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The Pitfalls and Important Distances in Temporal Bone HRCT of the Subjects with High Jugular Bulbs – Preliminary Report

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A – research concept and design; **B** – collection and/or assembly of data; **C** – data analysis and interpretation; **D** – writing the article; **E** – critical revision of the article; **F** – final approval of article; **G** – other

Abstract

Background. High jugular bulb (HJB) may be detected unilaterally or bilaterally in temporal bone high resolution computerized tomography (HRCT).

Objectives. In this retrospective study, we investigated the pitfalls and important surgical distances in patients with unilateral and bilateral HJB *via* temporal bone HRCT.

Material and Methods. In this preliminary report, the study group consisted of 20 adult patients (12 male, 8 female), or 40 ears, all of which underwent temporal bone HRCT. We divided them into groups that consisted of bilateral HJB (14 ears), unilateral HJB (13 ears), and control (No HJB, 13 ears). The anotomical relationships of the sigmoid sinus, jugular bulb, and carotid artery with several landmarks in the temporal bone were studied via temporal bone axial and coronal HRCT. The shortest distances between certain points were measured. These measurements were analyzed in respect to pneumatization. Dehiscence on the jugular bulb (JB) and internal carotid artery (ICA) and the dominance of JB were also evaluated for all of the groups.

Results. In the axial sections of the temporal bone HRCTs, the sigmois sinus (SS)-external auditory canal (EAC) distance of the bilateral HJB group (14.00 ± 1.17 mm) was significantly lower than that of the control group (16.46 ± 2.14 mm). The JB-posteromedial points of the umbo on the ear drum (ED) distance of the bilateral HJB (6.28 ± 1.72 mm) and the unilateral HJB groups (7.23 ± 2.00 mm) were significantly lower than that of the control group (11.15 ± 2.30 mm). In the coronal sections of the temporal bone HRCT, the JB-F distance of the bilateral HJB group (5.42 ± 2.10 mm) was significantly lower than that of the control group (8.30 ± 2.28 mm). As the mastoid pneumatisation and mastoid volume increased, the percentage of ICA-dehiscence and the percentage of JB-dehiscence increased.

Conclusions. In subjects with well-pneumatised mastoids, the doctors should be aware of the increased risk of ICA-dehiscence and JB-dehiscence. These measurements should be done in greater series to yield more thorough knowledge (**Adv Clin Exp Med 2015, 24, 2, 315–324**).

Key words: temporal bone high resolution computerized tomography, high jugular bulbus, mastoid pneumatisation, dehiscence on jugular bulb, dehiscence on internal carotid artery.

The jugular bulb varies widely in position and dimensions. If the jugular bulb, normally surrounded by a bony layer in the jugular fossa, is anatomically over the inferior surface of the bony annulus in the middle ear or over the basal turn of the cochlea, it is then named a high jugular bulb (HJB) [1]. Sometimes, there is dehiscence area of the normal petrous bony septum between the jugular bulb and middle ear [2]. A high jugular bulb is not an uncommon finding in temporal bones; it occurs in 6–20% of the general population. Abnormal bone formation, an aberrant sigmoid sinus and jugular system, or decreased pneumatization of the mastoid bone may predispose the ear to its occurrence. In some cases, this condition may be asymptomatic [3].

In mastoid surgery, trauma to the sigmoid sinus, jugular bulb, or carotid artery causes severe complications. Because of this matter, in the preoperative period, measurement of surgical landmarks to these vessels becomes very important in order to not destroy them. When the surgeon is confused by the patient's anatomy and manipulates the aforementioned to remove the disease and identify the location of these vessels, he or she puts these vessels at risk of injury. Moreover, injury of these vessels due to surgical trauma has been most commonly observed after mastoidectomy procedures. These findings prompted us to study the anatomical relationships of these vessels, namely, the sigmoid sinus, the jugular bulb, and the carotid artery [4].

The exact mechanism of the pneumatization of the mastoid air cell system and the factors influencing the pneumatization are poorly understood. Pneumatization has been linked to hereditary and genetic factors. It has also been related to the size of the skull and the height of the individual [5].

In the present retrospective study, we investigated the pitfalls and important surgical distances in patients with unilateral and bilateral high jugular bulbs (HJB). Temporal bone high resolution computerized tomography (HRCT) was used for this purpose. The shortest distances between two important anatomic points were measured. These measurements were also analyzed in respect to pneumatization, side differences (unilateral or bilateral), and the presence of HJBs. We aimed to provide a different view to surgeons who operate on patients with high jugular bulbs. Our results will provide a guide for clinical use and also contribute to the overall interpretation of the medical literature. We could not find any similar study about this matter in the literature. We want to present our results as a preliminary report. In the future, these results will be updated with a greater number of subjects.

Material and Methods

This retrospective study was assessed in the ear nose throat (ENT), radiology, and neurology departments at Kirikkale University Faculty of Medicine. The HRCTs of the temporal bones were performed by the Radiology Department of Kirikkale University Faculty of Medicine.

Subjects

In this preliminary report, the study group consisted of 20 adult patients (12 male, 8 female) and 40 ears, all of which underwent HRCT. These HRCT slides were retrospective data and were used in the authors' previous studies [6, 7]:

1. Fourteen ears were included in the bilateral HJB group. Seven subjects had bilateral high jugular bulbs upon reviewing their HRCTs.
2. Thirteen ears with unilateral HJB were included into the study (unilateral HJB group).
3. Thirteen ears without HJB comprised the control group.

The mean age of the patients was 55 years (range: 30 to 86 years).

Temporal Bone HRCT Evaluation

All patients in the study were evaluated with coronal and axial temporal bone HRCT. All HRCT scans were obtained on a Elsinct SeleCT (Picker SeleCT – Israel) (120 kV and 80 mA). Sections were obtained, with the patient breathing quietly, in the following sequence: 1.5 mm contiguous sections from the skull base to the upper mastoid bone surface.

The temporal bone axial and coronal HRCT sections were evaluated by one radiologist without knowledge of the clinical data; all scans were assessed for the presence or absence of the high jugular bulb and other anomalies of the temporal bone. The categorization of the high jugular bulb (a high-riding nondehiscent jugular bulb) as seen from the HRCT was bad if there was a high jugular bulb with diverticulum projecting a cephalad into the petrous temporal bone. When there was an absence of bone separating the jugular bulb from the middle ear cavity and the jugular bulb bulged into the middle ear cavity, it was cateogrized as a dehiscent jugular bulb [8].

In HRCTs of the temporal bone, we used special measurements on the high jugular bulb sides of the unilateral and bilateral HJB groups and on the non-high jugular bulb sides of the control group:

I. In the axial sections, the shortest distances were measured between:

1. Sigmoid sinus (SS) and aditus ad antrum (AA).
2. Sigmoid sinus (SS) and lateral surface of the mastoid (M).
3. Sigmoid sinus (SS) and lateral semisircular canal (LSSC).
4. Sigmoid sinus (SS) and lateral border of short process of incus (Is).

5. Sigmoid sinus (SS) and external auditory canal (EAC).

6. Jugular bulbus (JB) and posteromedial point of umbo on ear drum (ED).

7. Jugular bulbus (JB) and internal carotid artery (ICA) (this measurement was taken in the section containing the basal turn of the cochlea).

II. In coronal sections, the shortest distances were measured between the following:

1. Jugular bulbus (JB) and mastoid segment of facial nerve (F).

2. Jugular bulbus (JB) and lateral surface of mastoid (M).

3. Lateral surface of mastoid (M) and aditus ad antrum (AA).

4. Lateral surface of mastoid (M) and arcuate eminence (AE).

5. Internal carotid artery (ICA) and mastoid segment of facial nerve (F).

6. Internal carotid artery (ICA) and apex of cochlea (AC).

7. Internal carotid artery (ICA) and lenticular process of incus (Ilen).

8. Internal carotid artery (ICA) and lateral surface of mastoid (M).

III. In the axial and coronal sections:

1. Pneumatization of the mastoid was evaluated on a 0–3 scale (0 = none, 1 = low, 2 = intermediate, 3 = high degree of pneumatization).

2. The mastoid volume (CC × TR × AP) (mm^3) was measured.

IV. The other measurements:

1. The side diferences of the HJB (right or left ear) were also evaluated.

2. Dehiscence on the ICA.

3. Dehiscence on the JB.

4. Dominance: the dominant side of the jugular bulb was evaluated.

All steps of the study were planned and continued according to the principles outlined in the Declaration of Helsinki [9]. The local ethics committee of Adana Numune Education and Research Hospital approved this retrospective study (Date: October 5, 2012, No.: ANEAH.EK.2012/ 79).

Statistical Analysis

The statistical packet for SPSS (version 16.0) was used for statistical evaluation. The χ^2 test, the Kruskal Wallis variance analysis, the Mann Whitney *U* test with Bonferroni correction, and Spearman's correlation rho efficient test were used. A p value < 0.05 was considered as statistically significant.

Results

The measurements of the axial, coronal, and axial + coronal sections of the HRCTs in all of the groups are illustrated in Table 1. The mastoid pneumatization and mastoid volumes (CC × TR × AP) of all the groups are recorded in Table 1, Fig. 1. The mastoid volume values were 21.42 ± 11.81 mm^3 in the bilateral HJB group, 33.0 ± 19.54 mm^3 in the unilateral HJB group, and 32.96 ± 20.57 mm^3 in the control group. There was no significant difference between groups ($p < 0.05$). For each of the items, the difference between the bilateral HJB group, the unilateral HJB group, and the control group was analyzed using the Kruskal Wallis variance analysis. There was a statistically significant difference in the SS-EAC ($p = 0.013$) and JB-ED ($p = 0.000$) measurements of the axial sections and the JB-F ($p = 0.008$) measurement of the coronal sections.

To find the values that revealed a difference, we conducted pairwise comparisons with the Mann Whitney *U* test with Bonferroni correction (Table 2).

Axial Sections

The SS-EAC distance of the bilateral HJB group (14.00 ± 1.17 mm) was significantly lower than that of the control group (16.46 ± 2.14 mm) ($p = 0.002$) (Fig. 2).

The JB-ED distances of the bilateral HJB group (6.28 ± 1.72 mm) ($p = 0.000$) and the unilateral HJB group (7.23 ± 2.00 mm) ($p = 0.000$) were significantly lower than that of the control group (11.15 ± 2.30 mm) (Fig. 2, 3).

Coronal Sections

The JB-F distance of the bilateral HJB group (5.42 ± 2.10 mm) was significantly lower than that of the control group (8.30 ± 2.28 mm) ($p = 0.003$).

Dehiscence on the ICAs and JBs (Fig. 1, 2) and the dominance results (Fig. 4) of the groups are recorded in Table 3. For each of them, the difference between the groups was analyzed using the χ^2 test. There was a statistically significant difference for dehiscence on the ICAs ($p = 0.045$, X 2 = 6.206) and the JBs ($p = 0.009$, X 2 = 9.486). Dehiscence on the ICA occurred in 69.2% of the unilateral HJB group and in 35.7% of the bilateral HJB group, whereas it only occurred in 23.1% of the control group. Dehiscence on the JB was observed in 42.9.2% of the bilateral HJB group and in 23.17% of the unilateral HJB group, whereas

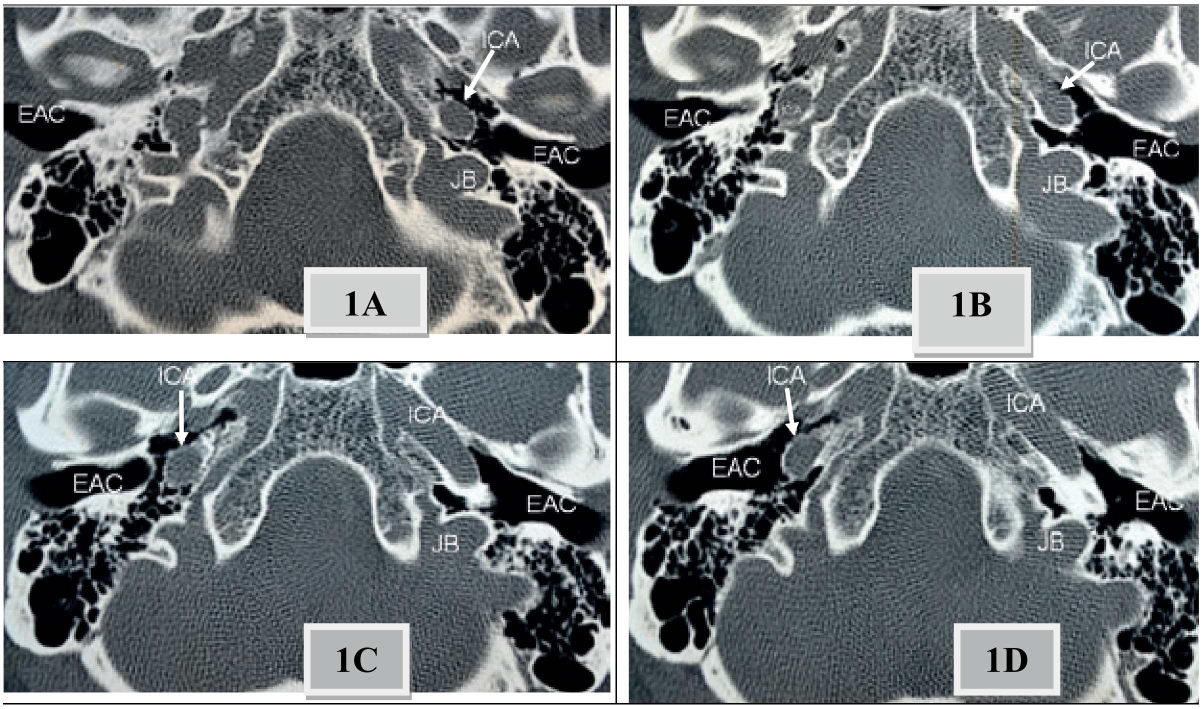

Fig. 1. Left unilateral high jugular bulb was demonstrated in the temporal bone HRCTs. Bilateral mastoid pneumatization was in high grade (+++) and there was bilateral ICA dehiscence. **1A**. Left ICA dehiscence (white arrow) was shown in the axial section of the temporal bone HRCT. **1B.** Left ICA dehiscence (white arrow) was shown in the axial section of the temporal bone HRCT. **1C**. Right ICA dehiscence (white arrow) was shown in the axial section of temporal bone HRCT. **1D.** Right ICA dehiscence (white arrow) was shown in the axial section of the temporal bone HRCT. EAC – external acoustic canal, JB – jugular bulb, ICA – internal carotid artery.

Table 1. Measurement results in bilateral HJB, unilateral HJB, and control groups

Section	Measurement (mm)	Bilateral HJB		Unilateral HJB		Control		p¶
		mean	std. dev.	mean	std. dev.	mean	std. dev.	
Axial	SS-AA	15.00	2.38	16.23	4.47	15.76	4.45	0.756
	SS-M	10.07	3.45	10.46	2.75	12.69	3.68	0.147
	SS-LSSC	15.14	1.70	15.76	4.16	14.38	2.10	0.563
	SS-Is	19.07	2.16	20.15	2.54	20.46	2.33	0.260
	SS-EAC	14.00	1.17	14.76	2.74	16.46	2.14	0.013
	JB-ED	6.28	1.72	7.23	2.00	11.15	2.30	0.000
	JB-ICA**	9.71	2.01	8.46	1.12	8.30	1.54	0.177
Axial + Coronal		median	min–max	median	min–max	median	min–max	
	pneumatisation of mastoid	2.00	0.00–3.00	2.00	0.00–3.00	2.00	0.00–3.00	0.359
		mean	std. dev.	mean	std. dev.	mean	std. dev.	
	mastoid volume (CC × TR × AP)	21.42	11.81	33.0	19.54	32.96	20.57	0.099
Coronal	JB-F	5.42	2.10	6.61	1.89	8.30	2.28	0.008
	JB-M	25.00	3.16	27.15	5.50	26.53	3.86	0.127
	M-AA	14.21	2.45	16.23	2.08	15.76	2.00	0.095
	M-AE	25.78	1.80	25.53	2.75	25.23	2.91	0.257
	ICA-F	1.05	2.31	1.30	3.14	1.15	1.98	0.073
	ICA-AC	6.00	1.92	6.15	2.07	5.92	1.60	0.924
	ICA-Ilen	9.21	1.84	9.23	1.42	8.92	1.89	0.825
	ICA-M	29.92	2.86	30.69	2.75	30.23	2.35	0.935

* HRCT – high-resolution computerized tomography, HJB – high jugular bulb, SS – the top point of the lateral border on the sigmoid sinus, M – lateral surface of the mastoid, AA – aditus ad antrum, LSSC – lateral semisircular canal, Is – lateral border of short process of incus, JB – jugular bulb, ED – posteromedial point of umbo on eardrum, EAC – external auditory canal, ICA – internal carotid artery, F – mastoid segment of facial nerve, AE – arcuate eminence, AC – apex of cochlea, Ilen – lenticular process of incus.

** The measurement was taken in the section containing the basal turn of the cochlea.

The p-value shows the results of the Kruskal Wallis variance analysis.

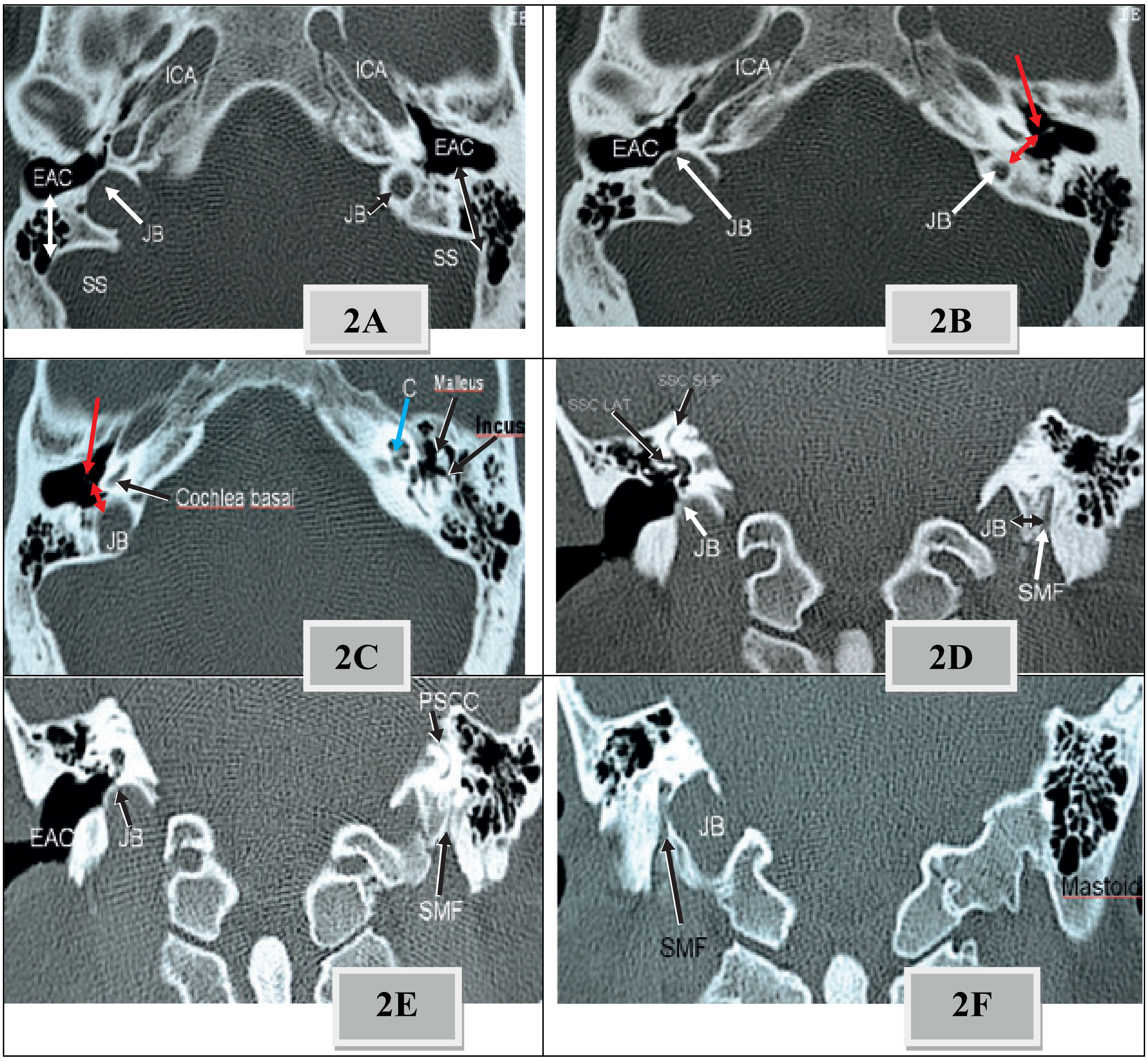

Fig. 2. Bilateral high jugular bulb was demonstrated in the temporal bone HRCTs. **2A.** Bilateral SS-EAC distance was shown in the axial section of the temporal bone HRCT (a double-tipped white arrow in the right side, a double-tipped black arrow in the left side). **2B.** Right JB dehiscence (white arrow), left JB-ED length (a double-tipped red arrow), and manubrium mallei and umbo (red arrow) were shown in the axial section of the temporal bone HRCTs. **2C.** Right JB-ED distance (a double-tipped red arrow), manubrium malleui and umbo (red arrow), and cochlea (C) (blue arrow) were shown in the axial section of the temporal bone HRCTs. **2D.** Right JB dehiscence (white arrow), SMF-JB distance (a double-tipped black arrow), and SSC SUP and SSC LAT were shown in the coronal section of the temporal bone HRCTs. **2E.** Right JB dehiscence (black arrow) and left SMF and PSSC (black arrows) were shown on the coronal section of the temporal bone HRCTs. **2F.** Right SMF-JB distance (a double-tipped black arrow) was shown on the coronal section of the temporal bone HRCTs. SMF – stylomastoid foramen, JB – jugular bulb, EAC – external acoustic canal, SS – sigmoid sinus, PSCC – posterior semicircular canal, SSC SUP – superior semicircular canal, SSC LAT – lateral semicircular canal

it was not observed in the control group (Fig. 2). The dominance evaluation values were not significantly different between groups (p = 0.980). Right side dominance was observed in 57.1% of the bilateral HJB group, 53.8% of the unilateral HJB group, and 53.8% of the control group. In all of the HRCTs of the bilateral HJB, unilateral HJB, and control groups, 22 (55.0%) of the ears showed right dominance and 18 (45.0%) of the ears showed left dominance (Fig. 4).

Discussion

The special localization of the sigmoid sinus, jugular bulb, and carotid artery within the temporal bone makes it vulnerable to surgical trauma. Hence, thorough knowledge of the anotomical relationships of these vessels is necessary. An inexperienced or occasional ear surgeon might have difficulty in identifying the localization and relationships of these vessels during the surgery [4].

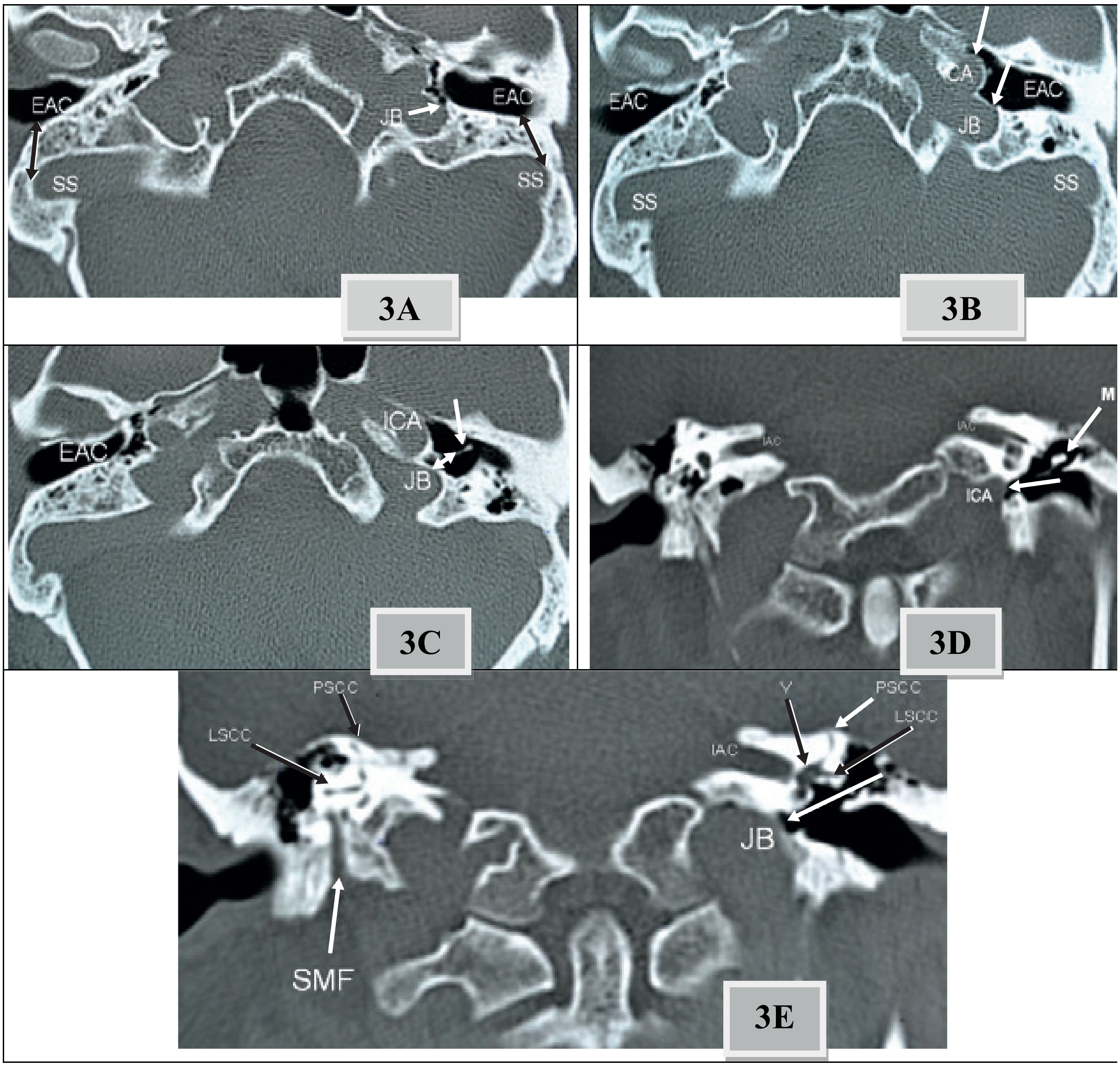

Fig. 3. Left unilateral high jugular bulb was demonstrated in the temporal bone HRCTs. **3A.** Left JB dehiscence (white arrow), SS-EAC length (a double-tipped black arrow) in the axial section of the temporal bone HRCTs. **3B**. ICA and JB dehiscence in the left (white arrows) in the axial section of the temporal bone HRCTs. **3C.** In the axial section of the temporal bone HRCTs, JB-ED length (a double-tipped white arrow) and the manubrium mallei and umbo (white arrow) were shown in the left side. **3D**. Left ICA dehiscence (white arrow) was shown in the coronal section of the temporal bone HRCTs. **3E.** Left JB dehiscence (white arrow) was shown in the coronal section of the temporal bone HRCTs. SMF – stylomastoid foramen, V – vestibul, IAC – internal acoustic canal, PSCC – posterior semicircular canal, LSCC – lateral semicircular canal, JB – jugular bulb, SS – sigmoid sinus, EAC – external acoustic canal, ICA – internal carotid artery, M – malleus

Table 2. Pairwise comparisons using the Mann Whitney *U* Test with Bonferroni correction

Measurements	Bilateral HJB – Unilateral HJB		Bilateral HJB – Control		Unilateral HJB – Control	
	z	p¶	z	p¶	z	p¶
Axial sections of HRCT						
SS-EAC	–0.474	0.636	–3.073	0.002	–1.894	0.058
JB-ED	–1.306	0.191	–4.071	0.000	–3.487	0.000
Coronal sections of HRCT						
JB-F	–1.449	0.147	–2.933	0.003	–1.927	0.054

The p-value shows the results of the Mann Whitney *U* test with Bonferroni correction.

* HRCT – high resolution computerized tomography, HJB – high jugular bulb, SS – the top point of the lateral border on the sigmoid sinus, EAC – external auditory canal, JB – jugular bulbus, ED – posteromedial point of umbo on eardrum, F – mastoid segment of facial nerve.

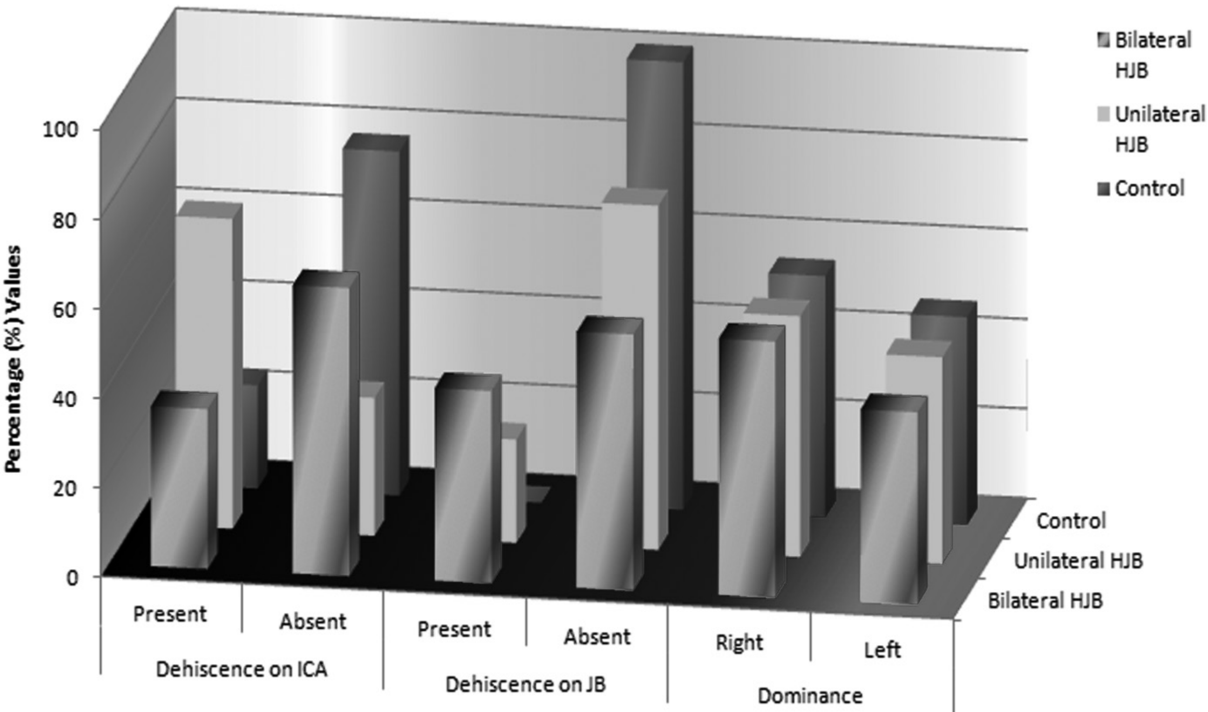

Fig. 4. Dehiscence on ICA and JB; dominance results of the groups. HRCT – high resolution computerized tomography, HJB – high jugular bulb, ICA – internal carotid artery, JB – jugular bulb

Table 3. Dehiscence and dominance results of the groups*¶

		Groups						X^2	p**
		bilateral HJB		unilateral HJB		control			
		n	%	n	%	n	%		
Dehiscence on ICA	present	5	35.7	9	69.2	3	23.1		
	absent	9	64.3	4	30.8	10	76.9		
	total	14	100.0	13	100.0	13	100.0	6.206	0.045
Dehiscence on JB	present	6	42.9	3	23.1	0	0.0		
	absent	8	57.1	10	76.9	13	100		
	total	14	100.0	13	100.0	13	100.0	9.486	0.009
Dominance	right	8	57.1	7	53.8	7	53.8		
	left	6	42.9	6	46.2	6	46.2		
	total	14	100.0	13	100.0	13	100.0	0.040	0.980

¶ The p-value shows the results of the Chi-square test.

* Evaluation was done on axial HRCT sections.

When the mastoid pneumatization was present, the JB tended to be situated toward the back and have a thicker lateral bone wall. The morphological and positional relationships between the SS and the JB are complicated. The development of the cranial base, the temporal bone pneumatization, and the non-synchronous dural venous development between the right and left sides are considered to contribute to the morphological and positional changes of the SS and JB [10]. The mastoid process has been found to be shorter in cases with drum pathology, and there was a significant correlation with the degree of pneumatization evaluated both planimetrically and directly [11].

In Turgut and Tos' study [11], the relationship between temporal bone pneumatization and the location of the lateral sinus and length of the mastoid process was investigated in 60 fresh frozen adult temporal bones. The length of the mastoid process was significantly shorter in specimens with small pneumatization than those with large pneumatization. The specimens with pathological eardrum and middle ear adhesions had a significantly shorter mastoid length than those without gross pathology.

There was no significant difference between degree of pneumatization and the shortest distance between the sigmoid sinus and the external auditory canal. The authors demonstrated that the "under-developed" masatoid process can be a consequence of hampered pneumatization. Further, they reported that there was a highly significant positive correlation between the length of the mastoid process and the degree of the pneumatization. There was no statistically significant correlation between the lateral sinus and the external auditory canal distance and the degree of the pneumatization [11].

In the present study, the anatomical relationships of the sigmoid sinus, jugular bulb, and carotid artery with several landmarks in the temporal bone were studied *via* temporal bone HRCTs. The mean of the mastoid volume values were 21.42 mm^3 in the bilateral HJB group, 33.0 mm^3 in the unilateral HJB group, and 32.96 mm^3 in the control group. There was no significant difference between the groups. In the axial sections, the SS-EAC distance of the bilateral HJB group and the JB-ED distance of the unilateral and bilateral HJB groups; and in the coronal sections, the JB-F distance of the bilateral HJB group were lower than that of the control group.

Dehiscence on the ICAs and JBs was significantly different between the groups. Dehiscence on the ICAs occurred in 69.2% of the unilateral HJB group and 35.7% of the bilateral HJB group, whereas it only occurred in 23.1% of the control group. Dehiscence on the JBs occurred in 42.9. 2% of the bilateral HJB group and in 23.17% of the unilateral HJB group; it was not observed in the control group. JB dominance status was not different between the groups. Right side dominance was observed in all of the groups. Fifty-five percent of the ears showed right dominance and 45% of the ears showed left dominance. Right dominancy of the JB was as follows: 57.1% of the bilateral HJB group, 53.8% of the unilateral HJB group, and 53.8% of the control group.

Aslan et al. [4] reported that the facial nerve was located 15 mm medial to the mastoid surface, according to the measurements from the temporal bone HRCTs. The distance from the facial nerve to the mastoid surface should be expected to be slightly longer on the right side (2 mm on average). This should be kept in mind while operating on the right ear. Pneumatization could not have any influence, since all measurements were performed in well-pneumatized bones.

Turgut and Tos (1992) [9] were unable to find significantly larger distances between the posterior meatal wall and the anterior border of the lateral sigmoid sinus, but there were tendencies toward the longest median distance in ears with large cell systems. They also measured the shortest surgical distance between the lateral edge of the external auditory canal and the anterior border of the lateral sinus. This distance is influenced by the longitudinal axis of the external auditory canal, which must be determined genetically and differs from one individual to the next. In our study, the distance between the SS and the EAC (14.00 mm) was significantly lower than that of the control group (16.46 mm).

The SS can serve as a good landmark for identifying the facial nerve at the beginning of mastoid surgery [4]. In the present study, the SS and lateral surface of the mastoid distance were 10.07 mm (bilateral HJB group), 10.46 mm (unilateral HJB group), and 12.69 mm (control group).

The facial nerve was found to be located 10.5 mm anteromedially to the sigmoid sinus. When the surgeon finds the sigmoid sinus, he can find the location of the facial nerve. This might be helpful, especially in revision cases of open cavity procedures [4]. This confirms Aslan et al.'s [12] findings, who determined this measurement to be 10.8 mm in formalin-preserved temporal bones. In the present study, the distance between the JB and mastoid segment of facial nerve was measured. The shortest distances were 5.42 ± 2.10 mm in the bilateral HJB group, 6.61 ± 1.89 mm in the unilateral HJB group, and 8.30 ± 2.28 mm in the control group. In the bilateral HJB group, the JB-F distance was significantly lower than in the control group. JB-dehiscence was observed more in ears with lower JB-F values and in HJB groups, especially in the bilateral HJB group.

Low positioned dura, short mastoid process, and narrow space in the attic, often found during surgery for cholesteatoma, have an "underdeveloped" mastoid process that supports the genetic theory of pneumatization [11]. Experimental studies on pigs [13] have shown that early postnatal middle ear infection hampers growth of the mastoid process, resulting in a shorter mastoid process with hypocellularity.

The jugular bulb is known to vary widely in position and dimension and to occasionally cause difficulty in temporal bone surgery [14]. The dehiscent jugular bulb can present a mass lesion in the middle ear and can unexpectedly be a problem during middle ear surgery. Moloy and Brackman address its problem in labyrinthine surgery: "At times the bulb is low-lying and need only be identified for purposes of surgical orientation. At other times the bulb is situated at or above the level of the internal auditory canal and interferes with exposure of the internal auditory canal" [15]. Patient characteristics should be considered in selecting the optimal technique and optimal post-operative care [16].

In Orr et al.'s study [14], the position and shape of the jugular bone were studied in 25 unilateral cadaver specimens in classic Runström II radiograph and computed tomography. Jugular bulb shape and position were determined by anatomic dissection and computed tomography. No association of jugular bulb shape or position with pneumatization was found. In our study, we demonstrated that the JB-ED measurements of the bilateral HJB (6.28 mm) and unilateral HJB groups (7.23 mm) were significantly lower than in the control group (11.15 mm). In subjects with bilateral and/or unilateral HJB, JB were positioned closer to the eardrum. Further, the sigmoid sinus was positioned closer to the EAC in the bilateral HJB group (14.00 mm) than in the control group (16.46 mm).

However, Orr et al. [14] reported that the dissection determined the distance from the plane of the lateral SSC to the roof of the jugular bulb (2 mm to 15 mm) had a good correlation with the distance from the internal auditory canal to the apex of the JB (1.5 mm to 15.0 mm) [10]. In the presnt study, we measured the SS-LSSC distance as 15.14 ± 1.70 mm in the bilateral HJB group, 15.76 mm in the unilateral HJB group, and 14.38 mm in the control group.

In conclusion, this radiological study reviews the anatomical relationships of the sigmoid sinus, jugular bulb, and carotid artery with the other anatomical landmarks in mastoid surgery. In the literature, we could not find any similar studies in terms of including all of the contents of our study. We attempted to determine the differences in the temporal bones in ears with bilateral and unilateral HJB. We want to present our results as a preliminary report. In the future, this study will be conducted with a greater number of subjects with HJB and the results will be subsequently updated.

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