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Original Article

Sectional anatomy of the fetal brain in uterus at term on the sagittal plane

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Abstract

Objective: To provide sectional anatomic data for the precise localization of developmental malformation of fetal brain in sagittal magnetic resonance imaging (MRI).
Method: After abdominal and pelvic MRI scanning, the gravid specimen was cut into serial sagittal slices in correspondence with MRI in a low temperature laboratory to demonstrate the structures of fetal brain.
Result: (1) Directional determination of the sloping and rotating fetal head. From the serial sagittal sections of pregnant cadaver at term, we concluded that, the longitudinal lying and cephalic presentation fetal had run into maternal pelvis, and rotated and sloped to right. Anteroposterior position and median sagittal plane of the fetal was in correspondence with his mother's. (2) Seven serial sagittal sections of the fetal brain were obtained through lateral surface of the right cerebral hemisphere, lateral sulcus, internal capsule, median sagittal plane, middle cerebellar peduncle, brainstem, and lateral surface of the left cerebral hemisphere.
Conclusion: Through the comparison study between sagittal sections and corresponding MRI of fetal brain at term, we could obtain morphological anatomic structures and MRI of fetal brain, providing morphological demonstration of the intrauterine development of fetal brain and auxiliary diagnosis of ultrasound and MRI in pregnant woman.

Keywords: Anatomy; Comparative; Fetus; Magnetic resonance imaging

Ultrasonography has proved to be a valuable method to examine the fetal brain. However, it has apparent limitations including maternal obesity and oligohydramnios. Magnetic resonance imaging (MRI) may be the only complementary modality available when ultrasonography findings are inconclusive and inadequate [1–3]. Many researchers have studied fetal brain using MRI. In 1985, McCarthy et al [4] chose nine patients whose gestational age was 34–36 weeks underwent MRI, which was the first study of fetal MRI. But the MRI is not clear enough for the low-field intensity, too much constructed defects, and sedatives were injected into the pregnant woman with potential side effects. In 2000, Lan et al [5] used half-Fourier rapid acquisition with relaxation enhancement imaging examining normal brains of 25 fetuses of 12–38 weeks *in utero*. Gyrus maturation, gray and white matter differentiation, ventricle-to-brain diameter ratio, and subarachnoid space size were evaluated. The sequence, which overcomes the previous defect can obtain images quickly, and was applied in clinic gradually. These studies emphasized on

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the feasibility of MRI examination for fetal brain. Because the referred anatomical structures of fetal brain in their studies were obtained from normal fetal *ex vivo*, and for the specificity of fetal brain *in utero*, the degree of confidence for diagnosis decreased. Because MRI was used more and more widely to fetal brain, sectional anatomic correlation is quite necessary. But there is little study to correlate MRI with pathologic anatomic findings because of difficulty to obtain pregnant specimen. In China, Ma et al [6] chose two cadavers of pregnancy at term to obtain serial transverse sections containing fetal anatomic structures to observate the fetus and fetal appendage. They also observed the corresponding relation between main fetal organs and mother's vertebrae. Their results had much practical value for imaging diagnosis in the third trimester of pregnancy. But they have only reported the findings of transverse sections and the fetal brain delineation is not three-dimensional. In our research, mature morphological structural features of fetal brain in uterus in the third trimester were fully described, providing morphological data for embryonic development of fetal brain and auxiliary diagnosis of ultrasound, computed tomography, and MRI in abdominal and pelvic part of full-term pregnant woman.

Materials and methods

MRI scanning

The pregnant cadaver in the late trimester who died from a road accident was donated by her family.

Scans of the cadaver were performed using a Phillips Electric 1.5-T superconducting magnet. Serial abdominal and pelvic sagittal MR images of the cadaver were obtained with a 5-mm thickness. Scanning condition: spin-echo sequence, T1-weighted image repetition time/echo time 550/15 milliseconds, reconstruction field of view 80%, field of view 375. T2-weighted image repetition time/echo time 2950/110 milliseconds, reconstruction field of view 80%, field of view 430 mm.

Manufacture of the serial sagittal sections in abdominal and pelvic part of the pregnant cadaver in the late trimester

After routinely antisepticized and deeply frozen, serial sagittal sections with a thickness of 10 mm were obtained using electrical sectional beltsaw. The thickness of waste by the beltsaw is 1 mm. Serial sagittal sections were flushed by water, and pictures were taken photos of and recorded.

Result

Direction of the sloping and rotating fetal head

From the serial sagittal sections of the pregnant cadaver in the late trimester (Fig. I–VII), the longitudinal lying fetus had run into maternal pelvis with extension of his cervical part, and the fetal position was occipitoposterior position. Only on the median sagittal plane, the total length of fetal spinal column can be seen, concluding that the median sagittal plane of pregnant women was in corresponding with the fetal. Nevertheless, as a identification marker of cerebral median sagittal plane, the corpus callosum appeared before the fetal median sagittal plane, suggesting that the fetal head sloped to his right; as the sagittal sections appeared from right to left of fetal cerebrum, the sections of cerebral falx retrudes, suggesting that the fetal head rotated to his right.

Twenty-eight sagittal sections of the pregnant cadaver were got, whereas there were only seven sections can show the fetal brain parenchyma. This article was the control study between the sagittal sections and corresponding MRI of fetal brain. The sections were obtained from left to right of the pregnant woman.

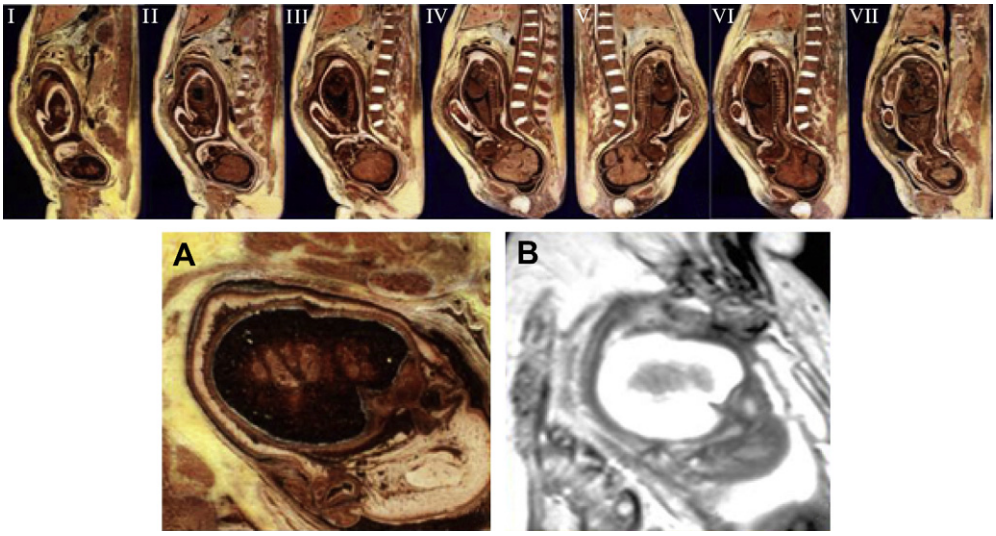

Fig. 1. I–VII. The serial sagittal sectional image of pregnant specimen at term. A. The sagittal section through the lateral convex of right cerebral hemisphere. B The sagittal magnetic resonance imaging through the lateral convex of right cerebral hemisphere.

Sagittal section through the lateral convex in the right cerebral hemisphere

This sagittal section (Fig. 1A) passed through the right convex surface of the fetal brain. Little fetal brain was cut in the section.

On the corresponding T2-weighted MRI (Fig. 1B), prominent subarachnoid space of high-signal intensity overlies the fetal brain of intermediate signal intensity.

Sagittal section through the lateral cerebral fissure in the right cerebral hemisphere

On this sagittal section (Fig. 2A), the lateral cerebral fissure can be seen clearly, whose extremity was surrounded by supramarginal gyrus. Anterior to supramarginal gyrus in turns were postcentral sulcus, central sulcus, and precentral sulcus. Posterior to the postcentral sulcus was a small part of superior parietal lobule. Inferior and paralleled to superior frontal gyrus were the middle frontal gyrus and inferior frontal gyrus. The inferior frontal gyrus was divided into three parts by the anterior branch and ascending branch of lateral sulcus, which were the orbital part posterior to anterior branch, the triangular part between the anterior branch and ascending branch, the opercular part posterior to ascending branch. The transverse temporal gyrus lied in the inferior border of lateral sulcus. Inferior and paralleled to the lateral sulcus were superior temporal sulcus and inferior temporal sulcus, which divided temporal lobe into superior temporal gyrus, middle temporal gyrus and inferior temporal gyrus.

On the corresponding T2-weighted MRI (Fig. 2B), the anterior branch and ascending branch of lateral sulcus cannot be seen clearly.

Sagittal section through the right internal capsule

On this sagittal section (Fig. 3A), there was much medullary substance in the section. Posterior to the midpoint of superior border of hemisphere lied the deep central sulcus containing interparies gyrus. Anterior to central sulcus was superior frontal gyrus. In the anterior part of the frontal lobe, two parallel and short sulci extending to the anterior border were superior frontal sulcus and inferior frontal sulcus. The parietooccipital sulcus and calcarine sulcus can be seen clearly. In the cerebral medullary substance, there can be seen parietopontine tract, occipitopontine tract, and temporopontile tract projecting downward through internal capsule. The thalamus lied posterior to the posterior limb of internal capsule, and the lenticular nucleus anteromedial to that. The fiber bundle in the inferior part of the hemisphere went downward forming the cerebral peduncle. Posterior to the midbrain was the temporal bone, the posterosuperior part of which was transverse sinus and anteroinferior sigmoid sinus.

On the corresponding T2-weighted MRI (Fig. 3B), the anterior and inferior horns of lateral ventricle of high signal were shown clearly. The transverse gray matter of low signal inferior and sticking tightly to inferior horn of lateral cerebral ventricle of high signal was subiculum hippocampi.

Sagittal section through corpus callosum (the median sagittal plane of fetal brain, and the lateral median sagittal plane of the pregnant woman)

This sagittal section (Fig. 4A), for the fetal head revolving and sloping to his right, passed through the frontal and parietal lobe of the left cerebral hemisphere, the posterior part of cerebral falx, the parietal and occipital lobe of the right cerebral hemisphere, tentorium of cerebellum, and the right cerebellar hemisphere. Superior to the cerebral falx and posterior to the tentorium of cerebellum, can be seen the superior sagittal sinus containing arachnoid granulations. The left paracentral lobule lied posterior to the paracentral sulcus. Anterior to the right marginal ramus of sulcus cingulatus, can be seen the deep central sulcus containing interparies gyrus. The parietooccipital sulcus can be seen clearly, and the calcarine sulcus not. The trunk and genu of corpus callosum were obviously, superior to which was the laterigrade cingule of association fibers and inferior fornix of commissural fibers.

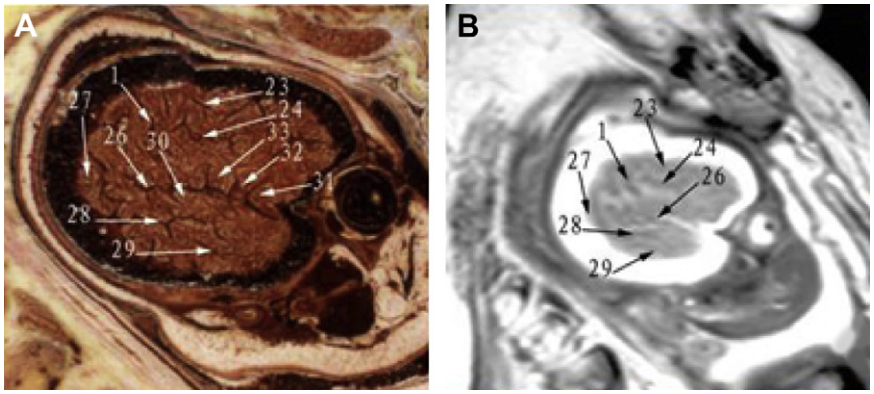

Fig. 2. A. The sagittal section through the lateral sulcus of right cerebral hemisphere. B The sagittal magnetic resonance imaging through the lateral sulcus of right cerebral hemisphere. 1. Central sulcus, 2. parietooccipital sulcus, 3. paracentral lobule, 4. hippocampalspiral fiber, 5. dorsal thalamus, 6. internal capsule, 7. caudate nucleus, 8. lenticular nucleus, 9. corpus callosum, 10. fornix, 11. lateral cerebral ventricle, 12. calcarine sulcus, 13. cerebral peduncle, 14. quadrigeminal bodies, 15. middle cerebellar peduncle, 16. fourth ventricle of cerebrum, 17. pons cerebelli, 18. cerebral falx, 19. tentorium of cerebellum, 20. cerebellum, 21. transverse sinus, 22. sigmoid sinus, 23. superior frontal sulcus, 24. inferior frontal sulcus, 25. subiculum hippocampi, 26. lateral sulcus, 27. superior parietal lobule, 28. superior temporal sulcus, 29. inferior temporal sulcus, 30. transverse temporal gyri, 31. orbital part, 32. triangular part, 33. opercular part.

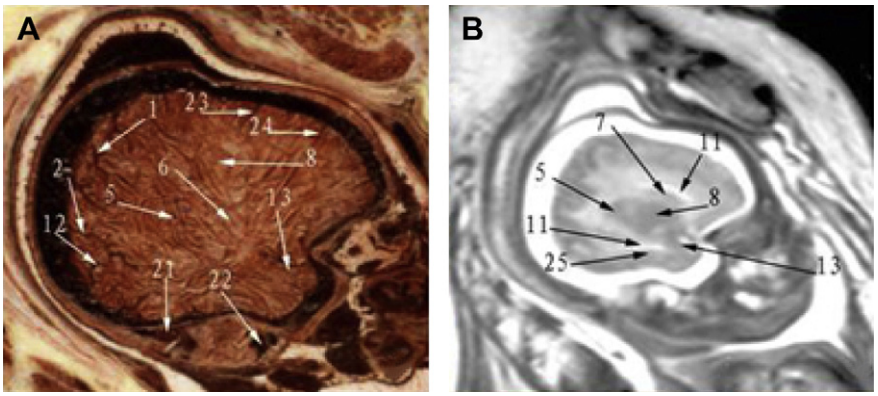

Fig. 3. A. The sagittal section through the right internal capsule. B The sagittal magnetic resonance imaging through the right internal capsule. 1. Central sulcus, 2. parietooccipital sulcus, 3. paracentral lobule, 4. hippocampalspiral fiber, 5. dorsal thalamus, 6. internal capsule, 7. caudate nucleus, 8. lenticular nucleus, 9. corpus callosum, 10. fornix, 11. lateral cerebral ventricle, 12. calcarine sulcus, 13. cerebral peduncle, 14. quadrigeminal bodies, 15. middle cerebellar peduncle, 16. fourth ventricle of cerebrum, 17. pons cerebelli, 18. cerebral falx, 19. tentorium of cerebellum, 20. cerebellum, 21. transverse sinus, 22. sigmoid sinus, 23. superior frontal sulcus, 24. inferior frontal sulcus, 25. subiculum hippocampi, 26. lateral sulcus, 27. superior parietal lobule, 28. superior temporal sulcus, 29. inferior temporal sulcus, 30. transverse temporal gyri, 31. orbital part, 32. triangular part, 33. opercular part.

The lacouna between fornix and corpus callosum was anterior horn of lateral cerebral ventricle. Anteroinferior to the clear triangular part of lateral cerebral ventricle was the kankar of thalamus. The fiber of internal capsule lied anterior to thalamus, and the spiral fiber of hippocampus posteroinferior. Superior to the internal capsule can be seen the edge of caudate nucleus lying in the inferior wall of lateral ventricle, and the lenticular nucleus lied lateral to internal capsule.

On the corresponding T2-weighted MRI (Fig. 4B), the cerebral falx and tentorium of cerebellum of low signal cannot be seen.

Sagittal section through the middle cerebellar peduncle and brainstem (left view of the left lateral median sagittal plane of the fetal brain and the median sagittal plane of the pregnant woman)

This sagittal section (Fig. 5A) passed through the frontal lobe, parietal lobe, brainstem, posterior part of cerebral falx, occipital lobe of the left cerebral hemisphere, tentorium of cerebellum and cerebellar hemisphere. In the left cerebral hemisphere appeared a great quantity of medullary substance, with the gross medullary process of anterior central gyrus and the thinner medullary process of posterior central gyrus seen clearly. Anterior to cerebral falx, the parietooccipital sulcus ran anteroinferior meeting with the calcarine sulcus and prolonged to be the anterior part of calcarine sulcus. In the cerebral medullary substance, can be seen the frontopontile tract and parietopontine tract projecting downward through internal capsule. The lacouna in the posteroinferior part of the telencephalon was lateral cerebral ventricle, superior to which lied the dorsal thalamus. The spiral fiber of hippocampus posterior to lateral cerebral ventricle went anteroinferior. The gastro of midbrain was cerebral peduncle, and dorso was quadrigeminal bodies. The middle cerebellar peduncle was clearly shown.

On the corresponding T2-weighted MRI (Fig. 5B), the wide subarachnoid space of high signal around the brain and a small

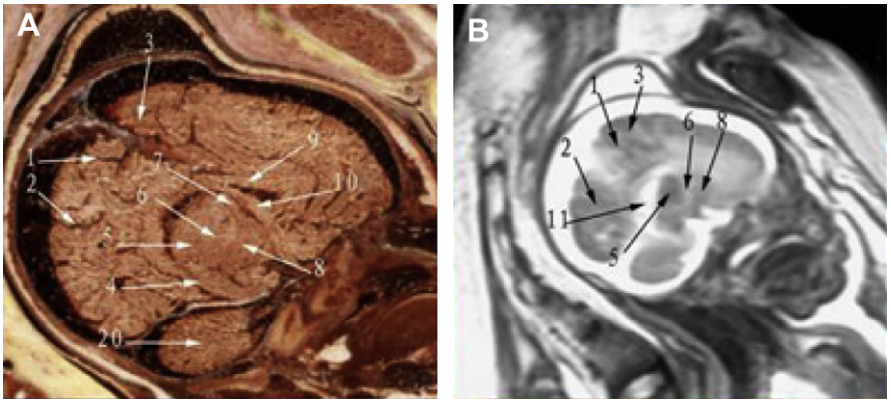

Fig. 4. A. The sagittal section through the corpus callosum. B The sagittal magnetic resonance imaging through the corpus callosum. 1. Central sulcus, 2. parietooccipital sulcus, 3. paracentral lobule, 4. hippocampalspiral fiber, 5. dorsal thalamus, 6. internal capsule, 7. caudate nucleus, 8. lenticular nucleus, 9. corpus callosum, 10. fornix, 11. lateral cerebral ventricle, 12. calcarine sulcus, 13. cerebral peduncle, 14. quadrigeminal bodies, 15. middle cerebellar peduncle, 16. fourth ventricle of cerebrum, 17. pons cerebelli, 18. cerebral falx, 19. tentorium of cerebellum, 20. cerebellum, 21. transverse sinus, 22. sigmoid sinus, 23. superior frontal sulcus, 24. inferior frontal sulcus, 25. subiculum hippocampi, 26. lateral sulcus, 27. superior parietal lobule, 28. superior temporal sulcus, 29. inferior temporal sulcus, 30. transverse temporal gyri, 31. orbital part, 32. triangular part, 33. opercular part.

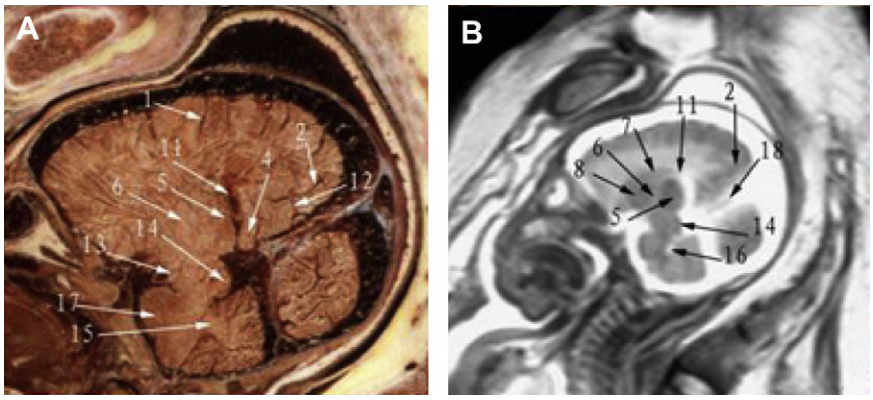

Fig. 5. A. The sagittal section through the middle cerebellar peduncle and brainstem (the left view of fetal brain). B The sagittal magnetic resonance imaging through the middle cerebellar peduncle and brainstem (the left view of fetal brain). 1. Central sulcus, 2. parietooccipital sulcus, 3. paracentral lobule, 4. hippocampalspiral fiber, 5. dorsal thalamus, 6. internal capsule, 7. caudate nucleus, 8. lenticular nucleus, 9. corpus callosum, 10. fornix, 11. lateral cerebral ventricle, 12. calcarine sulcus, 13. cerebral peduncle, 14. quadrigeminal bodies, 15. middle cerebellar peduncle, 16. fourth ventricle of cerebrum, 17. pons cerebelli, 18. cerebral falx, 19. tentorium of cerebellum, 20. cerebellum, 21. transverse sinus, 22. sigmoid sinus, 23. superior frontal sulcus, 24. inferior frontal sulcus, 25. subiculum hippocampi, 26. lateral sulcus, 27. superior parietal lobule, 28. superior temporal sulcus, 29. inferior temporal sulcus, 30. transverse temporal gyri, 31. orbital part, 32. triangular part, 33. opercular part.

part of the cerebral falx of low signal can be seen, whereas the tentorium of cerebellum not. Anterior to the brainstem were the interpeduncular cistern, cisterna pontis, and oblongatal cistern of high signal, and posterior were superior cerebellar peduncle of low signal and fourth ventricle of high.

Sagittal section through the middle cerebellar peduncle and brainstem (right view of the left lateral median sagittal plane of the fetal brain and the median sagittal plane of the pregnant woman)

This sagittal section (Fig. 6A) coincided with that of Fig. 5A on the whole, but they were different a little. The lenticular nucleus and dorsal thalamus can be recognized, and the middle cerebellar peduncle disappeared.

The corresponding T2-weighted MRI (Fig. 6B) was the same with that of Fig. 5B.

Sagittal section through lateral convex of the left fetal cerebral hemisphere

This sagittal section (Fig. 7A) passed through the left lateral convex of fetal cerebral hemisphere, but the sulci and gyri cannot be discriminated. Posterior to the tentorium of cerebellum can be seen the transverse sinus, and inferior a small quantity of cerebellar parenchyma. Anteroinferior to the cerebellum lied the sigmoid sinus.

On the corresponding T2-weighted MRI (Fig. 7B), the sulci and gyri of the left lateral convex of fetal cerebral hemisphere cannot be discriminated.

Discussion

Our research chose sagittal sections and corresponding MRI of gravid cadaver in late trimester and fully described the

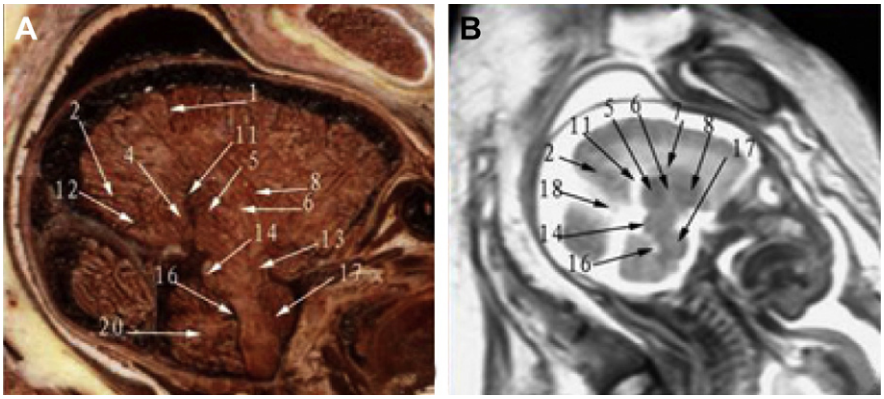

Fig. 6. A. The sagittal section through the middle cerebellar peduncle and brainstem (the right view of fetal brain). B The sagittal magnetic resonance imaging through the middle cerebellar peduncle and brainstem (the right view of fetal brain). 1. Central sulcus, 2. parietooccipital sulcus, 3. paracentral lobule, 4. hippocampalspiral fiber, 5. dorsal thalamus, 6. internal capsule, 7. caudate nucleus, 8. lenticular nucleus, 9. corpus callosum, 10. fornix, 11. lateral cerebral ventricle, 12. calcarine sulcus, 13. cerebral peduncle, 14. quadrigeminal bodies, 15. middle cerebellar peduncle, 16. fourth ventricle of cerebrum, 17. pons cerebelli, 18. cerebral falx, 19. tentorium of cerebellum, 20. cerebellum, 21. transverse sinus, 22. sigmoid sinus, 23. superior frontal sulcus, 24. inferior frontal sulcus, 25. subiculum hippocampi, 26. lateral sulcus, 27. superior parietal lobule, 28. superior temporal sulcus, 29. inferior temporal sulcus, 30. transverse temporal gyri, 31. orbital part, 32. triangular part, 33. opercular part.

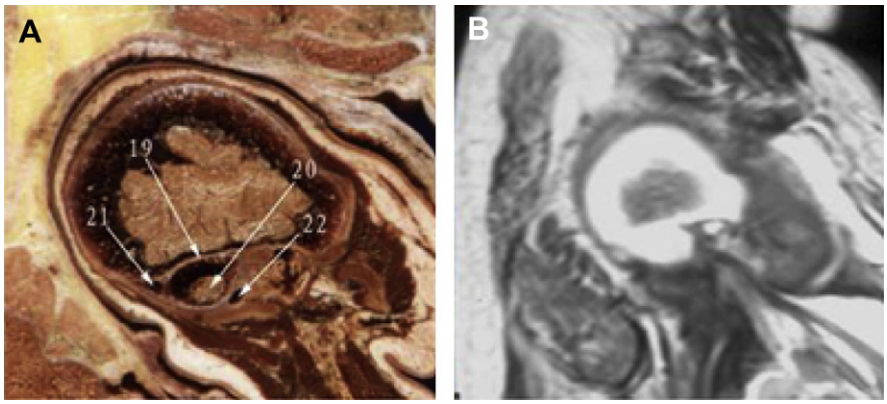

Fig. 7. A. The sagittal section through the lateral convex of left cerebral hemisphere. B The sagittal magnetic resonance imaging through the lateral convex of left cerebral hemisphere. 1. Central sulcus, 2. parietooccipital sulcus, 3. paracentral lobule, 4. hippocampalspiral fiber, 5. dorsal thalamus, 6. internal capsule, 7. caudate nucleus, 8. lenticular nucleus, 9. corpus callosum, 10. fornix, 11. lateral cerebral ventricle, 12. calcarine sulcus, 13. cerebral peduncle, 14. quadrigeminal bodies, 15. middle cerebellar peduncle, 16. fourth ventricle of cerebrum, 17. pons cerebelli, 18. cerebral falx, 19. tentorium of cerebellum, 20. cerebellum, 21. transverse sinus, 22. sigmoid sinus, 23. superior frontal sulcus, 24. inferior frontal sulcus, 25. subiculum hippocampi, 26. lateral sulcus, 27. superior parietal lobule, 28. superior temporal sulcus, 29. inferior temporal sulcus, 30. transverse temporal gyri, 31. orbital part, 32. triangular part, 33. opercular part.

morphosis of fetal brain *in utero*, providing normal morphologic data for embryonic development and imaging diagnosis of congenital disorders of fetal brain *in utero*.

On the section through the lateral cerebral fissure in the right cerebral hemisphere, the lateral sulcus and central sulcus shaped like declivate English letter "Y", and the lateral sulcus was very deep with interparietal gyrus appearing. Around the extremity of lateral sulcus was supramarginal gyrus. On the section through the right internal capsule, the central sulcus retreated, and the area of white matter increased. Between the thalamus and lenticular nucleus in the center area lies posterior limb of internal capsule. The subiculum hippocampi and uncinate gyrus can be seen clearly. On the section through the median sagittal plane of fetal brain, the corpus callosum lying in the center seemed like the letter of "C." The lacouna between the corpus callosum and fornix is anterior horn of lateral ventricle. Anteroinferior to the trigone of lateral ventrical lie the thalamus, caudate nucleus, and lenticular nucleus, among which lies the internal capsule. On the section through the middle cerebellar peduncle and brainstem, the cerebral peduncle can be seen clearly. Anteroinferior to the cerebellum is the tonsilla of cerebellum. The right occipital lobe and left frontal, parietal, occipital lobe were divided by the cerebral falx. Anterolateral to the shrinking lateral cerebral ventricle lies the internal capsule. The medulla process of superior frontal gyrus is thick comparatively. The above-mentioned structures can be recognized on the corresponding MRI. So diseases of fetal hydrocephaly, intracalvarium cyst, cerebellar malformation, brain with no fissure, macrogyria, intracerebral hemorrhage, and callosal agenesis can be seen clearly on MRI, which have considerable significance for prenatal monitoring and aristogenesis [7].

The optimal section for observing fetal brain in uterus on MRI is determined by the fetal position. The MRI plane, which is usually parallel or perpendicular to the maternal axial ray is often not the optimal section for observing fetal brain, because the fetal brain's transverse, sagittal, and coronal planes are usually not in corresponding with mother's [8]. In this specimen, the fetal head sloped and rotated to his right, which also testified the view above [9]. Furthermore, the fetal brain structures in uterus were identified by clinician according to that of standard of adult brain, resulting in errors in some research and diagnosis. Therefore, our sectional anatomical research of fetal brain in uterus was an urgent requirement for clinical imaging of fetus. However, up to now there are few reports in this field because there are few pregnant specimens examined both on MRI and gross sectional anatomic images.

In this study through the contrast analysis between the successive sections of fetal brain in uterus and their corresponding MRI, we provide precious data for embryonic development of fetal brain and auxiliary diagnosis of B-ultrasound, computed tomography, and MRI for pregnant women. In the developmental point of view, the fetal period and postnatal changes of fetal brain are an consecutive process, recognition of fetal brain in uterus is the base and precondition for studying postnatal brain development, which helps to diagnose the postnatal fetal brain diseases.

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References

[1] Manganaro L, Perrone A, Savelli S, Di Maurizio M, Maggi C, Ballesio L, et al. Evaluation of normal brain development by prenatal MR imaging. Radiol Med 2007;112:444–55.

[2] Grossman R, Hoffman C, Mardor Y, Biegon A. Quantitative MRI measurements of human fetal brain development in utero. Neuroimage 2006;33:463−70.
[3] Levine D, Barnes PD, Sher S, Semelka RC, Li W, McArdle CR, et al. Fetal fast MR imaging: reproducibility, technical quality, and conspicuity of anatomy. Radiology 1998;206:549−54.
[4] McCarthy SM, Filly RA, Stark DD, Hricak H, Brant-Zawadzki MN, Callen PW, et al. Obstetrical magnetic resonance imaging: fetal anatomy. Radiology 1985;154:427−32.
[5] Lan LM, Yamashita Y, Tang Y, Sugahara T, Takahashi M, Ohba T, et al. Normal fetal brain development: MR imaging with a half-Fourier rapid acquisition with relaxation enhancement sequence. Radiology 2000;215: 205−10.
[6] Ma YL, Jiang J, Han JR. Cross-sectional study of pregnant female pelvis. Acta Anatomica Sinica 1995;26:225−30.
[7] Ll L. The application of MRI in observing fetal brain development. Guangxi Med 2000;22:98−9.
[8] Weinreb JC, Lowe T, Cohen JM, Kutler M. Human fetal anatomy: MR imaging. Radiology 1985;157:715−20.
[9] Sturm R. Deposition and cellular interaction of cancer-inducing particles in the human respiratory tract: Theoretical approaches and experimental data. Thoracic Cancer 2010;1:141−52.