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Magnetic Resonance Cisternographic Evaluation of Glossopharyngeal, Vagus, and Accessory Nerves

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Abstract

Purpose: The individual visualization of the glossopharyngeal, vagus, and accessory nerves has been a troublesome issue. After the recent developments in the microsurgical field, the detailed knowledge of the relationship of these nerves and the tumour has gained importance. The purpose of this study is to compare the visibility of each of these nerves.
Methods: Thirty patients (M/F: 14/16; mean age 52.46 years) with complaints of vertigo, tinnitus, and hearing loss were examined with routine temporal magnetic resonance imaging (MRI) study. The imaging protocol consisted of 3-dimensional fast imaging with steady state acquisition in axial and sagittal oblique planes in addition to routine sequences. These images were transferred to a workstation and reformatted. Visibility of the nerves was evaluated by consensus of 2 radiologists who used an evaluation scale of 2 (excellently visible), 1 (partially visible), to 0 (not visible).
Results: In 26 patients, both sides were scanned; in 4 patients, only one side was scanned. A total of 168 nerves were investigated. The rates for visualization for each nerve were as follows: glossopharyngeal nerve, 100% and 100%; vagus nerve, 67.9% and 100%; and accessory nerve, 10.8% and 83.85% on axial and sagittal oblique 3-dimensional fast imaging with steady state acquisition, respectively.
Conclusions: Glossopharyngeal, vagus, and accessory nerve assessment improved when images were obtained in the sagittal oblique plane to the jugular foramen.

Résumé

Objet: La visualisation et l'individualisation des nerfs glosso-pharyngiens, vagues et spinaux ont longtemps posé problème. Devant les récentes avancées de la microchirurgie, il est devenu important de connaître et de décrire le trajet de ces nerfs ainsi que leur relation avec les processus tumoraux locaux. Le but de cette étude est d'évaluer et de comparer la visibilité de ces nerfs.
Méthodes: Trente patients (14 hommes et 16 femmes; âge moyen de 52,46 ans) atteints de vertige, d'acouphène et de perte auditive ont bénéficié d'une exploration de l'oreille et de la base du crâne en imagerie par résonance magnétique (IRM). Le protocole comportait en sus de l'exploration habituelle une séquence 3D FIESTA en acquisition axiale et sagittal oblique. Les données étaient ensuite transférées sur console de travail et reconstruites. La visibilité des nerfs a été évaluée après consensus d'une lecture faite par deux radiologues suivant l'échelle de visibilité suivante : 2 : excellente, 1 : partielle et 0 : nulle.
Résultats: En tout, 56 côtés de 30 patients ont été évalués. Un total de 168 nerfs a été examiné. Les taux de visibilité en séquence 3D FIESTA en acquisition axiale et sagittal oblique étaient respectivement de 100 et 100 % pour le nerf glosso-pharyngien, de 67.9 et 100 % pour le nerf vague et de 10.8 et 83.35 % pour le nerf spinal.
Conclusions: La visibilité et l'individualisation des nerfs glosso-pharyngiens, vagues et spinaux étaient meilleure en acquisition 3D FIESTA lorsqu'un plan sagittal oblique au foramen jugulaire était utilisé.

Key Words: Magnetic resonance imaging; Cisternography; Vagus nerve; Glossopharyngeal nerve; Accessory nerve

The detailed evaluation of posterior fossa tumours and the surrounding neurovascular structures has gained importance after new developments in microsurgical techniques. The visualization of the glossopharyngeal nerve (CN IX), vagus

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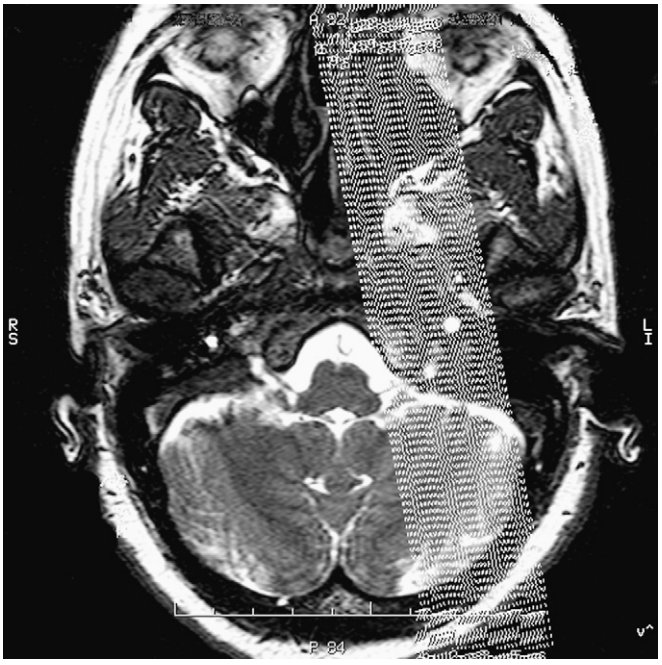

Figure 1. The 3-dimensional fast imaging with steady state acquisition sequence is obtained in the sagittal oblique plane in addition to the routine axial plane.

nerve (CN X), and accessory nerve (CN XI) in the cistern and jugular foramen level in relation to tumour have been a troublesome issue. Castillo and Mukherji [1] remarked about the potential role of combination of computed tomography (CT) and magnetic resonance imaging (MRI) in extensive evaluation of those nerves from the base of skull to the upper thorax. Nowadays, MRI has become the mainstream imaging modality [2]. MRI allows detailed evaluation of the nuclear origins and the normal course of the cranial nerves. CN IX, X, and XI are intimately located. They are regarded as a unit, the lower cranial nerve complex [1]. It is usually impossible to individually differentiate one from the other with routine MRI sequences. However, it is important to evaluate the nerves before surgery. The newer MRI sequences have potential for much better evaluation [3]. Contrast-enhanced 3-dimensional (3D) magnetization prepared rapid gradient echo (MP-RAGE) and 3D constructive interference steady state (CISS) sequences demonstrated the encasement of CN IX-XI in a case of adult pilocytic astrocytoma before surgery [4]. A broader study showed superiority of 3D sequences (CISS and MP-RAGE) when compared with 2-dimensional (2D) TSE T2-weighted sequences [5]. There few studies of MR (magnetic resonance) cisternography that used fast imaging with steady state acquisition (FIESTA) [6–8]. A selected group of posterior fossa tumour cases (12 schwannomas, 8 meningiomas, 3 epidermoid cysts) were successfully evaluated by 3D FIESTA sequence before surgery [6].

In this study, we sought to determine whether obtaining the images in the sagittal oblique plane could enhance the visualization of the glossopharyngeal, vagus, and accessory nerves compared with axial plane, which, in turn, could provide quick and reliable localization of the tumour-nerve intersurface at the jugular foramen–cistern level.

Materials and Methods

Thirty patients (M/F: 14 /16; mean age 52.46 years) with complaints of vertigo, tinnitus, and hearing loss were examined with a routine temporal MRI study. All examinations were performed on a 1.5 T whole-body MRI system (Excite; GE Medical Systems, Milwaukee, WI), with a 33 mT/m maximum gradient capacity. The imaging protocol consisted of 3D FIESTA (relaxation time [TR], 4.8 ms; echo time [TE], 1.4 ms; slice thickness, 0.5 mm; field of view [FOV], 18 × 18 cm; matrix, 352 × 192; number of excitations [NEX], 4) in the sagittal oblique plane in addition to routine sequences. The scans of the patients were in the sagittal oblique plane, which was more or less perpendicular to the nerves that pass through the jugular foramen (Figure 1). The imaging protocol of a temporal MRI study included the axially obtained 3D FIESTA. The images were transferred to an Advantage Workstation 4.0 (GE Medical Systems) and reformatted. A routine temporal MRI study included axial T1 W, T2 W, 3D FIESTA, and postcontrast axial and coronal T1 W sequences. The contrast agent used was 0.2 mL/kg gadolinium. T2 W images were obtained with fast spin echo sequences. The parameters for routine imaging were as follows: T1 W (TR, 500 ms; TE, 15.7 ms; slice thickness, 3 mm; interslice gap, 0.5 mm; FOV, 20 × 20 cm; matrix, 320 × 224; NEX, 3), T2 W (TR, 3000 ms; TE, 104.8 ms; slice thickness, 3 mm; interslice gap, 0.5 mm; FOV, 20 × 20 cm; matrix, 320 × 224; NEX, 3), 3D FIESTA (TR, 4.8 ms; TE, 1.4 ms; slice thickness, 0.5 mm; FOV, 18 × 18 cm; matrix, 352 × 192; NEX, 4). The consent forms were obtained according to the institutional guidelines. The visibility of 168 nerves was evaluated by consensus of 2 radiologists by using an evaluation scale of 2 (excellently visible), 1 (partially visible), to 0 (not visible). Cisternal parts of CN IX-XI were followed from the root exit zone from the brainstem to the cranial exit from jugular foramen on

Table 1
Visualization rates of CN IX, CN X, and CN XI on axial and sagittal oblique 3D FIESTA

	CN IX			CN X			CN XI		
Visualization rate	2	1	0	2	1	0	2	1	0
Axial 3D FIESTA, %	94.6	5.4	0	27.1	40.8	32.1	1.7	9.1	89.2
Sagittal oblique 3D FIESTA, %	100	0	0	100	0	0	80.3	3.55	16.15

CN IX = glossopharyngeal nerve; CN X = vagus nerve; CN XI = accessory nerve; 3D FIESTA = 3-dimensional fast imaging with steady state acquisition.