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Research Article

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Diagnostic value of high resolution CT scanning of temporal bone in cochlear implant recipients

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ABSTRACT

High resolution computed tomography (HRCT) is highly efficient in demonstrating the anatomy of the temporal bone. It allows a detailed presentation of anatomical features and achieves the prerequisites for selection of the various therapeutic options including cochlear implantation (CI). The present study was aimed to determine the diagnostic value of HRCT as a preoperative imaging technique for CI candidates. This was a cross-sectional study where the HRCT findings in 41patients who underwent cochlear implant were analyzed and compared with the surgical findings. The HRCT images were obtained in the axial and coronal planes using 0.5 mm slice thickness. The HRCT findings were analyzed for diagnosis of cochlear malformations and opening of the scala tympani, and round window niche (RWN) visibility. In 38 out of the 41 patients (92.68%), the HRCT image-based assessment of the cochlear malformations coincided with the surgical findings indicating sensitivity of 93.7%and specificity of 97.4%. Sensitivity and specificity of HRCT in detection of the opening of the scala tympani was 97.5% and 83.1%, respectively. The RWN visibility during HRCT assessment yielded the sensitivity of 92.3%and specificity of 79.5%.
Our findings suggest HRCT is highly useful method for studying the patients with a variety of temporal bone abnormalities and can be applied during clinical routine to facilitate cochlear implant candidacy process.

Keywords: High resolution Computed Tomography, Temporal bone, Cochlear implant, Surgery

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INTRODUCTION

More than three decades have passed since the first cochlear implant surgery and until December 2012, more than 324 thousand people have benefited from this technology worldwide(1). Cochlear implant is an electronic hearing implant for rehabilitation of deaf persons who have lost their auditory hair cells. A part of the implants was removed and another part of it is placed inside the ear. This tool bypasses hearing hair cells and stimulates the auditory nerve Spiral ganglion cells directly (2). The hearing prosthesis in terms of hardware consists of a speech processor that is implanted under the skin behind the ear auricle. The device is held with two wires to the middle ear and the first and third auditory ossicles (hammer and pedal) are connected and held in place with special cement. In the prosthesis the eardrum is used instead of the hearing aid microphone. Sounds are absorbed to the eardrum after hitting it and the first hearing ossicles (malleus) is transferred. Sound vibrations are transmitted from the bones in the ear speech processor forged by the first wire under the skin of the patient. In this device amplified sound waves as well as waste voices including noise filter and remove the ground voices, and then the strengthened flow is transmitted through a second wire from the device to third auditory ossicles (stapes) and the inner ear and auditory nerve. It also includes a remote control that can increase or decrease power the device and therefore the patient's hearing(1, 3).During the recent years using biomarkers for predicting disease progression or predicting treatment response has been dramatically developed. During recent years using pre- or concurrent operating monitoring techniques have been widely developed for various disorders. Magnetic resonance imaging and CT are among the most efficient techniques for this regard (4-9).

Cochlear implementation is a significant and effective method in the treatment of patients with profound (10)(dβ <90) and severe (70 -90 dβ) hearing loss (2, 11) (10). From every 1,000 children who are born apparently healthy, 2children have hearing loss and of them 9% have sensorineural hearing loss(12).Recent progress in spiral HRCT with sub millimeter resolution and surgical planning in patients undergoing cochlear implant is very useful. HRCT sections are performed extensively as 1-0.5 mm in the axial plane and in the Bone - window environment the smaller pixel size is used. Orientation of axial sections in a 30 degrees page prevents damage to the lens in the eye and also creates a better image of round windows and no contrast is not required(2). Due to the high cost of surgery and there is no limit in selection of candidate, then imaging in these patients is very important. Since the CT scan imaging modalities are cheap and readily available and is also the first that in these patients before surgery is done routinely in this study, in the present research it was aimed to evaluate the accuracy of the temporal bone HRCT images before action by compliance with operative findings(13).

MATERIALS AND METHODS

This was a cross-sectional study conducted on 41 patients undergoing cochlear implant surgery. The patients with inclusion criteria of the study were selected during one year period from patients referring to Ahvaz Imam Hospital of, HRCT of temporal bone was obtained in the axial and coronal sections cut in mm 0.5- 1mm and the findings were compared with intraoperative imaging sensitivity and specificity and positive predictive value (PPV) and negative predictive value (NPV) with 95% confidence intervals(14). Additionally, the statistical packages of SPSS and McNemar were used to analyze the data.

RESULTS

In 41 patients the results of the surgery and HRCT in 37 cases were similar about the openness of cochlear duct (Figs. 1,2), while cochlear duct was closed in 3 cases that was confirmed at the time of surgery with HRCT findings(Fig. 3).

In one case, ossified cochlear duct was reported in HRCT findings that have not been confirmed at the time of surgery and cochlear implantations were performed in the usual manner. No finding was reported in HRCT in cochlear duct that was proven during surgery.

Table 1. The sensitivity and specificity of HRCT for cochlear abnormality

		Surgery-Ch		Total
		Positive	Negative	
HRCT-Ch	Positive	3	1	4
	Negative	0	37	37
Total		3	38	41

Sensitivity: 100%
Specificity: 97.4%
Positive predictive value: 75%
Negative predictive value: 100%
Accuracy: 97.5%

The second variable under investigation was the round window and the level of ossification in it.

Among the 41 patients, findings of HRCT and surgery were consistent in 28 cases of being observed and naturalness of the round window, while in 4 cases round windows were not observed in the HRCT (Table 2). These findings were confirmed in the surgical findings and in these cases surgery operation was done through cochleostomy.

In 9 patients with normal round windows were reported using HRCT; however, it was not seen was at the time of surgery and surgery was performed by colostomy.

No case was reported in HRCT with abnormal round windows and at the time of surgery its opposite wasn't proven.

Table 2. The sensitivity and specificity of HRCT for cochlear round window abnormality

		Surgery-Round		Total
		Positive	Negative	
HRCT-Round	Positive	4	0	4
	Negative	9	28	37
Total		13	28	41

Accuracy: 78.1%
Sensitivity: 30.8%
Specificity: 100%
Positive predictive value: 100%
Negative Predictive Value: 75.7%

The third variable which was considered in this study was the ability of HRCT for discovering the associated abnormalities. Among the 41 patients, 3 had clear anomalies that were confirmed the findings during surgery (Table 3).

Two cases in HRCT were reported as lacking of any abnormalities, but at the time of surgery, the anomalies were observed in them.

HRCT and surgery findings were similar in 36 cases to the normal structures of the middle and inner ear.

No case was reported that was reported in HRCT with abnormalities and its opposite wasn't proven the time of surgery.

Table 3. The sensitivity and specificity of HRCT for the associated abnormalities of cochlear implant

		Surgery-Anomaly		Total
		Positive	Negative	
HRTCT-Anomaly	Positive	3	0	3
	Negative	2	36	38
Total		5	36	41

Accuracy: 95.1%
Sensitivity: 60%
Specificity: 100%
Positive predictive value: 100%
Negative Predictive Value: 94.7%

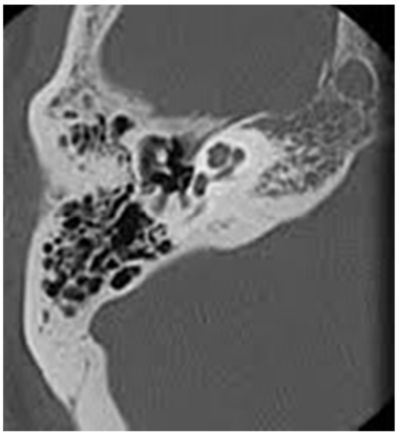

Fig 1: High resolution CT scan of normal cochlea

Fig 2: High resolution CT scan of normal cochlea

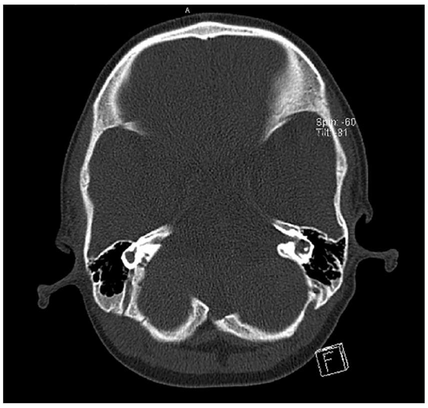

Fig 3: common cavity abnormality of cochlea in high resolution CT scan

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