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TECHNICAL NOTE

Identification of Cranial Nerve Impingement Using 3-Dimensional Constructive Interference in Steady State Sequence

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ABSTRACT

The use of 3-dimensional constructive interference in steady state magnetic resonance imaging sequence in the evaluation of vascular loops related to the various cranial nerves in patients with cranial neuropathies and a healthy population is described.

Key Words: *Cranial nerves, Magnetic resonance imaging*

INTRODUCTION

Cranial neuropathies due to vascular impingement on cranial nerves are well-documented in the neuroscience literature. Such conditions can be seriously debilitating, especially when the trigeminal, facial, vestibulocochlear, and/or hypoglossal nerves are involved.[1-7] Detailed pre-operative imaging is highly useful for identifying the offending vessels and their relationship to the cranial nerves. Vascular impingement of a particular nerve may indicate the need for neurovascular decompression surgery.

TECHNIQUE

Patients at the King Abdulaziz University Hospital in Saudi Arabia with cranial neuropathy were scanned on a 1-T superconductive magnetic resonance imager (MRI) with 18-m T/m maximum gradient capability (Magnetome Impact Expert, Siemens, Erlangen, Germany) and a standard head coil. The 3-dimensional (3-D) constructive interference in steady state (CISS) sequence parameters consisted of TR/TE/excitation of 12.2/5.9/1, flip angle of 70°, matrix of 256 x 512, and field of view of 160 x 160 mm. An axial 4.9 cm slab was imaged and divided into 70 sections (slice thickness, 0.7 mm). The average acquisition time was 6 minutes — similar techniques with minimal manufacturer specific modifications can be applied to other 1-T and 1.5-T MR units).

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For all patients, 3-D CISS sequences produced detailed images of the cerebellopontine angles and the internal auditory canals with visualisation of the cisternal and intracanalicular segments of the facial nerve and the various components of the vestibulocochlear nerve complex. Similarly, various vascular loops abutting the section plane or impinging on the facial nerves were also visualised (Figure 1).

DISCUSSION

Although MRI is useful for evaluation of vascular impingement of the cranial nerves, the exact relation of the vascular loop to the affected nerve is often difficult to assess using conventional MRI sequences. The 3-D CISS sequence provides detailed images of the cerebellopontine angles, internal auditory canals, root exit zone, and cisternal and intracanalicular segments of the cranial nerves.[8-10]

There appears to be a strong correlation between vascular impingement of the trigeminal, facial, vestibulocochlear, and hypoglossal nerves and nerve dysfunction. However, the significance of the exact anatomic relationship between the vascular loops and the adjacent nerves remains unconfirmed. Some of the vessels are noted to be displacing in nature, while others are only abutting, or in the same plane of the nerve.[11-13]

To evaluate the small vascular loops and dolichoectatic arteries in the cerebellopontine angles and the internal auditory canals, a technique with high in-plane resolution, thin section, and minimal or no cerebrospinal fluid (CSF) pulsation artefact is needed. Routine spin

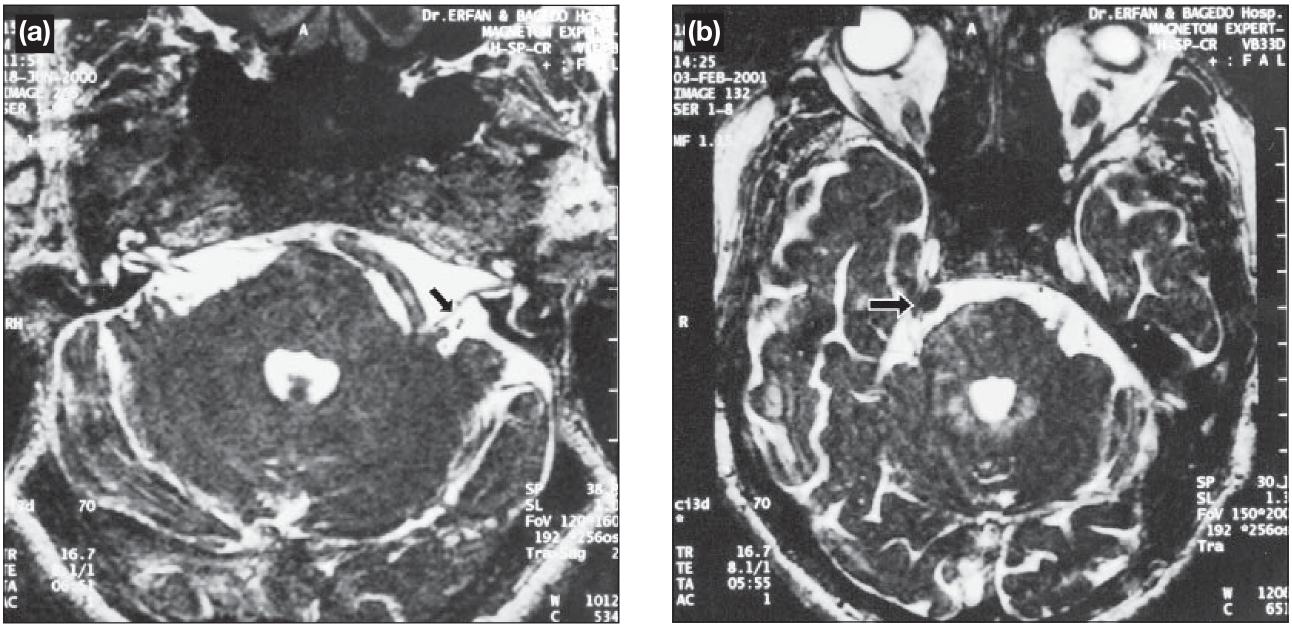

Figure 1. Axial 3-dimensional constructive interference in steady state magnetic resonance imaging scan at the level of the pons shows (a) impingement on the root exit zone of the left facial nerve by a dolichoectatic basilar artery in a patient with left hemifacial spasm (arrow identifies the left facial nerve); and (b) impingement on the right trigeminal nerve by the basilar artery in a patient with right trigeminal neuralgia (arrow identifies the right trigeminal nerve).

echo and fast spin echo sequences cannot usually acquire slices thinner than 2 mm. Such a slice thickness is not appropriate for the evaluation of small vascular structures. Similarly, these routine sequences have significant intraventricular and cisternal CSF pulsation artefacts.

The 3-D CISS sequence is a unique sequence in which 2 sets of 3-D Fourier transformation data are acquired using fast imaging with steady state precision. These sets of data are acquired using alternating and non-alternating radiofrequency pulses that cancel out the low frequency artefacts and produce images with high field homogeneity and superior soft tissue to CSF contrast.[14] The 3-D data acquisition technique enables slices of less than 1 mm to be obtained, while the absence of CSF artefacts and the high soft tissue to CSF contrast allows the identification of small anatomic structures such as the facial nerve and various vascular loops that are present in its vicinity.

The inherent multi-plane capability of the MRI adds an extra advantage since it allows the application of the 3-D CISS sequence in any desired plane. Although we apply 3-D CISS sequence in the axial plane only in routine practice, multiplanar reformation in any ortho-gonal planes (coronal, parasagittal, and sagittal) is pos-sible. This is made possible by the 3-D slab acquisition nature of this technique and the extremely thin partitions that result in near isometric voxels. Such additional reformatted images may be helpful to further outline the vascular and nerve anatomy for cases that cannot be resolved using the axial images alone.

The examination time for this technique is approximately 6 minutes using the 1-T magnet. However, with the continuous improvement in MRI technology and the use of magnets with higher magnetic fields, the acquisition time could be significantly shorter, making it possible to add this sequence whenever the clinical scenario indicates cranial neuropathy without any significant time penalty.

In conclusion, this sequence is valuable for demonstrating the anatomic relationship between various vascular loops and the cranial nerves in patients with cranial neuropathies.

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