recorded. The data obtained from the examinations made from both fontanelles were compared. Control MRI was performed in necessary patients. Thus, the contribution of the mastoid fontanel approach to the diagnosis was investigated in routine examinations.

In 8 patients, the findings were checked with MRI. All brain MRI scans were performed on a 1.5 Tesla system (Magnetom Avanto; Siemens Healthineers, Erlangen, Germany).

All ultrasonography and MRI examinations were performed by a pediatric radiologist with 16 years of experience.

The study was conducted in accordance with the principles of the Declaration of Helsinki, and all patients gave written informed consent to participate. This study was approved by the Ethics Committee of Ümraniye Hospital (number: 84, date: 21.03.2023)

Statistical Analysis

Statistical analyses were performed using SPSS software version 21. Percentages, medians, and minimum and maximum values were used, where appropriate, to present descriptive statistics.

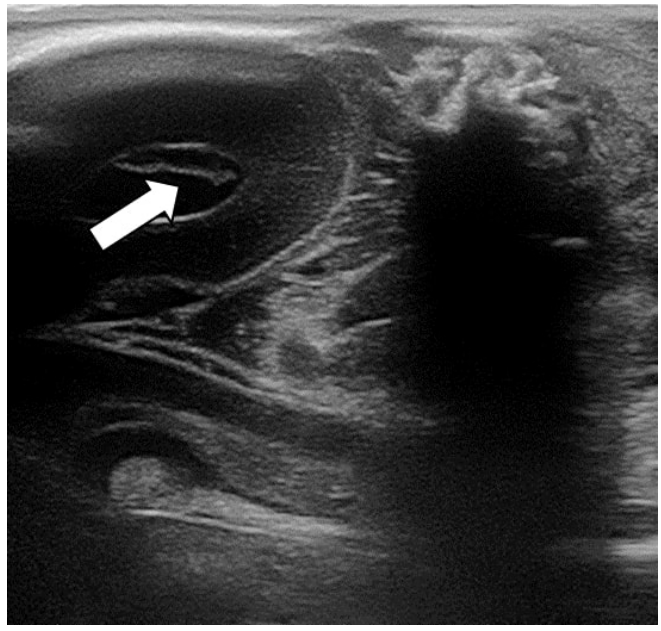

Figure 1. MF-CUS examination of a 34-week-old newborn reveals a dilated occipital horn of the lateral ventricle and echogenicity of hemorrhagic materials within it.

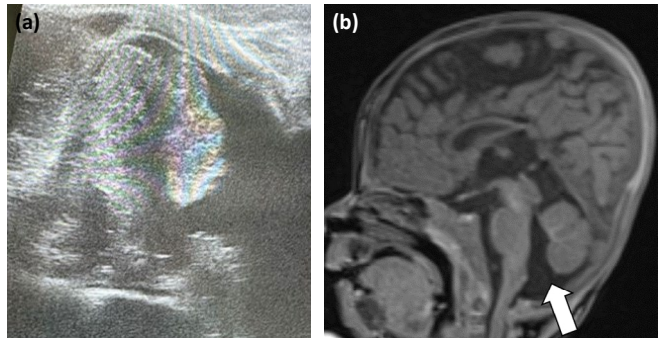

Figure 2. MF-CUS examination of a 32-week-old newborn shows a small gap inferior to the vermis and between the cerebellar hemispheres **(a)**. Sagittal magnetic resonance image in the same patient demonstrating a small gap inferior to the vermis (arrow) identified as 'inferior vermian hypoplasia' **(b)**.

RESULTS

Of the 2400 patients in total, according to their gestational weeks: 450 (18.7%) patients were at 24–32 weeks, 1200 (50%) patients were at 32–36 weeks, and 750 (31.2%) patients were over 36 weeks. The patients were evaluated from both anterior and mastoid fontanelles. Both convex and linear probes were used in the AF approach, and linear probes were used in the MF approach. There were abnormal radiological findings that could not be detected in the anterior fontanelle examination but could be detected by the mastoid fontanel approach in a total of 48 patients, consisting of 20 female and 28 male patients.

Thirty-five (73%) of the 48 patients were in the early preterm group (24–32 weeks). The pathologies of the patients are

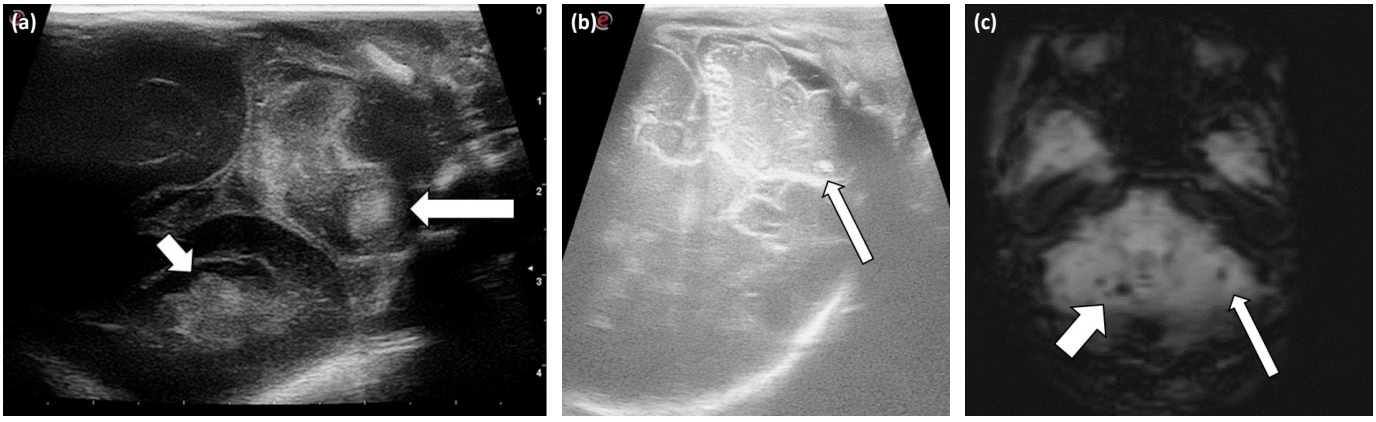

Figure 3. MF-CUS examination of a 28-week-old newborn identifies a left cerebellar parenchymal hematoma (long arrow) and hemorrhagic materials in the occipital horn of the lateral ventricle (short arrow) **(a)**. MF-CUS examination of a 36-week-old newborn shows a left cerebellar parenchymal millimetric hematoma **(b)**. In the same patient, SWI sequence MRI shows signals of millimetric hemorrhages in the other hemisphere in addition to the hematoma observed in MF-CUS **(c)**.

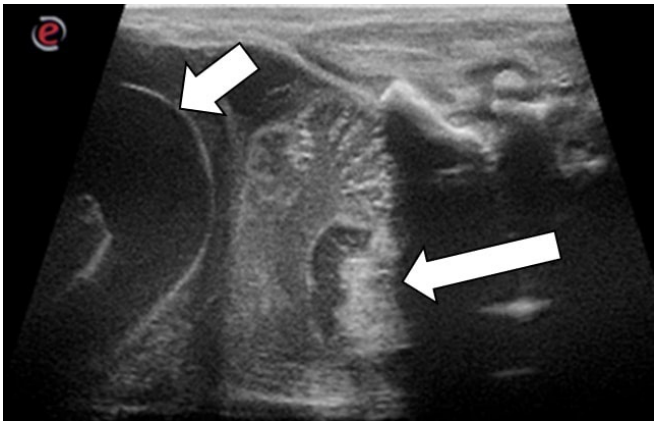

Figure 4. In a 32-week-old newborn, hemorrhagic materials (long arrow) and secondary obstructive hydrocephalus (short arrow) are observed in the 4th ventricle in the MF-CUS examination.

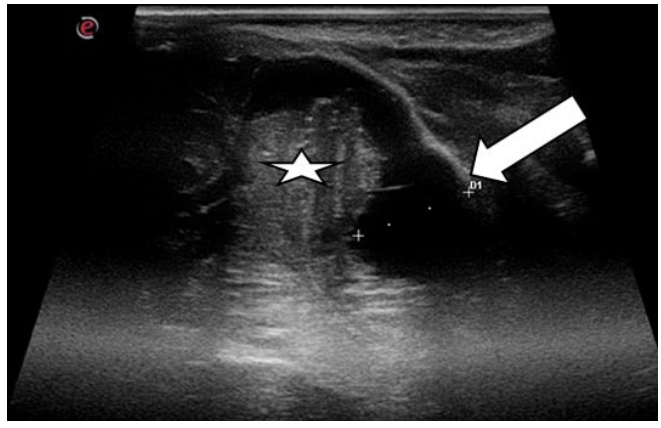

Figure 5. In a 35-week-old newborn, MF-CUS examination shows enlargement of the CSF space in the posterior of the cerebellar hemispheres (star) compatible with mega cisterna magna.

given in Table 1. Accordingly, the most common finding is hemorrhagic materials in the occipital horns of the lateral ventricle (Fig. 1). Apart from this, isolated cerebellar vermis hypoplasia (Fig. 2) and cerebral parenchymal hematoma (Fig. 3) are among the main findings. In the remaining group, cerebellopontine hypoplasia, hemorrhagic material in the 4th ventricle (Fig. 4), transverse sinus thrombosis, cerebellar hemispheric hypoplasia, Dandy-Walker malformation, mega cisterna magna (Fig. 5), cerebellar vermis hypoplasia (Walker-Warburg Syndrome) (Fig. 6), and a subdural collection were detected.

DISCUSSION

MF-CUS is an important window for the evaluation of the posterior fossa and partially occipital lobes and occipital horns of the lateral ventricle. It is useful in detecting congenital anomalies as well as acute findings such as bleeding, cerebellar injury, sinus vein thrombosis, and subdural collections.

In neonatal intensive care units, since CT evaluations involve radiation and MRI examinations are not routinely used in infants with very low birth weight, US evaluations are routinely performed. The main advantages of MF-CUS include being a safe examination that can be performed at the bedside, practical imaging, and requiring only a few minutes of additional scanning time in experienced hands. It provides diagnosis before MRI. In newborns, especially in critically ill patients, MRI may not be performed in the first days after birth. Infants with hemorrhagic materials in cisterna magna and subarachnoid spaces are considered to be at greater risk of developing hydrocephalus. These patients should be followed more closely (8).

Our study shows that adding MF imaging to standard AF-CUS, in parallel with the literature, greatly contributes to early diagnosis in newborns. The power of the MF-CUS is only a few minutes of extra scanning time and detects most major PF abnormalities much earlier than is possible with MRI.

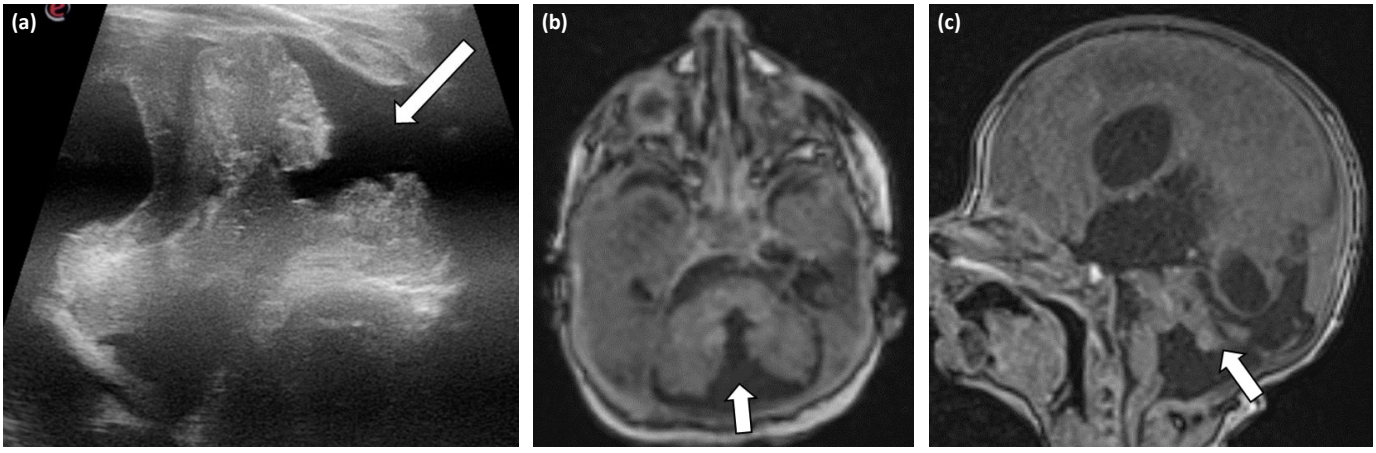

Figure 6. In a 38-week-old newborn, the cerebellar vermis cannot be clearly identified in the MF-CUS examination **(a)**. In the MRI examination of the patient, it is observed that the vermis is severely hypoplastic and angled towards the cranial (**b**, arrow). In this patient with a diagnosis of Walker Warburg syndrome, a kink in the brainstem was noted **(c)**.

Steggerda et al. (9) made comparative evaluations with MRI examinations in their study, and with MF-CUS examination, they were able to detect 82% of posterior fossa anomalies that could not be detected in TF-CUS examination in 113 term newborns.

Leszczyńska et al. (11) evaluated transfontanelle ultrasonography of 1337 newborns from the anterior and posterolateral fontanelles. In 14 of 134 patients with abnormalities, the posterior fossa findings were visualized with a mastoid approach.

Study Limitations and Pitfalls

First of all, it is an operator-dependent examination. Also, scanning artifacts may lead to misinterpretation and false diagnoses. Image quality may be affected by the small size of the MF. The echogenicity of the cerebellar hemispheres may seem asymmetric depending on the angulation and distance to the transducer. Evaluating both mastoid fontanels will improve the performance of MF-CUS in these cases. On images obtained through MFCUS, elevation of the calcar avis, the white matter that protrudes from the medial wall of the occipital horn of the ventricle, may overlap the occipital horns and simulate intraventricular hemorrhage (10). Color Doppler US can help to distinguish normal variants such as calcar avis and lobular choroid plexus. Communication between the 4th ventricle and the cisterna magna can give a false impression of inferior vermian agenesis. To prevent misdiagnosis of vermian hypoplasia in these patients, it is necessary to evaluate with AF or posterior fontanel.

CONCLUSION

Transcranial US examinations are the most preferred practical imaging method in neonatal intensive care units. In addition to the standard AF-CUS approach, the addition of routine MF-CUS examinations contributes to the diagnosis, especially in the evaluation of the posterior fossa. It is possible to reduce the limitations as much as possible and to evaluate the imaging in a short time in experienced hands.

Ethics Committee Approval: The Ümraniye Training and Research Hospital Clinical Research Ethics Committee granted approval for this study (date: 21.03.2023, number: 84).

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

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Authorship Contributions: Concept – ST; Design – ST, FYA; Supervision – İMA; Fundings – İMA; Materials – FYA, İMA; Data collection and/or processing – ST, FYA Analysis and/or interpretation – ST; Literature review – ST; Writing – ST; Critical review – ST, FYA, İMA.

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Hasta Onamı: Yazılı hasta onamı bu çalışmaya katılan hastaların ailelerinden alınmıştır.

Çıkar Çatışması: Yazarlar çıkar çatışması bildirmemişlerdir.

Mali Destek: Yazarlar bu çalışma için mali destek almadıklarını beyan etmişlerdir.

Yazarlık Katkıları: Fikir – ST; Tasarım – ST, FYA; Denetmele – İMA; Kaynaklar – İMA; Malzemeler – FYA, İMA; Veri Toplanması ve/veya İşlemesi – ST, FYA; Analiz ve/veya Yorum – ST; Literatür Taraması – ST; Yazıyı Yazan – ST; Eleştirel İnceleme – ST, FYA, İMA.

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