Int. Adv. Otol. 2012; 8:(2) 239-243

ORIGINAL ARTICLE

Analysis of Anatomic Variations in Temporal Bone by Radiology

Cigdem Tepe Karaca, Sema Zer Toros, Hulya Kahve Noseri

Department of Otorhinolaryngology/ Head and Neck Surgery, Haydarpaşa Numune Education and Research Hospital, Istanbul, Turkey (CTP, SZT)
Department of Otorhinolaryngology/ Head and Neck Surgery, Kizilay Medical Center, Istanbul, Turkey (HKN)

Objective: To analyze anatomic variations and their frequency, such as facial nerve dehiscence (FND), labyrinthine fistula (LF), dural exposure (DE), high juguler bulb (HJB), position of sigmoid sinus, körner's septum (KS), aberrant internal carotid artery, mastoid aeration in chronic otitis media and to imply the importance of their recognition before surgery.

Materials and methods: Data was obtained retrospectively from 356 temporal bone high resolution computed tomography (HRCT) of 178 patients who underwent tympanoplasty or tympanomastoidectomy.

Results: HJB was encountered in 113 ears (32%), KS in 98 ears (28%), anteriorly placed sigmois sinus in 121 ears (34%), low hanging dura in 94 ears (26%), aberrant internal carotid artery in 6 ears (0.02%) of total 356 ears. Mastoid bone pneumatization was classified as aerated mastoids (33%, n=117), diploic mastoids (31%, n=109) and sclerotic mastoids (36%, n=130).

Conclusion: Recognition of Körner's septum, facial nerve dehiscence, labyrinthine fistula, low hanging dura, high juguler bulb, anterior placed sigmoid sinus radiologically prior to mastoid surgery is imperative. Preoperative CT scan is mandatory in the evaluation of detailed anatomy of the temporal bone and decreases the possibility of surgical complications.

Submitted : 16 February 2012 *Revised : 3 April 2012* *Accepted : 13 May 2012*

Introduction

Mastoidectomy, which is one of the main surgical approaches for eradication of chronic ear disease, begins with drilling over the lateral surface of the mastoid bone and lasted until the diseased tissues are cleaned [1]. Surgeon doesn't know the extension of the disease and variations of the structures involving the ear before surgery[2]. To operate on ears the otolaryngologist should have the anatomical background and knowledge of variations by the assistance of high resolution computed tomography (HRCT).

Numerous otologists have reported cases with facial nerve dehiscence (FND), which is common in the human adult. According to literature, the frequency of FND varies from 0.5% to 74%, and mostly occurs in the tympanic segment near the oval window [3]. Severe anomalies of the course of the facial nerve occur in the tympanic and vertical portions. (Figure 1) The horizontal segment at times is displaced inferiorly to cover the oval window or lies exposed over the promontory. The facial canal is usually rotated laterally. The rotation varies a minor obliquity to a true horizontal course. [4]

The tegmen of the mastoid and attic passes usually in a horizontal plane slightly lower than the arcuate eminence produced by the top of the superior semicircular canal. A depression of the tegmental plate is not unusual, the floor of the middle cranial fossa deepens to form a groove lateral to the attic and to the labyrinth. The low hanging dura may cover the roof of the external auditory canal and the otologist will penetrate the cranial cavity during surgery [4].

Corresponding address:
Çigdem Tepe Karaca
Barbaros Mah. Soyak Gökyüzü Konutları C Blok D:58
Üsküdar/Istanbul, TURKEY
Phone: 0090 216 474 44 56, Gsm: 0090 505 681 72 68
E-mail: cigdemtepe@mynet.com

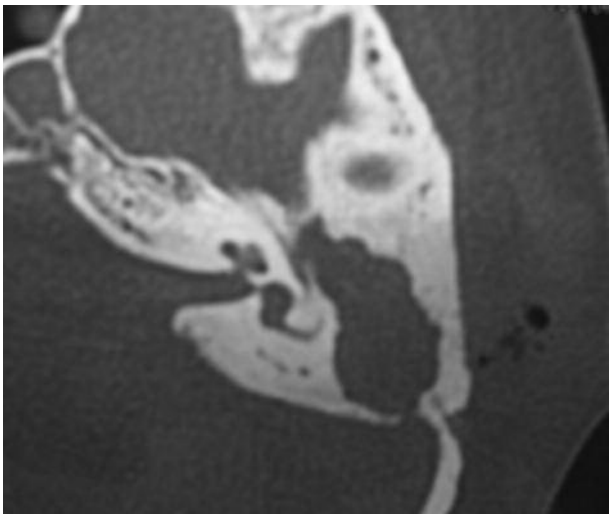

Figure 1. Axial CT scan of left temporal bone showing posterior fossa dural exposure and facial nerve dehiscence

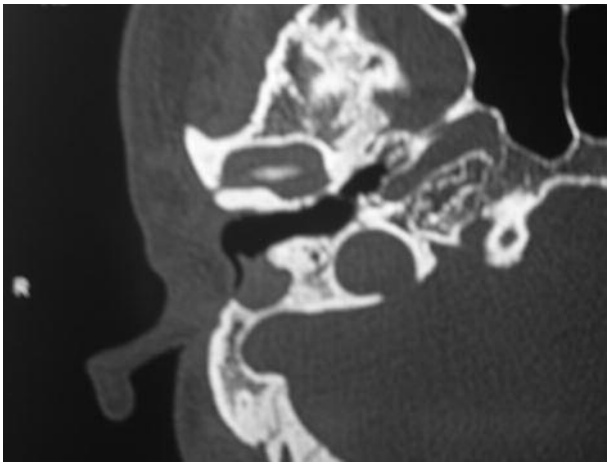

Figure 2. Axial CT scan of right temporal bone showing High Jugular Bulb

A variable anatomy of the jugular bulb is not rare and usually it manifests as a high jugular. (Figure 2) A more rare entity is the superior and medial extension of the jugular bulb into the bone of the posterior wall of the internal auditory canal called medial diverticulum A high jugular bulb with or without a diverticulum has influence on the approach in acoustic neurinoma surgery. When a dehiscent jugular bulb protrudes into the middle ear it can be confused with a glomus tumor by otoscopy. Bleeding complications during middle ear procedures have been reported in such cases [5].

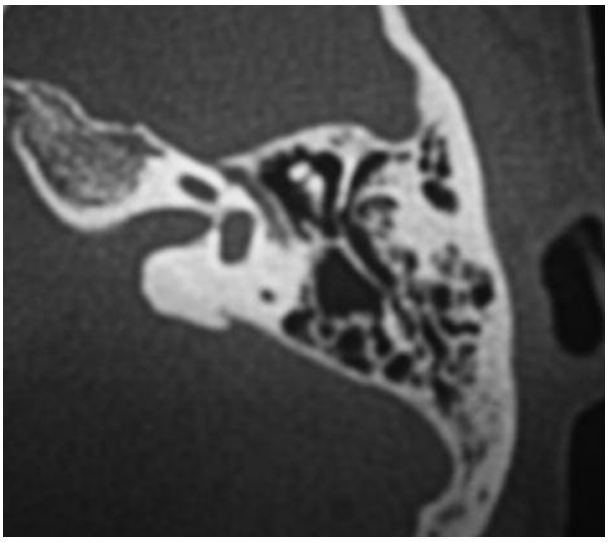

Figure 3. Axial CT scan of left temporal bone showing Körner' Septum and Facial Nerve Canal

Körner's septum (KS) refers to a dense, bony plate found in the mastoid process which represents the persistence of the petrosquamous suture line. (Figure 3) This septum, when present, divides the mastoid process into a superficial squamous portion and a deep petrous portion. KS is an anatomical structure that may create problems or complications during mastoidectomy [6].

An aberrant internal carotid artery (AICA) is a rare vascular anomally that internal carotid artery (ICA) takes in an aberrant lateral course in the temporal bone and passes through the middle ear cavity[7]. It is generally accepted to be a collateral pathway that occurs as a result of agenesis of first embryonic segment of the ICA. (Figure 4)

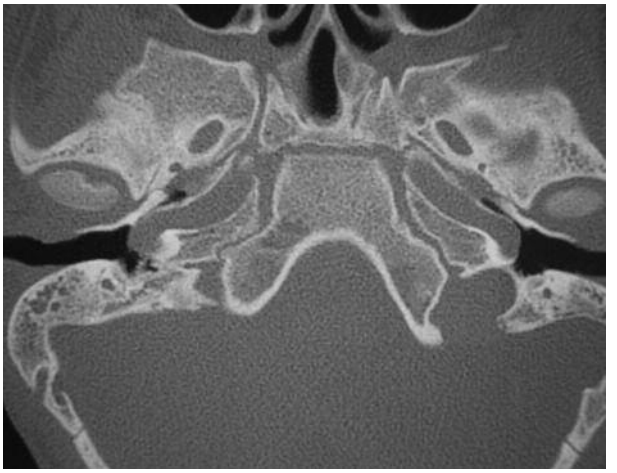

Figure 4. Axial CT scan of temporal bones of a child with bilateral AICA

The sigmoid sinus forms a shallow indentation on the posterior aspect of the mastoid. Occasionally the sinus courses more anteriorly and produces a deep groove in the mastoid, best seen in the axial sections. In some cases only a thin bony plate separates the sinus from the external auditory canal.

The semicircular canals are easily identified on axial and coronal CT images. Cholesteatomas can invade the semicircular canals. The most common site of fistulas is the lateral semicircular canal due to its proximity in cases of atticoantral cholesteatoma. Cholesteatomatous invasion of the semicircular canals is well seen with CT, with the coronal images being used to recognize the cholesteatomatous invasion of the lateral semicircular canal, seen as an osseous defect of the lateral portion of the canal wall [8].

The purpose of this study is to investigate the incidence of anatomic variations by high resolution computed tomography.

Materials and Methods

Data was obtained retrospectively from 356 temporal bone HRCT of 178 patients who underwent tympanoplasty or tympanomastoidectomy between 2002 January and 2009 January. Körner's septum presentation, facial nerve dehiscence in any part of the course of the nerve, detected in CT scans and its relation with cholesteatoma, high juguler bulb, low hanging dura which covers the roof of the external auditory canal, anterior placed sigmoid sinus, dural exposure, and aberrant internal carotid artery, type of mastoid aeration were looked over in the HRCT of the patients. CT scans of the temporal bones of the subjects were obtained with a Hitachi-Pronto AR HP spiral scanner. Contiguous sections with 1mm thickness were obtained parallel to the orbitomeatal line.

Results

356 ears of 178 patients were recruited in the study. HJB was encountered in 113 ears (32%) and it was bilateral in 23 (13%) patients. KS was seen in 98 ears (28%), anteriorly placed sigmois sinus in 121 ears (34%), low hanging dura in 94 ears (26%), aberrant internal carotid artery in 6 ears (0.02%) of total 356 ears. KS and anteriorly placed sigmoid sinus were seen bilateral in 17% of 178 patients. 14% of 178 patients have bilateral low hanging dural plate. Mastoid bone pneumatization was classified as aerated mastoids (33%, n=117), diploic mastoids (31%, n=109) and sclerotic mastoids (36%, n=130). FND was detected in 44 ears (12%), 26 of them with cholesteatoma and 18 of them without cholesteatoma. Six patients had bilateral FND (3.3%) . Dural exposure (DE) was detected in 11 ears (3%) and labyrinthine fistula was identified in 13 ears (3.6%), all with cholesteatoma. Seven of these 13 ears with labyrinthine fistula also had FND. Patients who have had fistula and dural exposure, were all on one side and related to the cholesteatoma.

Discussion

High-resolution computed tomography (HRCT) of the temporal bone has commonly been used in the evaluation of the chronic suppurative otitis media because of its high sensitivity in the presence of soft tissue disease, bone erosion and anatomical variations. A thorough knowledge of the surgical anatomy of the temporal bone is the key for satisfactory mastoid and middle ear surgery. High-resolution computed tomography (HRCT) is the main modality for the investigation of the ear diseases. As we declared here in this study, the variations in temporal bone which would effect the decision and the management of the surgeon, in ear surgery, were highly encountered in HRCT of temporal bones.

The computed tomography scan is the standard imaging technique for the temporal bone, but its exact role in the preoperative assessment of patients with chronic otitis media is controversial. Some studies declared that it should be used selectively in the preoperative preparation only if complications of the disease suspected[9]. Whatever said about the necessity of the CT, it was accurate in revealing tegmen defects, ossicular chain defects and inner ear fistulas, mastoid aeration degree, and enhanced the knowledge of surgical anatomy.

Low hanging dura, high jugular bulb (HJB), anteriorly located sigmoid sinus, facial nerve dehiscence (FND) and other situations are potential surgical hazards detected by the scans. These variations may lead to problems during surgical procedures in the mastoid region. The scan alerts the surgeon for the potential surgical dangers and complications of disease. High-resolution CT scan should be a routine examination prior to middle ear and mastoid surgery. Our study was based on to looking over the anatomical variations as HJB, Körner's Septum (KS), anterior placed sigmois sinus, low hanging dura, aberrant carotid artery and alterations due to chronic otitis complications as FND, dural exposure and labyrinthine fistula.

The frequency of a high jugular bulb varies between 6% and 34% in dependence on investigation method and definition: from over the floor of the middle ear up to over the basal turn of the cochlea. With 6%, Koesling et. al. found a rather low frequency, in contrast with ours [5]. HJB was seen in 32% of our cases which was closer to the upper incidence rates of the literature.

In a study which they concluded that CT scan could not be relied on to differentiate cholesteatoma from chronic mucosal disease so it should be used selectively in the preoperative preperation only if complications of the disease suspected.[9] But we realized that many anatomical variation which could effect the surgical situations would be seen. According to a study which surgical findings of 51 ears operated on were retrospectively compared with the CT findings, resulted as radio-surgical agreement for malleus and tegmen excellent, good for incus and semicircular canals[10]. They added that potential surgical hazards detected by the scans are low hanging dura, high juguler bulb, anteriorly located sigmoid sinus, facial nerve dehiscence and concluded that there is a good radio-surgical correlation in chronic otitis media for most middle ear structures so HRCT scan should be a routine examination prior to middle ear and mastoid surgery.

As we mentioned in a study prior this one; It is important to recognize KS prior to mastoid surgery. If it is unrecognized radiologically, it may be dangerous to mistake an extensive septum as the medial wall of the mastoid at surgery, thus leaving that portion of the medial mastoid air cells unexplored. Preoperative CT scan may be helpful in the evaluation of detailed anatomy of the temporal bone and decreases the possibility of surgical complications [11,12].

Knowledge of the surgical anatomy of the facial canal is essential in middle ear surgery .In many common otologic approaches, surgeons incur a high risk of iatrogenic injuring the facial nerve. As noted by Wiet[7] operative facial paralysis is the second most common reason for malpractice in ear surgery today in many common otologic approaches. As we mentioned before, the frequency of FND varies from 0.5% to 74% in the literature.[3] In our study it was detected in 44 ears (12%) and 6 of them (3%) were bilateral.

AICA in the middle ear is a rare congenital abnormality usually identified on CT imaging. The otolaryngologist should be aware of this potential life threatening anomaly because it may be obscured by chronic otitis media. CT scan of the temporal bone should be performed before any middle ear surgery in order to diagnose such anomalies [13,14].

Inappropriate intervention before certain diagnosis may lead to disastrous, life threatening consequences. Thus, it is imperative to recognize these anomalies before any surgical intervention.

Conclusion

In this study, the role of the CT in visualizing the temporal bone to imply low hanging dura, high jugular bulb (HJB), anteriorly located sigmoid sinus, facial nerve dehiscence (FND) and other situations which would be potential surgical hazards were detected and their probabilities were represented. Also complications of the diseases like tegmen defects, labyrinthine fistula could be identified. The computed tomography scan is the standard imaging technique for the temporal bone in preoperative assessment of patients with chronic otitis media to avoid any complications but the otolaryngologist must decide to perform or not, the CT scan prior of ear surgery.

Declaration of interest: The authors report no conflicts of interest.

References

1. Costa SS, Rosito LPS, Dornelles C. The Contralateral Ear in chronic otitis media. Arch Otolaryngol Head Neck Surg. 2008; 134:290-293.

2. Aslan A, Mutlu C, Çelik O, Gövsa F .Surgical implications of anatomical landmarks on the lateral surface of the mastoid bone. Surg Radiol Anat. 2004; 26: 263-267.

3. Wang HM, Lin JC, Leei KW.. Analysis of Mastoid Findings at Surgery to Treat Middle Ear Cholesteatoma. Arch Otolaryngol Head Neck Surg. 2006; 132:1307-1310

4. Endo K, Maruyama Y, Tsukatani T, Furukawa M, Aberrant internal carotid artery as a cause of objective pulsatile tinnitus, Auris Nasus Larynx 33 2006; 447–450.

5. Koesling S, Kunkel P, Schul T. vascular anomalies, sutures and small canals of the temporal bone on axial CT. Eur Jour Radiol. 2005; 54 335-343.

6. Özer E, Bayazıt YA, Kara C, Mumbuç S . Körner's septum (petrosquamosal lamina) and chronic ear disease. Surg Radiol Anat. 2004; 26:118-121

7. Wiet RJ, Iatrogenic facial paralysis, Otolaryngol. Clin North Am. 1982, 15:773-780.

8. Lemmerling M, Vanzieleghem B, Dhooge I, Van Cauwenberge P, Kunnen M. CT and MRI of the semicircular canals in the normal and diseased temporal bone. Eur Radiol. 2001; 11:1210-9.

9. Alzoubi FQ, Odat HA, Al-Balas Ha, Saeed SR. The role of preoperative CT scan in patients with chronic otitis media. Eur Arc Otorhinolaryngol. 2009; 266:807-9

10. Zhang X, Chen Y, Liu Q, Han Z, Li X. The role of high-resolution CT in the preoperative assessment of chronic otitis media. Lin Chuang Er Bi Yan Hou Ke Za Zhi. 2004; 18:396-8.

11. Toros SZ, Karaca CT, Habeşoğlu TE, Noşeri H, Ertugay CK, Naiboğlu B, Egeli E. Is there a relation between mastoid aeration and Körner's septum? Eur Arc Otorhinolaryngol. 2010; 267:1523-1526.

12. Jahrsdoerfer R. Clinical aspects of temporal bone anomalies. Am J Neuroradiol 1992; 13:821-5.

13. Mafee MF, Valvassori GE, Becker M, editors Imaging of the Head and Neck. Thieme, New York 2005.

14. Toros SZ, Karaca CT, Noseri H, Naiboglu B, Kalaycık C, Egeli E. Bilateral aberrant internal carotid arteries: A case report presenting with pulsatile middle ear discharge. International Journal of Pediatric Otorhinolaryngology. 74 2001; 97-98.