COCHLEAR IMPLANTATION IN IRAN

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Abstract — Deafness has been considered a non - resolving problem until the invention of cochlear implantation (CI). We are reporting the pre- and post-operative results of 14 patients underwent CI, for the first time in Iran, at the cochlear implantation Clinic of Tehran University of Medical Sciences. Four of our patients were able to hold a telephone conversation without difficulty 3 months post-operatively and the rest achieved considerable scores on audiologic tests and a remarkable improvement over 9 month interval between the two sets of tests. Also we have addressed the dramatic improvement in the quality of life of these patients in this paper as well as the results of promontory stimulation and audiometry.
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Key words: Cochlear implantation; Iran; Farsi, speech recognition, promontory stimulation; audometry.

INTRODUCTION

Deafness has been a problem resisting solution until the invention of cochlear implantation (CI). This method heralds emerging from silence, entering a new world, and gaining or regaining the wide variety of speech related skills. In this procedure a prosthesis is implanted in patient's ear and he or she will gain different auditory skills through training sessions. But this question has remained wihtout an adequate answer: Who will benefit from CI and to which extent? In an attempt to clarify the problem we have described the pre- and post-operative characteristics of 14 patients underwent CI, for the first time in Iran, at our center. We have addressed the pre- and post-operative audiograms, pre-operative promontory stimulation test (PS) and a battery of post operative speech recognition audiologic tests (SRAT).

It should be remembered, however, that unavailable data and small number of patients has rendered it almost impossible to use statistical procedures. This study, should rather be regarded as a preliminary report than an original article.

MATERIALS AND METHODS

Cochlear Implantation Team

Cochlear implantation is a team work and implantation could turn out to be successful only if the team works properly together. A CI team consists of the following sections: (1) otologic surgery (2) audiology (3) speech pathology (4) psychiatry (5) deaf education (6) electrophysilogy (7) technical engineering (8) manufacturing technology.

Prosthesis

A CI prosthesis is generally consisted of the following parts: (1) microphone (2) speech processor (3) two coils for transmitting and receiving signals (4) a spiral shaped electrode array with approximate length of 17mm which has 22 channels in the most developed models (all of the prostheses we have used had 22 channels). The prosthesis is implanted by surgeon into the scala tympani. CI prostheses come in different makes and models (we have used 4 different prostheses, namely, Nucleus 22, Nucleus Spectra, MED-EL, and Clarion).

Patient Selection

Patients most suitable for CI are post-linguistically deaf patients (post-L), i.e. those who have lost their hearing after developing language and speech related skills. Next group in line are patients under 5 years of age as most of the speech related skills are gained in the first 5 years of life. Candidates should be totally or profoundly and bilaterally deaf and should not be albe to benefit from a hearing aid. The CI outcome is highly dependent on the success of the training sessions which demands the cooperation of the patient and his/her family. Thus a psychiatric evaluation should confirm the feasibility of implantation prior to the operation. Moreover, there are a few test and evaluations that are performed to verify whether the candiate will experience auditory sensations from electrical stimulation.

Pre-operative Tests

a) Promontory stimulation: By insertion of a needle transtympanically onto the promontory, electrical stimulation is transmitted and hearing thresholds, maximum acceptable levels, and dynamic ranges were assessed at 50 to 1600 Hz frequencies. Gap detection (GAP) and temporal difference limen discrimination (TDL) was also evaluated in this test as well as frequency discrimination.

b) Pre-operative pure tone audiometry was done for all the patients. An attempt was made to elicit and acoustic reflex as well. This was done by wearing headphones on the prosthesis and putting the probe

inside the contralateral ear canal.

c) Other tests: These included a temporal bone CT scan, ABR, OAE, and electronystagmography as well as other routine preoperative tests. The results of these tests are not discussed in this paper.

Surgical procedure

Using the technique for intact canal wall facial recess approach we expose the round window after completing a mastiodectomy. After removing the tip of the round window niche or cochleostomy the electrode array is placed into the scala tympani. (1,2,3,4)

Post-operative Audiometry

Post-operative audiometry was performed within 6 weeks after operation as described.

Device Fitting and Adjustment

This is a necessary step taken one month after operation. At this time the best strategy is chosen for each patient by a number of tests including impedance measurement and channel-by-channel stimulation of prosthesis (4).

Training Sessions

Training sessions begin as soon as the device is fitted and adjusted. They are 30 to 40 minutes each and must usually be continued for up to 6 months. In these sessions patients receive live voice in three conditions (5,6): (1) audiotory (2) lip reading (3) audiotory plus lip reading. Experiments show that the latter condition has better results than the first two. Stages in auditory training program are as follows: (1) selective attention to environment sounds. (2) discrimination of everyday sounds and voices; (3) recognition of suprasegmental sounds (4) recognition of segmental features of voice (5) auditory comprehension of numbers, words, phrases, sentences and text. At the end of the program patients practice everyday situations (e.g. shopping, job interview) and making a phone call. Beside auditory training patients also receive speech training that includes voice controlling and improving stress, rhythm and intonation.

Speech Recognition Audiologic Tests

This consisted of a battery of 9 tests which were preformed 3 and 12 months post-operatively. The score was the percent of correct answer/discriminations to each test. All test were performed in a free field.

RESULTS

It should be stated that not all the data were available for every patient as the tests and procedures were not designed to serve a prospective study at first. Thus some data are missing and some were excluded due to non-standard method of obtaining.

Since 1992, fourteen patients have been implanted by the cochlear implantation team. Mean age of the patients was 21.8 ± 14.5 years. The oldest patient was 51 years while the youngest was only 2½ at the time of surgery. Five of our patients were male and 9 were female. Six pre- and 8 post-linguistically deaf patients (pre-L and post-L) consisted our study population. Two of our patients were bilingual (Azari language being spoken at their homes by their family rather than Farsi). Mean deafness duration was 9.1±6.8 years, ranging from 1 to 24 years. Meningitis was responsible for deafness in 3 patients while in 2 patients otitis media, and in 1 patient mumps was the etiology. Five of our patients were congenitally deaf and the remaining 3 had suffered a progressive hearing loss. None of the patients had cochlear ossification.

Pre-operative Tests

Acoustic reflex in impedance audiometry could not be elicited in any of the patients. Pure tone audiometry was done for all patients. Eight were totally deaf and no threshold could be obtained for them. Mean PTA in the remaining 6 patients was 107 db with a standard deviation of 6 db.

Dynamic ranges assessed by promontory stimulation are shown in Table 1. Eight patients had both GAP and TDL of 250 ms, 4 patients had both GAP and TDL of 150 ms, and 2 patients had both GAP and TDL of 100 ms at 100 to 400 Hz frequencies.

Table 1. Dynamic ranges

Frequency	dynamic range mean ± SD
100Hz	209.4 ± 226.3
200Hz	206.3 ± 222.2
400Hz	202.6 ± 237.7

Post-operative Tests

Pure tone audiometry was performed for all patient within 6 weeks after operation. The results are shown in Table 2. Speech discrimination score, which was assessed at least 3 months post-operatively, could be obtained only in 2 patients as the sound distortion due to wearing headphones over the prosthesis made it impossible for other patients to hear properly.

Acoustic reflex could be elicited in all but 3 of the patients post-operatively.

Table 2. Audiometry

	Mean ± SD
PTA	58.2 ± 20.2
SRT	51.7 ± 10.3
MCL	77.1 ± 11.2
SDS	78.7 ± 10.3

Results of SRAT 3 and 12 months after operation are shown in Table 3.

Table 3. SRAT

	after 3 months		after 12 months	
	Mean ± SD	(n)	Mean ± SD	(n)
Environmental sound	88.6 ± 16	(8)	98.6 ± 3.5	(8)
Sylabic number	87.5 ± 13.8	(8)	93.5 ± 8.5	(7)
Nowels	86.1 ± 15.2	(8)	92 ± 13.7	(7)
Minimal pairs	86.8 ± 13.1	(5)	87 ± 18.7	(5)
Question/statement	95 ± 7.1	(2)	91.8 ± 12.7	(6)
CSW	84.1 ± 15.2	(7)	90.7 ± 10.2	(7)
OSW	68.1 ± 31.8	(6)	80 ± 18.7	(8)
CSS	79.8 ± 19.7	(5)	96 ± 8.9	(5)
OSS	100	(2)	89 ± 13.9	(5)

Almost all of the patients had a considerable progress over the 9 month interval between the two sets of tests. This was reflected by the percent increase in the mean score of each test over this period in Table 4.

Table 4. percent increase in the mean score of each test

	Means ± SD	n
Environmental sounds	11.4 ± 16.7	(5)
Sylabic number	6.2 ± 12.5	(4)
Vowels	3.7 ± 7.5	(4)
CSW	10 ± 10	(3)
OSW	11.6 ± 10.4	(3)
CSS	3 ± 4.2	(2)

Comparing pre-L and post-L

Pre-L patients had lower scores at both set of test than post-L patients but the rate of progress (as reflected by the mean difference between the test scores at 3 and 12 months) were not different between the two groups. T-testing did not prove the above mentioned differences to be statistically significant, apparently due to lack of sufficient data. Dynamic ranges, GAP, TDL and audiology tests were not significantly different across these groups.

Other Results

Dynamic ranges at 200 and 3400 Hz showed a positive and significant (p=0.018 - 0.002) correlation with the mean difference between the test scores at 3 and 12 months. But, again, it should be noted that there were only 3 patients with available data for all the variables needed for this analysis. Duration of deafness showed no correlation with the post operation variables neither did dividing samples into two groups with short and long duration of deafness reveal any significant difference.

DISCUSSION

In the past 5 years, 14 patients has been implanted with CI prostheses. We consider all cases successful but not all of these patients benefit similarly from implantation. In an attempt to describe factors influencing the outcome of implantation we studied a few parameters.

Bilingual patients (those who are brought up and live among people who speak Azari more often than Farsi) are confronted with the obstacle of confusing the two languages and therefore are harder to teach and slower to learn.

Our population had a rather large age range and patients at both extremes seemed to benfit alike. Our oldest patient, a 51 years old man who had become dependent on others for most of his routine activities is now capable of managing his shop on his own. On the other end we have a 13 years old girl who picks up the phone as it rings and use it like when she had not yet experienced hearing loss.

Being pre-L, on the other hand, has a major impact on the outcome and these patients seem to gain less. Pre-L patients do less well on open set words and open set sentences, the two tests which demonstrate their difference clearly. Nevertheless, a pre-L bilingual 13 years old girl, which we consider at the patient with the most unfavorable results, who was never able to get acceptable scores in open set words or sentences, is now able to discriminate environmental sounds, shows sound alertness, and reacts when her name is called. This is accepted by her and her family as such as precious gift that makes them leave a trip unended to come back and fix a broken device.

Four of our patients are now able to hold a telephone conversation and 2 have done well (with a score of 100%) on trans-telephonic open set sentences test. All 3 were post-L, they use different prosthesis types (Clarion, Spectra and Nucleus) and their deafness duration vary from 1 to 20 years. None had a GAP or TDL of less than 100 ms on PS, though the last three parameters are usually known to be inversly proportional to the outcome. Cochlear implantation has changed the quality of life of our patients to a great extent one of them, whose results we regard only as mediocre, is a 21 years old woman who had lost her hearing after meningitis 5 years prior to the operation. She had no lip-reading ability and this forced her to give up education and led her to several suicide attempts. Now she is continuing with her educations and is leading a married life.

It can be noticed that the above anecdotal notes picture the outcome for our patients more clearly than the test results. This is, at least partially, due to lack of standardized Farsi battery of test for evaluating and comparing the CI patients, something comparable to the

Central Institute for the Deaf (CID) Everyday Sentence Test, for example. Developing and standardizing such a test battery in Farsi, with two different levels for each class of tests (regarding pre-L and post-L patients) should be regarded as a valuable step forward. This is a challenging task which is being undertaken at present in our center.

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