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Determining compliance of ear CT scan with interaoperative findings in deaf children with cochlear implantation

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ABSTRACT

Introduction: Defecated or impaired hair cell function of the cochlea causes deafness. Cochlear implantation allows transmission of sound information through central auditory pathways using direct electric stimulation of auditory nerve dendrites. Using radiologic imaging, including CT scan is very helpful in selection of candidates and evaluation after implantation. The purpose of this study is to determine compliance of CT findings in deaf children undergoing cochlear implantation compared with the intra-operative findings.

Method: In a periodical-descriptive study, 100 patients (56 male and 44 female), 6 months to 6 years of age, who were candidates for cochlear implantation at Baqiyatallah Hospital in Tehran between January 2010 and October 2011, were studied. After getting informed consent form the parents of patients, demographic data was recorded. CT scan and surgical data were double blindly collected in the designed questionnaire which was approved by three radiologists and three ENT specialists. Finally, surgical and radiological data were compared and *t*-test and chi-square test was used.

Results: Atic status in 89 patients (89%) was statistically significant between radiology and surgery ($P = 0.06$). Positive Predictive Value and Negative Predictive Value were respectively 100 and 92.8. Middle ear space was same in 85 patients (85%) in the two methods ($P = 0.01$) (NVP = 63.4). Pyramid status was similar in radiology and surgery results in 67 patients (67%) ($P = 0.000$) and PPV and NPV were 100 and 63.4 respectively. Jugular bulb was similar in 73 patients (73%) ($P = 0.00$). There was no significant difference between other modalities.

Conclusion: In most cases examined in this study, compliance between the surgical and radiological findings was above 80%. In some cases, CT scan could give confidence to the surgeon, but in atic, middle ear space, pyramid and jugular bulb there might be insufficient reliance to CT findings and there would be need to more accurate observation during surgery.

1. Introduction

The movement of hair cell produces an electrical current in auditory nerve. This electrical current is transmitted to the higher central auditory nerve systems in brainstem and then to primary and associative auditory cortex [1–3]. Usually, loss and/or disorder in hair cells of ear cochlea results in hearing loss. Normal cochlea function is conduction of the hearing mechanical signals to synaptic activity. Therefore, deficient in normal cochlea function results in disability in hearing sensation [1–3]. Cochlear implantation resolves this impaired circle and transmits sound information using electrical stimulation directly from cochlear nerve dendrits [1–3].

One of important and necessary proceeding for cochlear implantation is assessment of diagnostic method for study of anatomical and structural anomalies in ears especially inner ear. Hyun Joon Shim (2010) showed that CT scan play role in Eustachian tube (ET) evaluation [4]. Majdani et al. (2009) showed that multi-slice devices had more accurate evaluation from temporal bone [5]. Usually, CT scan is done before cochlear implantation to find etiologies of hearing loss, local pathologies

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and the appropriate ear for surgery [6–10]. In addition to CT scan, we can use MRI to diagnose congenital cochlear deformities, inner ear hypoplasia, and patency of cochlear duct [6–10]. Furmanek (2007) showed that multi detector CT scan can diagnose inner ear anomalies and can be a method for deciding about selection of implanted ear and implementation of surgery [11]. Imaging with CT scan is suitable and it is determiner guidance for surgery [6–10].

Although, most studies showed that CT scan was most accurate method for predicting ear status before implantation but it seems that there are ambiguous points between CT scan and intraoperative findings. As there are not any study in the literature,comparing findings of CT scan and intraoperative measures therefore, in this study we compared diagnostic findings of CT scan and intraoperative.

2. Methods

This study was a periodical–descriptive study. 100 patients (56 male and 44 female), 6 months to 6 years of age, who were candidates for cochlear implantation at Baqiatallah hospital in Tehran between January 2010 and October 2011, were studied. After getting informed consent from the parents of the patients, demographic data was recorded. CT scan and surgical data were double blinded and collected in the designed questionnaire which was approved by three radiologists and three ENT specialists. The questionnaire included 15 questions about status of temporal bone, middle and inner ear structures. These structures were tegmen mastoideum, lateral venous sinus, mastoid cells, atic, middle ear space, malleus, stapes, ET, promontory, facial nerve canal in middle ear, pyramid, jugular bulb and carotid.

CT scan was done by using GE high speed multi slice in axial and reconstructed coronal with 1 mm cuts for all of patients. Time duration between CT scan and cochlear implantation surgery was less than one month. Finally, surgical and radiological data were compared.

We analyzed data by SPSS software version 17. For analyzing of quantified variables, we used mean scores and standard deviations and for comparing of CT scan and intra-operative findings, we used independent *T*-test and *Q*-square test.

3. Results

In this study, 100 CI patients (56 Male and 44 female) were participated.

Table 1 showed the results of CT scan and intra-operative observation in different variables (tegmen mastoideum, lateral venous sinus, mastoid cells, atic, middle ear space, malleus, stapes, ET, promontory, facial nerve canal in middle ear, pyramid, jugular bulb and carotid).

Tegmen mastoideum was normal in all patients with CT scan and in intra-operative observation. According to the surgery criteria, lateral venous sinus was normal in 94 (94%) patients and fronted in 6 (6%) patients and according to the radiographical criteria, it was normal in 98 (98%) patient and fronted in 2 (2%) of patients. For the lateral venous sinus, there were 95% compliance between CT scan and intra-operative observation ($P = 0.9$). Sensitivity was 33.3% and specificity was 100%. Positive predictive value (PPV) and negative predictive value (NPV) were 100%.

According to the surgery criteria, mastoid cells were clean in 93 (93%) patients and were dirty in 4 (4%) patients and also, 3 (3%)

Table 1
The comparison between intra-operative surgery and CT scan findings.

Variables	Intraoperative findings	CT Scan findings	*P*-value	Compliance (%)	Sensitivity	Specificity	PPV	NPV
Tegmen mastoideum	100	100	–	100	100	0	0	100
Sinus								
Normal	94	98	0.9	95	100	33.3	100	94
Fronted	6	2						
Mastoid cells								
Clean	93	94	0.30	87	100	85.7	100	98.9
Dirty	4	6						
Polyp	3	0						
Atic								
Clean	91	98	0.06	89	100	85.7	100	92.8
Dirty	9	2						
Middle ear space								
Clean	87	98	0.01	85	100	15.38	0	100
Soft	9	1						
Fluid	4	1						
Malleus	100	100	–	100	100	0	0	100
Stapes								
Complete	100	99	0.5	99	99	0	0	100
Incomplete	0	1						
Eustachian tube								
Normal	98	100	0.49	98	100	50	100	98.9
Soft	2	0						
Promontory								
Normal	88	93	0.15	87	100	58.3	100	94.6
Small	6	6						
Displaced	6	1						
Facial nerve canal in middle ear								
Complete	92	100	0.007	92	100	0	0	92
Incomplete	8	0						
Pyramid								
No	34	8	0.00	67	100	37.5	100	63.4
Small	52	82						
Swelled	14	10						
Jugular bulb								
Normal	99	72	0.00	73	72.7	100	3.5	100
Swelled	1	28						
Carotid	100	100	–	100	100	0	0	100