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The value of the heavily T2-weighted sequence in evaluation of the cisternal and petroclival segment of the abducent nerve

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The purpose of the study was to evaluate the usefulness of magnetic resonance (MR) in imaging of the cisternal and petroclival segments of the abducent nerve. Heavily T2-weighted submillimetric 3D sequence in axial plane, T1-weighted 3D, 1.5 mm slice thickness sequence in axial plane and TOF sequence were performed on 16 volunteers. Additionally the reformatted T2-weighted images in sagittal and in oblique parasagittal plane parallel to the abducent nerve in the pontine cistern were performed. The heavily T2-weighted sequence provides high contrast between fluid and other structures. High signal intensity of the cerebrospinal fluid is a kind of background for cranial nerves, vessels, meninges as well as for bony and fibrous structures. The authors identified the abducent nerve in at least one plane of the submillimetric, heavily T2-weighted sequences in 84.4% cases (in 84.4% in axial plane, 68.8% in sagittal and 84.4% parasagittal parallel to the VI-th cranial nerve in the pontine cistern). Dorello's canal was identified in 27/32 abducent nerves (84.4%) on the submillimetric, heavily T2-weighted sequence in parasagittal parallel to the abducent nerve in the pontine cistern plane. In 71.9% (23/32) of cases, the abducent nerve was in contact with the arterial vessel in pontine cistern.

key words: abducent nerve, magnetic resonance imaging, heavily T2-weighted sequence

INTRODUCTION

The abducent nucleus is located in the lateral part of the medial eminence of the pons [1,3,6].

The abducent nerve exits the brainstem at the pontomedullary sulcus. In the pontine cistern the cisternal segment of the sixth nerve passes superiorly, anteriorly and laterally.

The nerve pierces the dura of the posterior sphenoid bone and enters the osteofibrous canal in the petrous apex known as Dorello's canal. After leaving Dorello's canal, the nerve enters the posteroinferior aspect of the cavernous sinus. This part of the nerve is called a petroclival segment.

The next segment of the abducent nerve courses within the cavernous sinus proper inferolateral to the cavernous portion of the ICA. It passes through the superior orbital fissure to the orbit where it supplies the lateral rectus muscle which is responsible for lateral horizontal ocular movement [1,6].

MATERIAL AND METHODS

Patients

Our study included 16 healthy volunteers (10 women and 6 men). The average age of the patients was 38 years (range 20–49 years).

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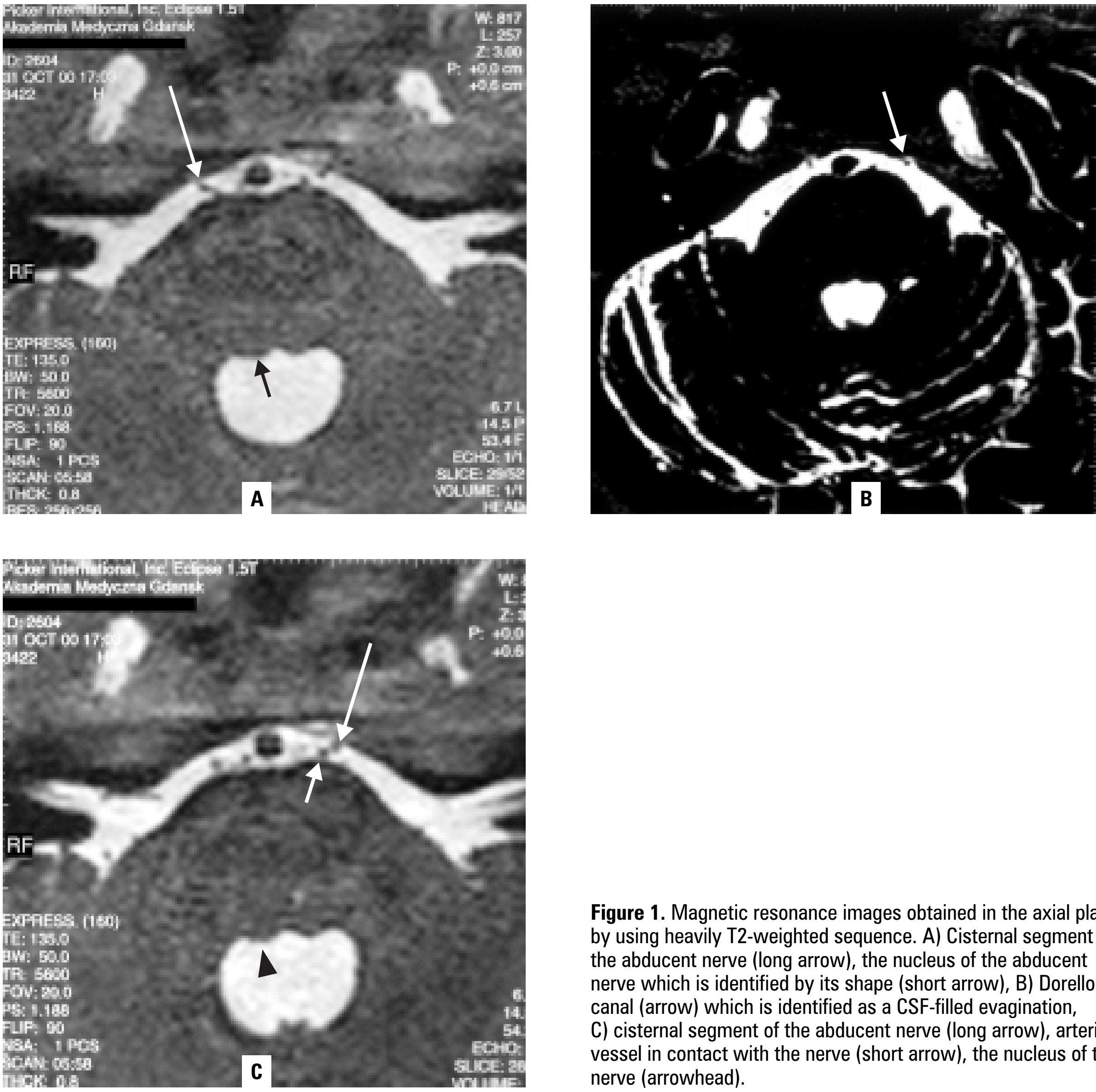


Figure 1. Magnetic resonance images obtained in the axial plane by using heavily T2-weighted sequence. A) Cisternal segment of the abducent nerve (long arrow), the nucleus of the abducent nerve which is identified by its shape (short arrow), B) Dorello's canal (arrow) which is identified as a CSF-filled evagination, C) cisternal segment of the abducent nerve (long arrow), arterial vessel in contact with the nerve (short arrow), the nucleus of the nerve (arrowhead).

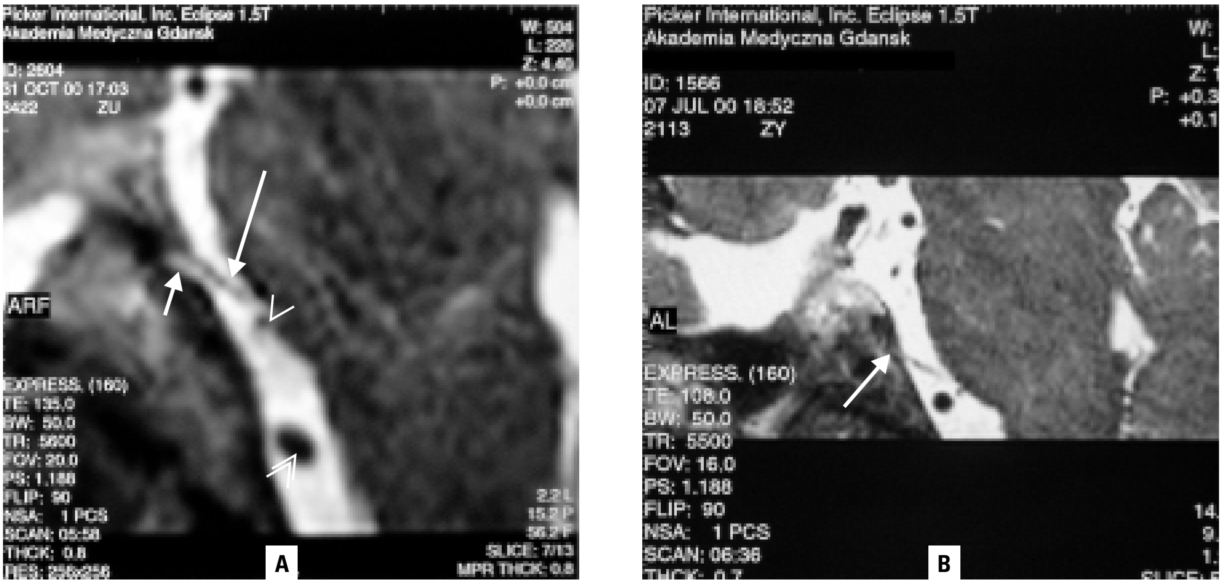
Examination protocol

MRI examinations were performed on a 0.5 T Philips Gyroscan NT and 1,5T Eclipse Picker using a standard head coil. Four sequences were used: 1) SE PD/ /T2 sequence (TR 2200 ms, TE 20/80 ms, FA 90, slice thickness 6 mm, gap 0.6 mm, NSA 1 in axial plane, 2) T2/3D/TSE-weighted sequence (TR 4000 ms, TE 250 ms, NSA 2, FOV 140, slice thickness 0.8 mm, or T2/ /3D/FSE-weighted sequence (TR 6600 ms, TE 1350 ms, FA 90, NSA 1, slice thickness 0.8 mm, matrix 256 × 256), axial planes 3)T1/3D/ FFE-weighted sequence (TR 30 ms, TE 13 ms, FA 3, NSA 1, slice thickness 1.5 mm, matrix 256 × 256 or TR 20 ms, TE 4.6 ms, FA 30, NSA1, slice thickness 1mm, matrix 256 × 256) in axial plane 4) time of flight (TOF) sequence in axial plane (TR 31 ms, TE 6.9 ms, FA 25, slice thickness 0.7 mm, NSA 1, matrix 256 × 256 or TR 20 ms, TE 2.9 ms, FA 15, NSA 2, slice thickness 1.0 mm, matrix 256 × 256).

The set of data obtained using the T2/3D/TSE (T2/ /3D/FSE) sequence in axial plane was reconstructed in sagittal and parasagittal plane parallel to the abducent nerve in pontine cistern with 0.6 or 0.8 mm slice thickness.

RESULTS

The cisternal segment of the abducent nerve was seen in heavily, submillimetric T2-weighted at axial plane in 84.4% (Fig. 1), at sagittal in 68.8%, at parasagittal plane parallel to the nerve in the pontine cistern in 84.4% (Fig. 2). The abducent nerve



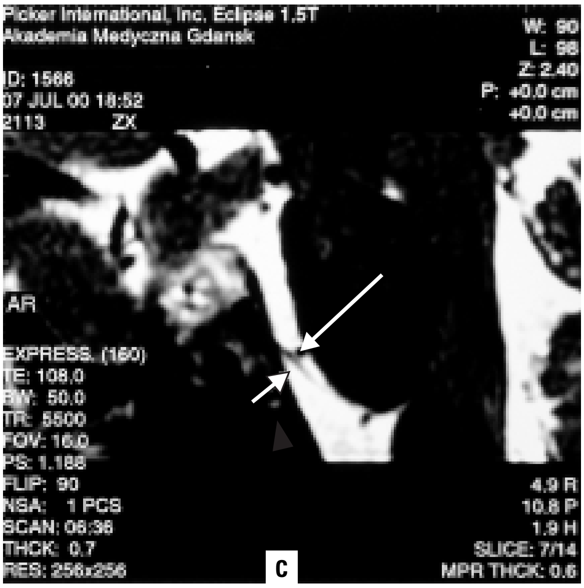


Figure 2. Magnetic resonance images in parasagittal parallel to the abducent nerve in pontine cistern nerve plane. A) The abducent nerve in the pontine cistern (long arrow). Dorello's canal (short arrow), AICA (arrowhead) inferior to the nerve, basilar artery (double arrowhead), B) Dorello's canal (arrow); C) AICA (long arrow) is superior to and in contact with the nerve (short arrow).

was seen in all performed parasagittal reconstructed plane. We did not perform the reconstruction in parasagittal planes when the abducent nerve was not seen at axial plane. We could not identify the abducent nerve using either T1/3D/FFE or TOF sequence in any case (Table 1).

Dorello's canal was identified in 84.4% and the entry point of the VI-th cranial nerve to the cavernous sinus was identified in 84.4% cases on the heavily T2-weighted sequence in the parasagittal plane parallel to the abducent nerve in the pontine cistern. It was always possible to identify Dorello's canal in parasagittal parallel to the abducent nerve in the prepontine cistern plane.

Table 1. Identification of the cisternal segment of the abducent nerve in performed sequences

Sequence	Visible		Invisible	
	R	L	R	L
Heavily T2/3D axial	14	13	2	3
Heavily T2/3D sagittal	11	10	5	6
Heavily T2/3D parasagittal	14	13	2	3
FFE/3D/T1 axial	0	0	32	32
TOF	0	0	32	32

We defined contact between the abducent nerve and a blood vessel as a lack of CSF between them on the heavily T2-weighted, submillimetric images. We identified the vessel by following its course to the parent artery or vein and compared vessels identified on heavily T2-weighted images with corresponding structures identified on TOF images. We found nerve-vessel contact with abducent nerve in 71.9% (26/32 nerves).

DISCUSSION

MRI is the first method which allows for direct visualisation of the cranial nerves. Submillimetric 3D, long TR and long TE (heavily) T2-weighted images allow for an evaluation of the detailed anatomy of the cranial nerves unequalled by any other imaging technique. In the heavily T2 sequence, high signal intensity of the cerebrospinal fluid in the basal cisterns is a kind of background for cranial nerves, vessels, dura as well as for bony and fibrous structures. One of the potential drawbacks of the T2--weighted sequence is fluid flow and pulsation sensitivity [2,4,6].

The abducent nerve is very difficult to identify on conventional magnetic resonance imaging because of its oblique course (in the prepontine cistern it runs superiorly, anteriorly and laterally) and its small cross-sectional area [6]. Because of arachnoidea which surrounds the abducent nerve in Dorello's canal, CSF can surround the petroclival segment for a variable distance into Dorello's canal [6].

We identified 84.4% of the abducent nerves in the prepontine cistern using the submillimetric (0.8 mm), heavily T2-weighted sequence. The axial plane and parasagittal plane parallel to the nerve in pontine cistern are better for identification of the abducent nerve than sagittal plane (Table 1). The high detection rate of the nerve is most probably related to the slice thickness (0.8 mm) without gap and high contrast between CSF and nerves/vessels. Yousry [6] identified the abducent nerve in 100% in one of three planes using 3D CISS sequence.

We could not identify the abducent nerve either in T1/3D/FFE or TOF sequence in any case.

Vessels which enter into some anatomical relationship with the abducent nerve are AICA, PICA, VA, BA and veins [5,6]. TOF sequence allows for the identification of the arteries but not the nerves. We found blood vessel contact with 71.9% of the abducent nerves. Yousry et al. [6] found contact between abducent nerve and blood vessel in 94.0%. Marinkovic et al. [5] found in post-mortem examinations that all abducent nerves were crossed and/or penetrated by the surrounding vessels.

The signal intensities of the vascular cisternal structures observed in the heavily T2-weighted sequence are indistinguishable from those of nerves and the identification of the abducent nerve can be confirmed by mapping the course of the structures, using the anatomical landmarks such as e.g. Dorello's canal or MR-angiography, which can be used in differentiation of these structures too.

Dorello's canal can be evaluated best only on parasagittal images parallel to the course of the nerve in the pontine cistern (Table 1).

CONCLUSION

The submillimetric, heavily T2-weighted sequence appears to be very useful for demonstrating the cisternal and petroclival segment of the abducent nerve.

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