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TECHNICAL NOTE

Classification of the venous architecture of the pineal gland by 7 T MRI

Classification de l'architecture veineuse de la glande pinéale en IRM 7 T

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Summary Magnetic resonance imaging (MRI) at 7.0 Tesla (7 T) can show many details of anatomical structures with unprecedented resolution and contrast. In this report, we describe for the first time the unexpected wide variation in pineal gland structure, as visualized by MR images obtained with 7 T in a group of healthy young volunteers. A total of 34 volunteers (22 men and 12 women) were enrolled in the study. Their 7 T MR images revealed such wide variations in pineal gland shape that it led us to attempt to classify the patterns seen in these pineal glands. Indeed, they were successfully correlated with a previous human cadaver study of venous structures by Tamaki et al., who classified the venous structures of the pineal gland into three categories. This is the first human in vivo pineal vein imaging study using 7 T MRI. Pineal venous imaging may permit the early diagnosis of a pineal tumor.

Introduction

The markedly improved resolution obtained with ultra-high-field magnetic resonance imaging (MRI), such as 7 T, can reveal many details of anatomical structures, such as the hippocampus and thalamus, with unprecedented resolution and contrast [1—3]. In this report, we describe in detail the anatomical structure of pineal glands on 7 T MR images as has never been seen before.

There is an unusually wide variation in the structure of pineal glands when observed by ultra-high-resolution 7 T MRI in vivo (Fig. 1). This prompted us to investigate the variability in the morphology of pineal glands and related vascular structures, as previously reported in postmortem human studies [4,5]. The present report presents the results of classification of the various venous blood-drainage morphologies on in vivo pineal gland images from 34 young healthy volunteers. This observation was made possible by the recently available ultra-high-field MRI at 7 T. As shown in Fig. 2 (upper), visualization of the pineal gland was largely limited by the poor resolution of the currently available commercial scanners, such as the 1.5 and 3.0 T MRI machines [6,7]. Ultra-high-field 7 T MRI, especially with its markedly

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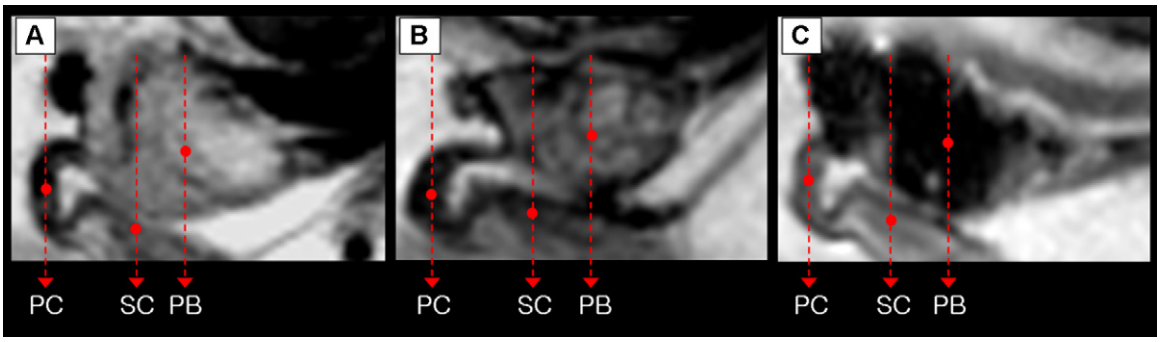

Figure 1 Widely varying shapes of pineal glands, as typically observed by 7 T MRI with T2* sagittal view: (a) nonspecific inner structure with streamlined external shape; (b) net-like inner structure with elliptical external shape; and (c) completely filled inner structure with a sharp external shape. PB: pineal body; PC: posterior commissure; SC: superior colliculus.

Table 1 MR imaging parameters used in the study.

	7 T MRI sagittal T2* image	3 T MRI sagittal T2* image
TR	750 ms	5790 ms
TE	21.6 ms	103 ms
Voxel resolution	0.25 mm × 0.25 mm × 2 mm	0.34 mm × 0.34 mm × 2 mm
Matrix size	896 × 1024	560 × 640

TR: repetition time; TE: echo time.

enhanced T2* imaging capability, however, allows visualization of details in the inner structures of the pineal gland (Fig. 2, lower), thereby permitting examination of the variations found in the inner structures of pineal glands.

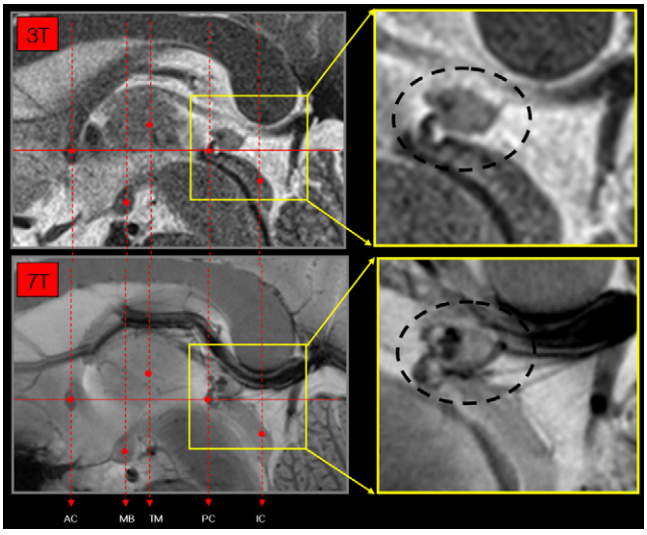

Figure 2 Comparison of images of pineal glands and their surroundings obtained in the same subject with 3 and 7 T MRI, respectively. The horizontal red lines indicate the anterior commissure (AC)—posterior commissure (PC) line; the vertical dotted red lines and red dots indicate landmark brain structures such as the AC, mammillary body (MB), thalamus (TM), PC and inferior colliculus (IC); the yellow boxes on the left of the images indicate the expanded view of the images seen on the right.

Case report a technical note

Altogether, 34 healthy volunteers (22 men and 12 women) were studied. The average age of the men was 25 years, and the average age of the women was 23 years. The study was approved by the Gachon University Gil Hospital Institutional Review Board and the Korea Food & Drug Administration. MRI was performed with a Siemens 7.0 T MRI (Magnetom; Siemens, Erlangen, Germany) scanner, using a home-built eight-channel transmitting-receiving (TX-RX) head coil.

A set of sagittal T2* contrast-enhanced MR images was obtained from each volunteer. In addition, to compare the quality of the ultra-high-resolution images with conventional MR images, a few additional 3.0 T MRI (Verio; Siemens) images of the pineal gland were also obtained. The MR imaging parameters used in the study are summarized in Table 1. A typical dataset from the same subject is also displayed to show the resolution and contrast differences in images from the 3 and 7 T MRI scanners (Fig. 2). After collecting the images from the 34 volunteers, the various shapes and morphologies of the pineal vein were then classified (Fig. 3). In the postmortem human study mentioned above [4], it was also found that the structure of the pineal vein can be classified into three types, mainly based on the location of the draining veins. We therefore attempted to classify our sagittal-view pineal gland images according to that study's classification system, and found a close correlation between the two (Fig. 3, Table 2): Type I (15 men and 3 women); Type II (5 men and 7 women); and Type III (2 men and 2 women). Such an in vivo imaging classification of the pineal gland venous architecture in correlation with that of the postmortem studies is unique, thanks to the higher anatomical MRI resolution obtained at 7 T.