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Case Report

Application of magnetic resonance neurography in neonatal brachial plexus injury: A case report and literature review ☆,☆☆

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ARTICLE INFO

Article history:
Received 20 February 2022
Revised 30 March 2022
Accepted 8 April 2022

Keywords:
Neonatal
Brachial plexus injury
Magnetic resonance neurography

ABSTRACT

Neonatal obstetric brachial plexus palsy is common in newborns with fetal macrosomia, especially those who are delivered vaginally with shoulder dystocia or breech delivery. The anatomical structure of brachial plexus in newborns is thin, and it is neither collinear nor coplanar in space; The location, the type and degree of neonatal brachial plexus injury need to be comprehensively judged by clinical history, neurological and imaging examination. Conventional MR imaging is not sufficient to diagnose brachial plexus injury. In this case report, we describe the clinical and imaging data of a newborn with brachial plexus injury diagnosed by the fat-suppressed T2-weighted sequence and MR myelography and confirmed by surgery. In addition, we review the related literature in an attempt to provide a better understanding of the principles and characteristics of neonatal brachial plexus injury diagnosed by magnetic resonance neurography.

Introduction

Neonatal obstetric brachial plexus palsy (OBPP) is common in newborns with fetal macrosomia, especially those who are delivered vaginally with shoulder dystocia or breech delivery. Functional recovery from neurologic impairment is closely related to the type of impairment, early rehabilitation training, and aging [1]. The clinical application of electrophysiology for neonatal screening of avulsion injuries is limited by its low sensitivity [2]. At present, magnetic resonance neurography (MRN) is recognized as the most valuable approach to evaluate and diagnose brachial plexus injury [3] because it can noninvasively display preganglionic and postganglionic lesions of the brachial plexus with good diagnostic accuracy.

☆ Acknowledgments: The study is supported by Baoding Science and Technology Plan Project, Project No: 2041F003.
☆☆ Competing Interests: This article has no financial / personal interests, potentially competitive interests or beliefs that may affect its objectivity. All authors have seen and approved the final version of the manuscript and agreed to submit *Radiology Case Reports*. There is no conflict of interest to declare.
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https://doi.org/10.1016/j.radcr.2022.04.017

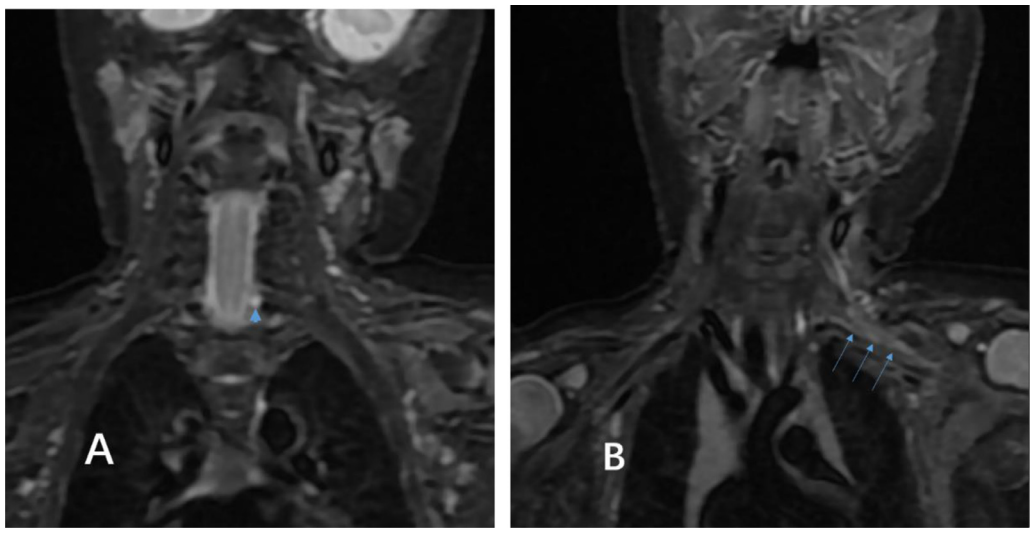

Fig. 1 – Coronal T2-STIR MRI sequence (A) centered a pseudomeningeal cysts (short arrow) on the left side at the level of C7; (B) revealed a thickened, swollen, and tortuous spinal root at the extraspinal segments of C5–T1 (long arrow) on the left side, with a high signal intensity.

Clinical information

A 26-day-old male was born at 39+3 weeks of gestation. He weighed 3950 g and was delivered by vaginal delivery with shoulder dystocia. The patient had no history of asphyxia. He was unable to voluntarily mobilize the left upper limb since birth. Upon physical examination, the neonatologist found that the child's left upper limb was adducted and internally rotated, with reduced muscular strength and tension. There were no abnormalities in muscular strength, tension, or voluntary movements of the right upper and lower limbs. Thus, neonatal left brachial plexus injury was highly suspected.

Subsequent MRN was performed using three-dimensional (3D) fast imaging employing steady-state acquisition (3D-FIESTA) and T2- short time inversion recovery (T2-STIR) sequences. These 2 sequences revealed a thickened, swollen, and tortuous spinal root ganglion at the extraspinal segments of C5-T1 on the left side, with high signal intensity on the T2 fat-suppressed sequence (Fig. 1). On the left intervertebral foramina of C5-C7, two roundish regions with low T1 and high T2 signals and high signal intensity on the fat-suppressed sequence were observed. The preganglionic roots of C5-C6 were slender, while the preganglionic root of C7 had disappeared (Fig. 1). No abnormal signs were found in the adjacent spinal cord. MRN diagnosed left brachial plexus injury and C7 preganglionic root avulsion with traumatic meningeal cyst formation. Brachial plexus reconstruction was soon performed. In the operative field, we found ruptured preganglionic roots in C5 and C6; an avulsed preganglionic root in C7; two pseudomeningeal cysts in C5-C7; and enlarged and swollen upper, middle, and lower nerve trunks. The child recovered after surgery.

Discussion and literature review

Depending on the site of brachial plexus nerve root, the injury is divided into intraspinal (preganglionic) root injury and extraspinal (postganglionic) root injury. The degree of injury is divided into 5 grades, as follows: first degree injury manifests as temporary conduction block, which recovers in a short time; second degree injury manifests as axonotmesis, but the endoneurial sheath of the nerve fibers is preserved; third degree injury manifests as disintegration of the axons and endoneurial sheath, and despite the nerve trunk being preserved, the chance of recovery is negligible; fourth degree injury manifests as a disorganized nerve trunk with only a strand of epineurium preserved; and fifth degree injury presents as loss of nerve trunk continuity. Fifth degree injury is the most severe and usually requires surgical intervention [4].

Neonatal brachial plexus injury is an acute injury that often affects surrounding tissues. The common complications include muscular hematoma and edema, adipose layer edema, and clavicular fracture, which often interfere with the diagnosis of brachial plexus injury. In addition, the anatomical structure of brachial plexus in newborns is thin, and it is neither collinear nor coplanar in space; electrophysiology has low sensitivity in detecting avulsion injury, especially when preganglionic and postganglionic injury exist at the same time, electrophysiology is difficult to judge whether avulsion injury is isolated postganglionic injury or combined with preganglionic injury. Therefore, clinically, the location, the type and degree of neonatal brachial plexus injury need to be comprehensively judged by clinical history, neurological, and imaging examination. A single examination or conventional MR imaging is not sufficient to diagnose brachial plexus injury.

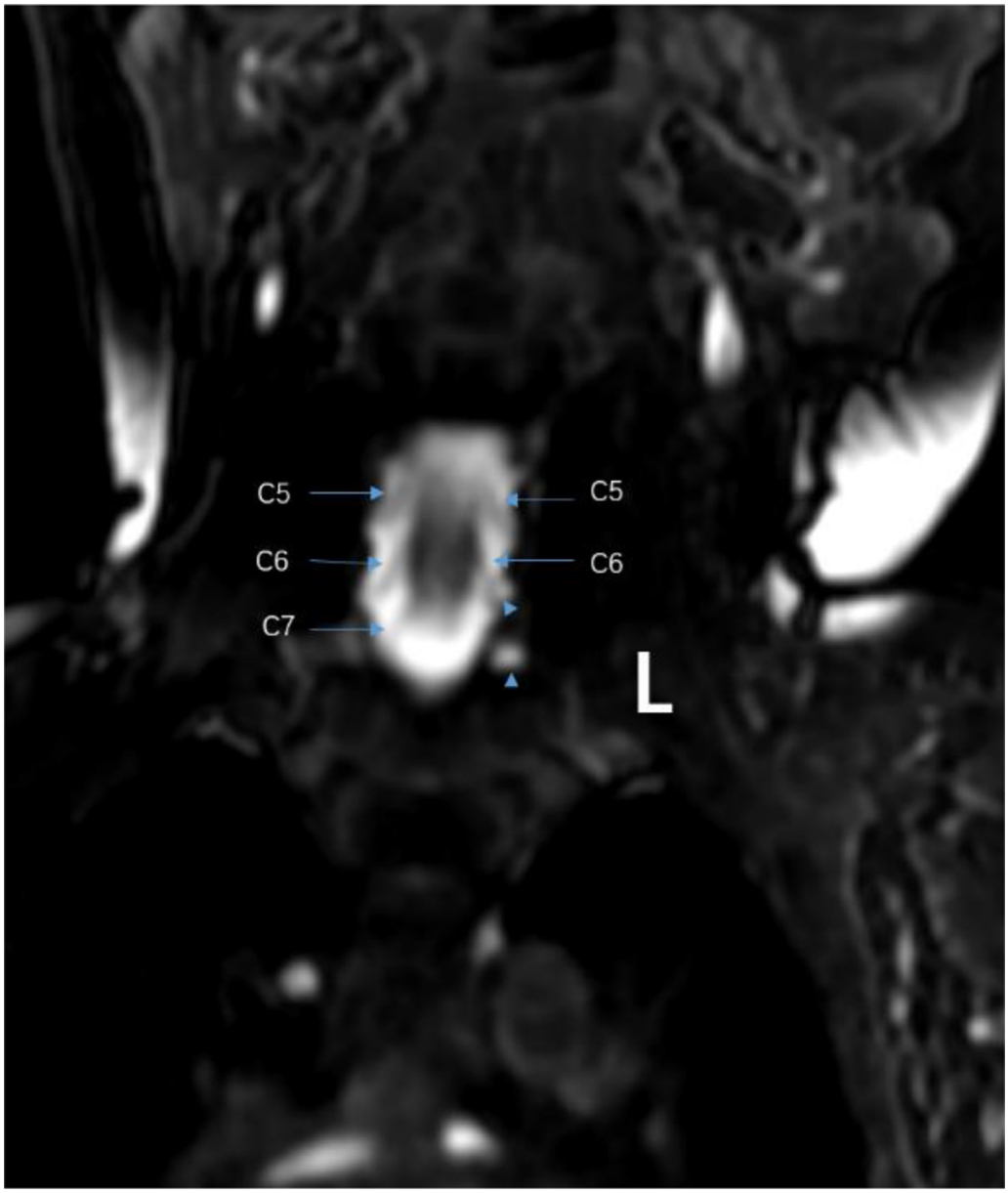

Fig. 2 – Coronal 3D-FIESTA sequence showed the left C5 and C6 nerves (long arrow) were slender, disorderly, and rigid, with lack of the left C7 nerve root in spinal canal. Cystic accumulation of spinal fluid in intervertebral foramen and paravertebral region, forming a pseudomeningeal cysts (short arrow) .

With the development of MR techniques, the fat-suppressed T2-weighted sequence and MR myelography (MRM) in MRN allow imaging of extraspinal segments and the intraspinal segment of the brachial plexus, as well as imaging of the surrounding tissue lesions of the limb. The new MRN sequence allows for early diagnosis of neonatal brachial plexus injury, which may facilitate early treatment, reduce sequelae, and improve the quality of life of affected children [5].

In this case report, the patient was scanned using the T2-STIR sequence, and revealed a grid-like high signal of edema in the left limb, shoulder and chest wall soft tissue; thickening and high signal in five postganglionic root and three continuous nerve trunks; pseudomeningeal cysts formation. These signs indicated extraspinal segmental injury of the left brachial plexus. The 3D-FIESTA sequence revealed the absence of a signal in the spinal canal of the left C7 intraspinal segment, with dilation of the corresponding nerve root sleeve, thinning of the preganglionic root of C5-C6 compared with the contralateral side, and formation of two pseudomeningeal cysts. These signs suggested intraspinal segmental injury of the left brachial plexus. All of the above findings were confirmed during surgery (Figs. 2 and 3).

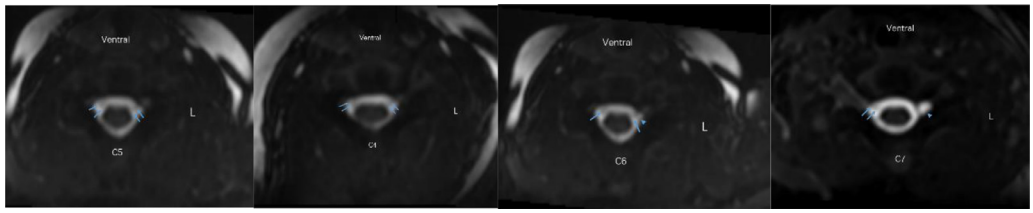

Fig. 3 – Axial 3D-FIESTA sequence of the C4-C7 nerve root (long arrow) in spinal cannal. This group of images demonstrates the lack of a C7 root on the left side, and has two associated pseudomeningocele (short arrow) near C6/C7 intervertebral foramen. The root sleeve of the C7 nerve was dilated and extended outward.

The T2-STIR sequence is a traditional T2 fat-suppressed sequence. The T2 value of the brachial plexus is higher than that of other surrounding tissues, and its transverse relaxation time is longer than that of other surrounding tissues. Taking advantage of the long echo time of T2-weighted imaging, the increased signal intensity of the brachial plexus with a higher T2 value facilitates the display of the extraspinal segments of the brachial plexus. Combined with the fat-suppression technique, the high signal of edema indicates enhancement. Compared with electromyography and physical diagnosis, MRN can indicate possible brachial plexus injury in children [6]. Meanwhile, the T2-STIR sequence has lower requirements in terms of the uniformity of the magnetic field. This makes the T2-STIR sequence more effective for fat suppressed in the case of the brachial plexus, where there are multiple tissue components and uneven tissue signals. The 3D-FIESTA sequence is a new MRM method that was developed by GE company in recent years. It uses steady-state free precession gradient echo technology [7]. This sequence has the advantage of fast imaging, which reduces phase-shift artifacts due to cerebrospinal fluid flow, highlights tissue signals with high T2/T1 ratios, and makes cerebrospinal fluid appear distinctly hyperintense. Because 3D-FIESTA can form a good contrast between the preganglionic roots of the brachial plexus in the spinal canal, it can reveal the microstructure of the intraspinal segment of the brachial plexus [8]. By simultaneously combining 3D scanning and image post-processing technologies, such as multiplanar reconstruction and maximum signal projection, it is possible to clearly display the morphology of the nerve roots and the nerve root sleeves in the spinal canal and improve the detection rate of brachial plexus preganglionic nerve root injury [9].

In conclusion, the brachial plexus of newborns should be scanned with the T2-STIR sequence and the 3D-FIESTA sequence. These sequences clearly show the anatomical details of the intraspinal and extraspinal segments of the brachial plexus, as well as changes to surrounding structures. They also provide strong imaging support for the qualitative grading of neonatal brachial plexus paralysis and provide a reliable basis for follow-up treatment.

Patient consent

The authors have obtained consent from the patient to appear in this case report.

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