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Mannitol as a Potential Pitfall for Peak Assignment on Magnetic Resonance Spectra (MRS) for Brain Tumors: A Case Report[1]

Jee Young Kim, M.D., Kookjin Ahn, M.D., Won Jong Yu, M.D., Ik Sung Park, M.D.[2], Bum-soo Kim, M.D.

Mannitol is a xenobiotic commonly used for the control of brain edema in patients with brain tumors. Although not typically identifiable with the use of routine proton magnetic resonance spectroscopy (MRS), we report a case where the mannitol peak was clearly visible on the MR spectra of a recurrent meningioma.

Index words : Magnetic resonance (MR), spectroscopy
Brain neoplasms, mannitol

Proton magnetic resonance spectroscopy (MRS) is a non-invasive technique that provides information about metabolites present in brain tissue. Thus, the use of MRS may potentially raise the diagnostic specificity and improve the diagnostic capacity of magnetic resonance imaging (MRI). Since MRS may provide additional information about patient prognosis and response to treatment, MRS has recently become a prevalent technique (1-3). It is rare to find examples of MRS that demonstrate the presence of a peak associated with mannitol, which is a substance commonly used to control cerebral edema in brain tumors. The presence of mannitol can cause confusion in the interpretation of MRS. We report here a case where recognition of a characteristic mannitol peak seen in the MR spectra of a 43-year-old woman with recurrent meningioma helped in the interpretation of MRS.

[1]Department of Radiology, College of Medicine, The Catholic University of Korea
[2]Department of Neurosurgery, Holy family Hospital, College of Medicine, The Catholic University of Korea
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Address reprint requests to : Kookjin Ahn, M.D., Department of Radiology, Kangnam St. Mary's Hospital, College of Medicine, The Catholic University of Korea, 505 Banpo-dong, Seocho-gu, Seoul 137-040, Korea.
Tel. 82-2-2241-7492 Fax. 82-2-599-6771 E-mail: Ahn-kj@catholic.ac.kr

Case Report

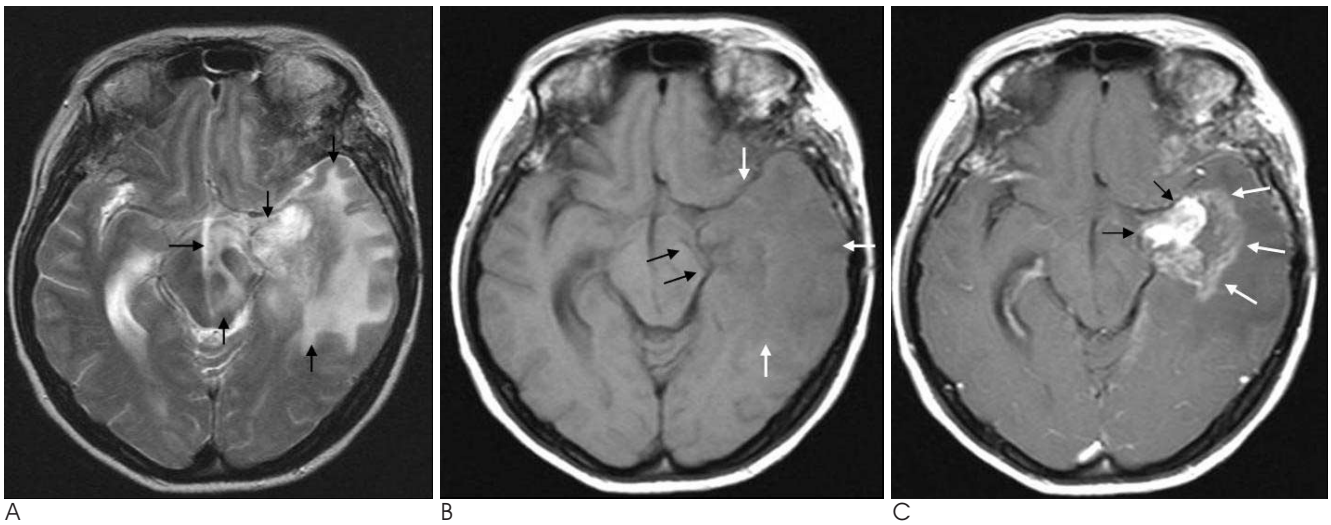
A 43-year-old woman presented with severe headache that had persisted for three days. The patient had a history of a meningioma located at the medial portion of the left middle cranial fossa. A partial resection had been performed eight years prior. The meningioma recurred at the resection site and the patient was treated four years after the initial resection with a dose of 6,400 cGy with radiation therapy for 48 days. Brain MRI performed upon admission showed a mass with strong contrast enhancement at the previous meningioma resection site with severe surrounding edema and heterogeneous enhancement (Fig. 1). A recurrent meningioma with radiation necrosis was suggested. For treatment of the cerebral edema, 2,500 ml of 25% mannitol was administered for four days. On the sixth day after the administration of mannitol, brain MRS was performed using a 1.5 T Signa Excite MR Scanner (GE Healthcare, Milwaukee, WI U.S.A.). Using a single-voxel point resolved spectroscopy sequence (PRESS; repetition time/echo time, 1,500/144 msec; number of excitations, 8; spectral width 2,500 Hz; number of data points, 2,048; voxel size, 2 × 2 × 2 cm), proton MR spectra of the mass, surrounding parenchyma and normal contralateral brain were obtained. The raw data were post-

processed by water-referenced correction of the eddy current effect, Lorenz-to-Gauss transformation, Gaussian line broadening filtering, zero-filling of 8K, Fourier transformation and zero-order phasing of the transformed spectra.

Major spectral peaks that occurred at 2.01, 3.03, 3.22 and 3.55 ppm were assigned to N-acetylaspartate (NAA), creatine and phosphocreatine (total Cr), choline-containing compounds (Cho) and glycine, respectively. The spectrum of the recurrent meningioma demonstrated reduced concentrations of NAA and a slightly increased concentration of Cho. The 1.33 ppm lactate double peaks were as large as the Cho peak. A large peak detected at 3.8 ppm did not correspond to any of the standard metabolites found in the brain (Fig. 2). The peak at 3.8 ppm was assigned to mannitol based on a comparison of a spectrum of the patient to a spectrum of a mannitol solution. Similarly, for the spectrum of the surrounding edema, a large peak was detected at 3.8 ppm. In the right insular region that showed normal signal intensity, a small peak was also detected at 3.8 ppm (Fig. 3).

Discussion

Mannitol is a cell-impermeable, non-toxic alcohol that has been widely used to reduce intracerebral pressure. Although its mechanism of action is controversial, especially in the case of vasogenic edema, mannitol has been reported to reduce cerebral pressure by elevating the os-



A B C

Fig. 1. An axial T2-weighted image (A) demonstrates diffuse high signal intensity in the left temporal lobe and left sided midbrain with gyral swelling (black arrows). This lesion shows diffuse low signal intensities in the left temporal lobe (white arrows) with mild compression of the left sided midbrain due to the mass effect (black arrows) on the axial T1-weighted image (B).
C. A Gd-enhanced axial T1-weighted image shows a strongly enhanced, irregular mass at the left medial temporal lobe representing a recurrent meningioma (black arrows) with a slightly enhancing mass in the temporal lobe adjacent to the recurrent meningioma, probably due to radiation necrosis (white arrows) and extensive edema in the left temporal lobe.

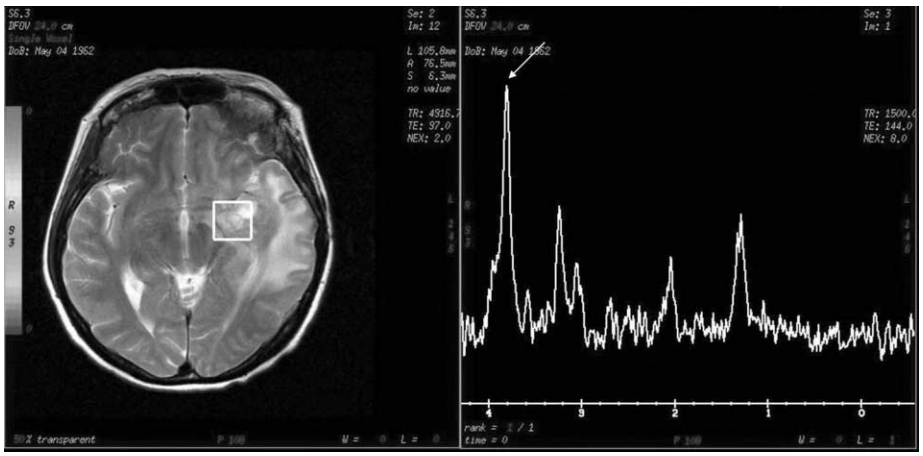


Fig. 2. A spectrum obtained from the strongly enhanced mass at the left medial temporal lobe shows a large peak at 3.8 ppm (arrow). The peak, assigned to mannitol, shows much higher intensity than the Cho and Cr peaks. The peak intensity of NAA at 2 ppm is markedly decreased. Increased intensity of the lactate peak at 1.3 ppm is similar to that of Cho.

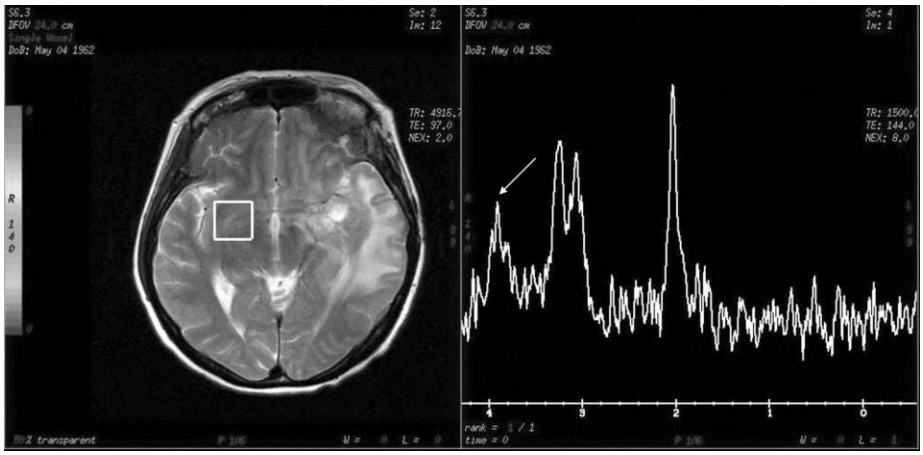


Fig. 3. A spectrum obtained from the normal right insular region also shows a small mannitol peak at 3.8 ppm (arrow).

motic pressure of cerebrospinal fluid and plasma and by reversibly opening the blood-brain barrier. Thus, mannitol reduces the rate of cerebrospinal fluid production and the amount of water in brain tissue (4).

Mannitol peaks are rarely seen on routine MR spectra. The mannitol peak occurs near the commonly detected 3.56 ppm myo-inositol peak and is therefore often overlooked. In this case, however, the mannitol peak was distinct. The clear mannitol peak was attributed to the large dose of mannitol that was administered and to an injured blood-brain barrier, which led to the accumulation of mannitol in the recurrent meningioma and surrounding edema. This situation produced a large mannitol peak in the recurrent meningioma and surrounding edema, but a small peak in the contralateral normal brain tissue.

Characteristically, mannitol is seen distinctly with short echo times (TE = 30 ms). As the echo time becomes longer, the signal is lost, leading to the disappearance of the mannitol peak for MRS obtained with a long echo time (TE = 270 ms). Loss of signal at a long echo time confirms that the peak does not arise from a normal brain metabolite (5). In this patient, although spectra were obtained with a relatively long echo time (144 ms), the mannitol peak was still distinct.

Other xenobiotics that may be detected on brain MRS are propylene glycol (a solvent for pediatric drugs), which is seen at 1.14 ppm, and ethanol (seen when a patient has consumed a large amount of alcohol), which peaks at 1.16 ppm. As with the mannitol peak, these peaks could potentially confuse the interpretation of MR spectra (6). Although a mannitol peak is rarely detected on routine MRS, recognizing a mannitol peak when it does appear greatly helps the interpretation of MRS for the diagnosis of tumors.

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뇌종양의 자기공명분광법 해석에 있어 잠재적 함정인 만니톨 피크: 증례 보고[1]

[1]가톨릭대학교 의과대학 영상의학과교실
[2]가톨릭대학교 의과대학 성가병원 신경외과

김지영 · 안국진 · 유원종 · 박익성[2] · 김범수

만니톨은 뇌종양 환자에서 뇌부종 치료를 위해 흔히 사용하는 생체 이물이나 일상적인 자기공명분광법에서는 잘 나타나지 않는다. 저자들은 재발성 수막종에서 시행한 자기공명분광법에서 특징적인 만니톨 피크가 보여 이를 보고하고자 한다.