Radiology Case Reports 19 (2024) 4904–4907

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Case Report

Double echo steady-state free precession technique in MR neurography to evaluate extracranial facial nerve involvement in a case of Bell's palsy ☆

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ARTICLE INFO

Article history:
Received 4 June 2024
Revised 20 July 2024
Accepted 22 July 2024

Keywords:
Bell's palsy
MR neurography
Facial nerve

ABSTRACT

Bell's palsy is the most common cause of facial weakness involving the facial nerve. While brain MRI is often acquired to evaluate for pathology along the intracranial course of the facial nerve, evaluation of inflammation affecting the extracranial segments of the facial nerve, particularly the intraparotid segments, is uncommon. We present a case report of acute Bell's palsy in a 35-year-old pregnant patient at 38 weeks' gestation. A double-echo steady state MR neurography technique, MENSA (Multi-Echo iN Steady-state Acquisition), acquired with a conformable prototype neck coil, was utilized to visualize abnormal enlargement and signal hyperintensity of the left intraparotid facial nerve. The case highlights a presentation of Bell's palsy affecting the extracranial segments of the facial nerve. This technique may be useful for longitudinal monitoring of Bell's palsy, planning of targeted treatments, and for evaluating other pathologies affecting the facial nerve.

Introduction

Bell's palsy is the most common diagnosis involving the facial nerve (cranial nerve VII), with an annual incidence of 35 per 100,000 people in the United States [1]. Most affected individuals are between 15-45 years old, with no sex predilection, although pregnancy confers increased risk, affecting 2 per 1000 pregnant women [2]. The condition typically presents with idiopathic rapid onset unilateral facial muscle weakness, and sometimes complete paralysis, which can result in difficulty eating and ocular injury from inability to control eyelid closure [1]. While more than 70% of cases are self-limited, symptoms are typically treated with oral steroids, with or without

☆ Competing Interests: The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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https://doi.org/10.1016/j.radcr.2024.07.130

antivirals in order to concurrently treat an associated herpes zoster infection [1,3]. Refractory cases may benefit from botulinum toxin injection or surgery [1].

Bell's palsy typically affects the intracranial segments of the facial nerve but can less commonly affect the extracranial segments outside of the temporal bone [4,5]. Conventional brain MRI in the acute stage is utilized to assess for discrete etiologies of peripheral neuropathy, including infection, infarct, trauma, or malignancy [1]. A contrast-enhanced brain MRI, typically focused on the internal auditory canals, may demonstrate enhancement of the intracranial segments of the facial nerve in Bell's palsy [6]. However, the extracranial segments of the facial nerve are not typically imaged as part of routine brain MRI protocols, in part due to challenges such as poor contrast resolution through the temporal bone, parotid gland, and subcutaneous fat [4]. As such, tailored high-contrast MR neurography sequences may be utilized noninvasively to detect specific peripheral facial nerve involvement as a cause of facial neuropathy [4]. Depicting neuromuscular abnormalities of the extracranial facial nerve segments may yield new information to more completely describe the pathology of Bell's palsy.

We describe a high-resolution MR neurography (peripheral nerve MRI) technique to evaluate the intraparotid facial nerve course in a patient with Bell's palsy. The techniques facilitate visualization of the course of the extracranial intraparotid branches of the facial nerve, which include the bifurcation of the facial nerve into the temporofacial branch and the cervicofacial branch. Evaluation of these facial nerve segments of the facial nerve may be beneficial not only in the diagnosis and monitoring of recover of Bell's palsy, but also for detailed planning of targeted treatments [7,8].

Case presentation

A 35-year-old primigravid, nondiabetic woman presented to the Emergency Department at 38 weeks' gestation for left facial weakness that began 1 day prior. She also endorsed left ear pain and left eye discomfort and twitching, but denied any headache, visual or hearing changes, or numbness. On physical exam, her left facial weakness was further qualified by inability to fully close her left eyelid. Eyelid closure and eyebrow raise was asymmetric. Hearing was grossly intact bilaterally. She was diagnosed with Bell's palsy, prescribed oral prednisone 60 mg daily for 1 week, and given a neurology follow-up appointment. She had a spontaneous, uncomplicated vaginal delivery with epidural anesthesia 4 days later.

On day 9 after symptom onset, she saw an ophthalmologist and a plastic surgeon for continued left facial weakness. A subsequent contrast-enhanced brain MRI and noncontrast MR neurography of the face was ordered to detect any abnormality of the intracranial or extracranial segments of the facial nerve. The brain MRI was normal and the MR neurography demonstrated enlargement and signal hyperintensity of the left intraparotid facial nerve relative to the contralateral side, without intrinsic or extrinsic mass along the course of the nerve (Fig. 1). At subsequent follow-up on day 16 after symptom onset, she noted slight improvement in the facial weakness after the prednisone course. By day 38 after initial symptom onset, the patient reported marked improvement in symptoms, nearly returned to baseline, with a mild lag in left eyelid closure.

Technique

Extracranial facial nerve MR neurography was acquired using multiplanar fluid-sensitive fat-suppressed and proton density fast spin-echo sequences at 3.0 Tesla (T) (Premier, GE Healthcare, Waukesha, WI) using a prototype phased-array coil, specifically designed to contour to the facial and cervical anatomy to improve signal-to-noise (SNR) in the extracranial nerves [9]. In particular, the SNR allows the use of an imaging protocol with higher spatial resolution, including a 0.7-0.8 mm isotropic resolution, double echo steady state (DESS) sequence, known as MENSA (Multi-Echo iN Steady-state Acquisition). MENSA was obtained in both the coronal and sagittal planes to provide coverage of the facial nerves. MENSA also utilizes a signal combination of 2 distinct steady-state free precession echoes, free induction decay (FID) and echo signal, which, combined, results in a fluid-sensitive T2-weighted image that also has high SNR [10]. Additionally, we utilized a previously evaluated 3D deep learning reconstruction algorithm, trained to increase sharpness and decrease noise, to improve nerve conspicuity, allowing for acquisition of high isotropic spatial resolution [11].

Discussion

Diagnostic imaging of Bell's palsy has focused on the intracranial segments of the facial nerve, as involvement of the extracranial segments of the facial nerve is less recognized [4,5]. We present a case utilizing high resolution MR neurography techniques to depict the morphologic and signal changes of the extracranial, intraparotid facial nerve course in a pregnant female with Bell's palsy.

The MENSA sequence utilized relies on low signal intensity fibrofatty tissue of the parotid gland as background contrast to illuminate the intraparotid nerve segments [7]. There are several advantages of MR neurography. In particular the MENSA sequence acquires signals from 2 separate echoes for every TR. The echo signal from the free induction decay gradient from the fast imaging with steady-state free precession (FISP) sequence contributes anatomic detail while the echo signal from the time-reversed FISP (PSIF) sequence potentiates the long T2 properties of tissue. Further, uniform fat suppression allows for better contrast and delineation of structures, specifically, the facial nerve branches from the background intraparotid fat [12].

Prior studies have utilized different MR neurography sequences to delineate the extracranial peripheral nerves, including the intraparotid facial nerve branches. These studies include sequences similar to MENSA, namely DESS to evaluate the intraparotid facial nerve at 1.5T and 3.0T MR [12,13]. Qin et al. differentiated the intraparotid facial nerve course from

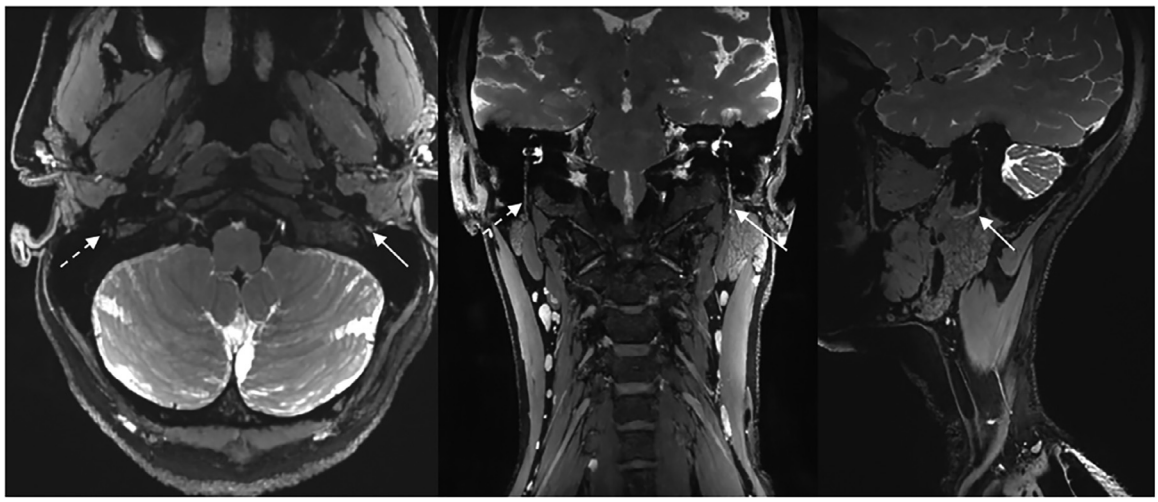

Fig. 1 – MR neurography of the neck: axial (*left*), coronal (*middle*), and oblique sagittal (*right*) dual-echo steady state MENSA (Multi-Echo iN Steady-state Acquisition) curved multiplanar reconstructions demonstrate asymmetric enlargement and signal hyperintensity of the left mastoid, extratemporal, and intraparotid segments of the left facial nerve (*solid arrow*) relative to the right (*dotted arrow*).

the parotid duct and retromandibular vein with high signal intensity relative to low signal background by utilizing 3D DESS with water excitation on a 1.5T magnet in healthy subjects [12]. In our study, using the specialized coil and deep learning reconstruction techniques, isotropic voxels of 0.7-0.8 mm thickness were obtained, compared to 1.5 mm thickness in the study by Qin and colleagues [12]. In addition, Fujii et al. showed in a retrospective sample of 90 patients with intraparotid tumors that the location of the mass could be reliably differentiated from the intraparotid facial nerve segments utilizing 3D DESS with water excitation [13]. The combination of advantages from the FID and spin-echo signal from the FISP and PSIF sequences, respectively, allowed for the high resolution anatomic detail of the facial nerve, similarly seen in our patient case of Bell's palsy.

In a different variation of technique, Chu and colleagues utilized a 3D-PSIF-diffusion weighted protocol on a 3.0T MR system to evaluate the intraparotid facial nerve in a sample of healthy volunteers, comparing the use of a head coil versus a surface coil centered over the parotid gland. They demonstrated complete visualization of the main facial nerve trunk and cervicofacial and temporofacial divisions with both types of coils, and greater visualization of secondary intraparotid branches with use of the surface coil [7]. The use of this steady state free precession diffusion weighted technique takes advantage of the anisotropic characteristics of the peripheral facial nerve to provide high contrast of the nerve from surrounding tissue [7]. While MENSA is not a diffusion weighted sequence, it utilizes properties of time-reversed steady state free precession to accentuate long T2 signals.

Our case demonstrates that the relatively new MR protocol technique can be beneficial to the diagnosis and management of Bell's palsy affecting the extracranial segments of the facial nerve. The MENSA technique in delineated the extracranial facial nerve segment abnormality, enabled by a high channel count neck coil [9]. While the majority of Bell's palsy cases can be diagnosed based on patient presentation, we hypothesize that the ability to delineate changes of the extracranial facial nerve segments may have prognostic implications. Identifying the extracranial involvement of the nerve may allow for targeted localized injections and treatments that could help to alleviate the facial weakness and decreased function affecting these patients. Additionally, other implications of precise delineation of intraparotid facial nerve branches include preoperative planning for intraparotid mass resection, as has been investigated in previous studies [13].

Conclusion

We presented a case of acute Bell's palsy in a pregnant patient for which we utilized a double-echo steady state MR neurography technique to visualize the extracranial segments of the facial nerve. The neurography technique was beneficial in demonstrating signal and morphology change of the affected intraparotid segment of the facial nerve. The technique can have prognostic value in allowing for localized targeted treatments and to monitor disease progression. Further, the high-resolution technique may be used in the evaluation of additional extracranial facial nerve pathologies, such as intraparotid masses.

Patient consent

Consent was obtained for research purposes from the patient included in the case report.

REFERENCES

[1] Baugh RF, Basura GJ, Ishii LE, Schwartz SR, Drumheller CM, Burkholder R, et al. Clinical practice guideline: Bell's palsy. Otolaryngol Head Neck Surg 2013;149:S1–27. doi:10.1177/0194599813505967.

[2] Katz A, Sergienko R, Dior U, Wiznitzer A, Kaplan DM, Sheiner E. Bell's palsy during pregnancy: is it associated with adverse perinatal outcome? Laryngoscope 2011;121:1395–8. doi:10.1002/lary.21860.

[3] Gilden D. Bell's Palsy. NEJM 2004;351:1323–31.

[4] Chhabra A, Bajaj G, Wadhwa V, Quadri RS, White J, Myers LL, et al. MR neurographic evaluation of facial and neck pain: normal and abnormal craniospinal nerves below the skull base. Radiographics 2018;38:1498–513. doi:10.1148/rg.2018170194.

[5] Leonetti J, Marzo S. Extratemporal Causes of Facial Paralysis. In: Slattery WH, Azizzadeh B, editors. The facial nerve. Stuttgart: Georg Thieme Verlag KG; 2014. p. 125–8.

[6] Gupta S, Mends F, Hagiwara M, Fatterpekar G, Roehm PC. Imaging the facial nerve: a contemporary review. Radiol Res Pract 2013;2013:248039. doi:10.1155/2013/248039.

[7] Chu J, Zhou Z, Hong G, Guan J, Li S, Rao L, et al. High-resolution MRI of the intraparotid facial nerve based on a microsurface coil and a 3D reversed fast imaging with steady-state precession DWI sequence at 3T. AJNR Am J Neuroradiol 2013;34:1643–8. doi:10.3174/ajnr.A3472.

[8] Motamedi O, Mohebbi S, Samimi K, Borjian MA. Extracranial facial nerve imaging in parotid surgery candidates. Could 1.5 T MRI be beneficial? Imaging 2023;15:37–44. doi:10.1556/1647.2023.00121.

[9] Abel F, Tan ET, Lunenburg M, van Leeuwen C, van Hooren T, van Uden M, et al. Flexible array coil for cervical and extraspinal (FACE) MRI at 3.0 Tesla. Phys Med Biol 2023;68:215011. doi:10.1088/1361-6560/ad0217.

[10] Hu S, Li Y, Hou B, Zhang Y, Liu WV, Wu G, et al. Multi-echo in steady-state acquisition improves MRI image quality and lumbosacral radiculopathy diagnosis efficacy compared with T2 fast spin-echo sequence. Neuroradiology 2023;65:969–77. doi:10.1007/s00234-023-03130-z.

[11] Sneag DB, Queler SC, Campbell G, Colucci PG, Lin J, Lin Y, et al. Optimized 3D brachial plexus MR neurography using deep learning reconstruction. Skeletal Radiol 2024;53:779–89. doi:10.1007/s00256-023-04484-4.

[12] Qin Y, Zhang J, Li P, Wang Y. 3D double-echo steady-state with water excitation MR imaging of the intraparotid facial nerve at 1.5T: a pilot study. AJNR Am J Neuroradiol 2011;32:1167–72. doi:10.3174/ajnr.A2480.

[13] Fujii H, Fujita A, Kanazawa H, Sung E, Sakai O, Sugimoto H. Localization of parotid gland tumors in relation to the intraparotid facial nerve on 3D double-echo steady-state with water excitation sequence. AJNR Am J Neuroradiol 2019;40:1037–42. doi:10.3174/ajnr.A6078.