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The relationship between jugular bulb position and jugular bulb related inner ear dehiscence: a retrospective analysis☆

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ABSTRACT

Objective: High jugular bulb (HJB) can erode inner ear structures creating a jugular bulb related inner ear dehiscence (JBID). The aim of this study was to analyze the relationship between the position of jugular bulb (JB) and JBID using high-resolution computed tomography (HRCT).
Material and methods: In this retrospective study HRCT images of 552 ears of 276 patients with hearing loss, otogenic vertigo, tinnitus or idiopathic peripheral facial nerve paralysis were analyzed. HJB type-1 was defined when JB dome reached above the inferior part of the round window, but was below the inferior edge of the internal acoustic meatus (IAM). HJB type-2 was defined when the dome of JB was higher than the inferior edge of IAM. The frequencies and types of HJB were evaluated. JBID for each HJB type was determined. Frequencies of JBID eroding the vestibular aqueduct (VA), the cochlear aqueduct and the posterior semicircular canal were examined.
Results: HJB type-1 and HJB type-2 were found in 19% (105/552) and in 15.8% (87/552) of studied ears. JBID showed to be in 3.8% (21/552) of all ears. 90.5% (19/21) of JBID revealed eroding of VA. Jugular bulb related cochlear aqueduct dehiscence and jugular bulb related posterior semicircular canal dehiscence were found in one ear each. The frequency of jugular bulb related vestibular aqueduct dehiscence (JBVAD) in patients with HJB reaching above IAM was higher than in patients with HJB lower than IAM.
Conclusions: HJB is common, but JBID is rare. JBID prevalently erodes VA. HJB rising above IAM is most at risk to show JBVAD.

1. Introduction

The jugular bulb (JB) is the bulbiform connection between the sigmoid sinus and the internal jugular vein at the skull base. Its morphological structure is variable. Yetiser et al. discussed that the abnormal position of JB might be a potential reason for Meniere-like symptoms [1]. Recently, Friedmann et al. reported that JB abnormalities such as the high jugular bulb

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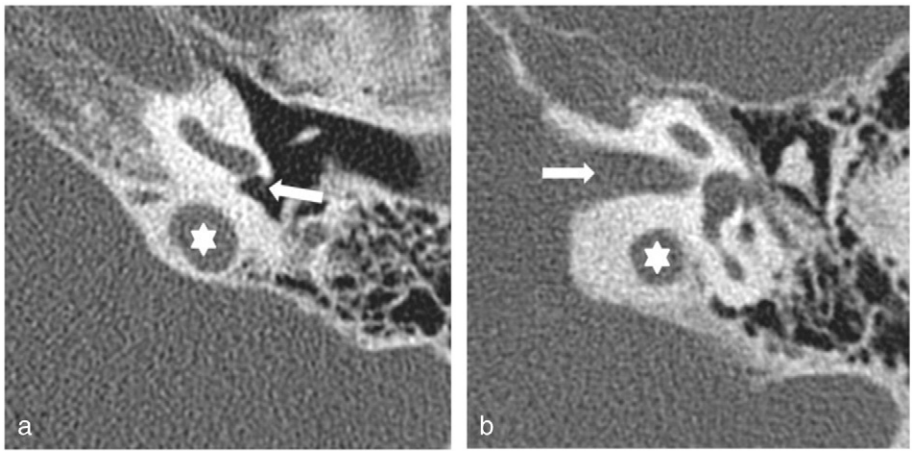

Fig. 1 – (a) High jugular bulb type-1, jugular bulb (JB) (*asterisk*) dome reaches above the inferior part of round window (*arrow*) on the axial image of temporal bone high-resolution computed tomography (HRCT). (b) High jugular bulb type-2, the dome of JB (*asterisk*) is higher than the inferior edge of the internal acoustic meatus (arrow) on the axial image of temporal bone HRCT.

(HJB) are not rare in population [2]. Moreover, HJB can erode into inner ear structures such as the vestibular aqueduct (VA) creating an inner ear dehiscence [2]. It has been described that jugular bulb related vestibular aqueduct dehiscence (JBVAD) may cause hearing loss, vertigo and pulsatile tinnitus [3,4]. On the other hand Kupfer et al. investigated the prevalence of JBVAD in pediatric patients and concluded that JBVAD plays a poor role in hearing loss [5]. Until now, only few studies have been conducted examining jugular bulb related inner ear dehiscence (JBID).

Couloigner et al. summarized various definitions and criteria for HJB [6]. HJB has been defined when the dome of JB reaches above the inferior part of the round window (RW) [7], the inferior edge of the internal acoustic meatus (IAM) [8], the inferior part of the cochlear [9] and the inferior bony annulus of the tympanic membrane [10]. For each type of HJB different occurrence rates were reported [6]. Until now it is not known how the type of HJB influences the occurrence of JBID. It has not been described which type of HJB is found most in JBID. Since inner ear structures lie at the skull base JB position and JB height should play a role in the development of JBID. The aim of this study was to evaluate the frequencies of HJB and JBID in adult temporal bones and to analyze the relationship between the height of JB and the incidence of JBID using high-resolution computed tomography (HRCT).

Table 1 – Frequencies of JBID (n).

	Total	JBID	JBVAD	JBCAD	JBPSD
Ear numbers	552	21 (3.8%)	19 (3.4%)	1 (0.2%)	1 (0.2%)

JBID: jugular bulb related inner ear dehiscence, n: number of ears, JBVAD: jugular bulb related vestibular aqueduct dehiscence, JBCAD: jugular bulb related cochlear aqueduct dehiscence, JBPSD: jugular bulb related posterior canal dehiscence.

2. Material and methods

This retrospective study analyzed HRCT images of 552 ears of 276 adult patients (117 men and 159 women) who had been examined in the Department of Otorhinolaryngology and Head and Neck Surgery and the Department of Radiology and Interventional Radiology at the University Hospital of Aachen from 2002 to 2013. Patients had undergone HRCT due to clinical workup of hearing loss, otogenic vertigo, tinnitus or idiopathic peripheral facial nerve paralysis. The age of patients ranged from 19 to 90 years (mean 52.5 years).

HRCT images were acquired using a spiral scanner (Tomoscan AV E1, Philips, Best, The Netherlands). All patients included in this study underwent scanning in supine position with the head reclined and the neck flexed. The scan plane was parallel to the infraorbital meatal line and the skull base. Images were acquired in sequential mode with a slice thickness of 0.7 mm without overlap between consecutive slices. Scanning parameters were 125 mA and 120 kV. The rotation time was 1 s. The images were reconstructed from raw data using a 512 × 512 matrix. The field of view was adapted to the subject's head size and varied between 176 and 185 mm. Accordingly, the pixel size ranged from 0.12 to 0.13 mm^2. It took about 15 min to finish an examination for one patient. Measurements were performed on a workstation (Easy Vision, Philips, Best, The Netherlands). All images were displayed with a window width of 1600 HU and a window center of 400 HU on double enlarged axial images.

The position of JB was assessed according to the following criteria. Normal JB height was defined when the dome of JB was below the inferior part of RW. HJB type-1 was defined when the JB dome reached above the inferior part of RW (Fig. 1a), but below the inferior edge of IAM. HJB type-2 was defined when the dome of JB was higher than the inferior edge of IAM (Fig. 1b). JBID was defined as any deossification between JB and VA, between JB and the cochlear aqueduct (CA) and between JB and the posterior semicircular canal (PSC) on at least two of either coronal, oblique sagittal or axial plane in HRCT. The frequencies of JBID and HJB were