Alignment between the basal turn of cochlea and the horizontal segment of the petrous carotid artery: a landmark for predicting round window accessibility in cochlear implant patients

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Introduction

Cochlear implant surgery is a well established procedure for enhancing the quality of life in the patients with profoundly compromised hearing.

Cochlear implantation (CI) surgery is achieved within a very narrow area surrounded by vital neurovascular structures such as internal carotid artery ,jugular bulb and facial nerve. [2]

Preoperative imaging is a mandatory prerequisite for cochlear implant surgery; the benefits include determining the pathology, evaluating the detailed anatomy of the cochlea and its surrounding structures and predicting difficulties that may be encountered during surgery

Adept knowledge and experience with surgical anatomy of the cochlea and nearby structures is mandatory for correct placement of the electrode and avoidance of complications. [3]

Patients and methods

The study included 50 patients that underwent CI surgery. All patients attended to cochlear implant committee meeting in a tertiary referral hospital and performed the surgery within the period from January 2015 to January 2016. All patients underwent imaging studies of the petrous bone and cochlea including CT and MRI.

Imaging studies were assessed by both surgeons and radiologist and the anatomical relations were addressed during attending CI committee meeting and later on before surgery, Radiological and surgical findings were compared Compatible data were grouped for statistical purposes into true positive and true negative; incompatible data were grouped into false positive (radiological findings not confirmed at surgery) and false negative (normal inner and middle ear anatomy not confirmed at surgery).

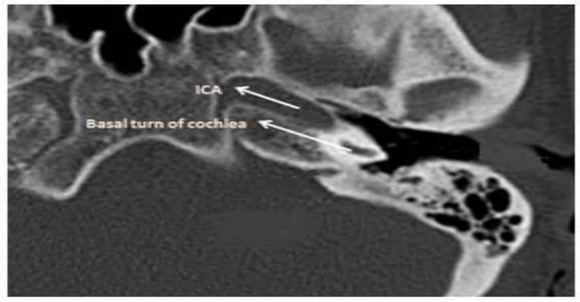

Figure1. Axial CT scan of the petrous bone showing alignment between the basal turn of the cochlea and the horizontal segment of the petrous carotid artery.

Results

Radiological assessment of basal turn alignment with ICA revealed that three patients (6%) had posterior rotated cochlea while 47 patients (94%) had basal turn in line with ICA.

Surgical evaluation of the patients revealed that five patients (10%) had posterior rotated cochlea (one of them detected radiologically) with difficult access to the round window and 45 (90%) had no posterior rotation

Further analysis found that 43 patients are true positive (had no posterior rotation in both radiological and surgical assessment), one patient is true negative (had radiological posterior rotated cochlea and had also surgical assessment posterior rotated cochlea), four patients are false positive (had radiological basal turn in line with ICA and had posterior rotated cochlea in surgery) while two patients are false negative (radiological assessed posterior rotated cochlea and had no posterior rotation during surgery)

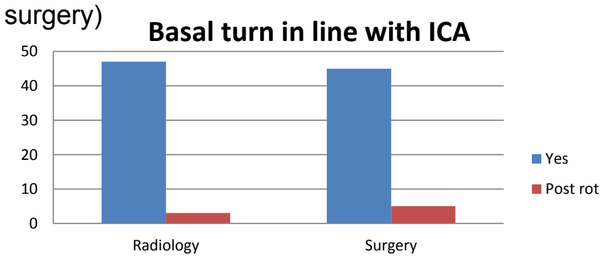

Figure 2. Radiological versus surgical findings as regard of basal turn alignment with ICA

Radiology	Surgery		total
	no post rotation	post rotation	
no post rotation	43 (true +ve)	4 (false+ve)	47
post rotation	2 (false -ve)	1 (true -ve)	3
Total	45	5	50

Table 1. Crosstabulation of radiological and surgical assessment of basal turn alignment with ICA

Discussion

The carotid artery is one of the most important vital structures passing in close proximity to the cochlea representing a potential surgical risk during cochlear implant surgery. The genu of the petrous carotid canal at the junction of its vertical and horizontal segments is anatomically closest to the basal turn of the cochlea. The average distance between the carotid canal and basal turn of the cochlea was discussed in many literature studies; also carotid artery abutting the basal turn of the cochlea was reported.[1,4,5]

In this study we consider the relation of the carotid canal to the basal turn of the cochlea as a key for predicting the orientation of the round window niche.

The cochlea lies superior and posterior to the petrous carotid canal, the alignment between these structures can be viewed in axial plane CT; when they are situated close to each other they will be seen in the same tomographic section.[8]

Identification of the Round window niche and round window membrane is a crucial step in Cochlear implantation surgery. However, large variation in the orientation of the round window is perceived by surgeons approaching through the facial recess. Posterior rotation of the round window may occur in certain cases adding to the difficulty of surgery; this anomalous orientation of the round window is related to the coiling pattern of the basal turn of the cochlea.[6]

In this study preoperative radiological assessment of the alignment between the transverse segment of the petrous carotid canal and the basal turn of the cochlea as perceived in axial CT scans is used to assess the coiling pattern of the basal turn of the cochlea and hence predict the intraoperative orientation of the round window.

We found that posterior rotation of the cochlea is a predictive factor of difficulty associated with round window accessibility.

the study conducted by pendem and his colleagues in 2015 depended on measuring the distance between oval window and round window niche in preoperative HRCT temporal bone in predicting rotation of the round window and it was then correlated with intraoperative measurements.[7]

Conclusion

Studying the alignment between the basal turn of the cochlea and the horizontal segment of the petrous carotid canal is a reliable method for predicting the intraoperative orientation of the round window

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