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Cochlear Implant Surgery Experiences of a Tertiary Health Center in the Thrace Region

Trakya Bölgesinde Üçüncü Basamak Bir Sağlık Merkezinin Koklear İmplant Cerrahisi Deneyimleri

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ABSTRACT

Aim: Cochlear implants (CIs) aid in language and speech development through improved hearing in patients with bilateral severe or profound hearing loss. In this study, we evaluated the outcomes of our patients undergoing CI surgery.

Materials and Methods: Preoperative, perioperative and postoperative clinical and audiological findings, hearing loss etiology, surgical approach techniques, and complications were evaluated retrospectively in 31 patients (35 ears) undergoing CI surgery.

Results: Thirty one patients (13 adults and 18 children) were included in the study. After posterior tympanotomy following cortical mastoidectomy, electrodes were introduced through the round window in 21 ears and via cochleostomy in 14 ears. CIs with different number of electrodes (22, 16, 12) from 3 different companies were used. No postoperative complications were observed in any of the patients. The mean free field audiogram (FFA) was 95.2±19.13 dB preoperatively and 37.8±8.46 dB postoperatively in 24 patients who attended the control visits. Postoperative hearing gains were significantly different from the preoperative values (p<0.001). There was no significant difference between different devices (p=0.340). Electrodes were introduced through the round window or by cochleostomy, and comparison of these two groups revealed no statistically significant difference in terms of postoperative FFA values (p=0.425) or speech awareness threshold and speech reception threshold values (p=0.132).

Conclusion: The significant hearing gains in the postoperative period without any complications indicate the success of the surgical technique utilized in this study. It can be said that the difference in electrode insertion location and numbers does not affect the postoperative results.

Keywords: Cochlear implantation, postoperative complications, cochleostomy, round window, correction of hearing impairment

ÖZ

Amaç: Koklear implantlar (Kİ), iki taraflı ciddi veya ileri derecede işitme kaybı olan hastalarda işitmeyi iyileştirerek dil ve konuşma gelişimine yardımcı olur. Bu çalışmada, Kİ cerrahisi geçiren hastalarımızın sonuçlarını değerlendirdik.

Gereç ve Yöntem: Kİ cerrahisi uygulanmış olan 31 hastada (35 kulak); preoperatif, perioperatif ve postoperatif klinik ve odyolojik bulgular, işitme kaybı etiyolojisi, cerrahi yaklaşım teknikleri ve komplikasyonlar retrospektif olarak değerlendirildi.

Bulgular: Otuz bir hasta (13 yetişkin ve 18 çocuk) çalışmaya dahil edildi. Kortikal mastoidektomiyi takiben posterior timpanotomi sonrası 21 kulağa yuvarlak pencereden ve 14 kulağa kokleostomi ile elektrotlar yerleştirildi. Üç farklı firmadan farklı sayıda elektrotlu (22, 16, 12) Kİ'ler kullanıldı. Hiçbir hastada postoperatif komplikasyon görülmedi. Kontrole gelen 24 hastanın ortalama serbest alan odyogramı (FFA) ameliyat öncesi 95,2±19,13 dB, ameliyat sonrası 37,8±8,46 dB idi. Ameliyat sonrası işitme kazanımları ameliyat öncesi değerlerden anlamlı derecede farklıydı (p<0,001). Farklı marka cihazlar arasında anlamlı bir fark yoktu (p=0,340). Elektrotlar yuvarlak pencereden veya kokleostomi ile yerleştirildi ve bu iki grubun karşılaştırılmasında, postoperatif FFA değerleri (p=0,425) veya konuşma farkındalığı eşiği (SAT) ve konuşmayı algılama eşiği (SRT) değerleri (p=0,425) açısından istatistiksel olarak anlamlı bir fark görülmedi (p=0,132).

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Sonuç: Postoperatif dönemde herhangi bir komplikasyon olmaksızın elde edilen önemli işitme kazanımları, bu çalışmada kullanılan cerrahi tekniğin başarısını göstermektedir. Ayrıca elektrot yerleştirme yeri ve sayıları arasındaki farklılığın da ameliyat sonrası sonuçları etkilemediği söylenebilir.

Anahtar Kelimeler: Koklear implantasyon, postoperatif komplikasyonlar, kokleostomi, yuvarlak pencere, işitme bozukluğunun düzeltilmesi

INTRODUCTION

Cochlear implant (CI) is an electronic neuroprosthesis, applied in patients with bilateral severe or profound sensorineural hearing loss (SNHL) who do not benefit from conventional hearing aids, and it is effective in rehabilitation of prelingual and postlingual deafness[1]. CI allows children to improve their speech skills by giving them an opportunity to hear. In adults who develop deafness later in life, CI supports communication through regained hearing[2,3].

Most cases of deafness are caused by the absence or damage of cochlear hair cells. The defect in cochlear functions interferes with the transformation of mechanical acoustic signals into synaptic activity of the auditory nerve[4]. CIs are electronic devices that convert sound into electrical signals, bypass defective cells and directly stimulate the spiral ganglion cells. This allows the transmission of acoustic information to the central nervous system through direct electrical stimulation of cochlear nerve fibres[4].

The main components of a CI system include a microphone that collects the sound and converts it into an electrical signal, an external processor that processes these signals, an internal receiver-stimulator, and an electrode carrier fitted inside the cochlea to transmit electrical signals to spiral ganglion cells[5,6]. Devices of different brands have different features such as consisting of 32, 22, 16 or 12 electrodes, and containing singlechannel or dualchannel sound processors[7]. While the electrodes are often implanted through a round window, in some cases, they may need to be implanted through cochleostomy. Different techniques can also be used to place the CI receiver-stimulators in the skull. CI receiverstimulators are usually implanted in a special bony bed created by drilling the skull and fixed with sutures into the holes created in this area. However, rare intracranial complications and migration of receiverstimulators have been reported with this standard method[8]. In 2009, Balkany et al.[8] described the subperiosteal temporal pocket technique, which allows anchoring the receiverstimulator with anatomically compatible strong fixation points without an extra surgical procedure while preventing migration and dural complications.

In the present study, we wanted to share our experiences by evaluating our results as the first center to perform CI surgery in the Thrace region. We also investigated whether the differences of the electrode placement and the number of electrodes of the CIs had an effect on the postoperative results of our patients who underwent subperiosteal temporal pocket technique in our clinic.

MATERIALS AND METHODS

Preoperative, perioperative and postoperative clinical and audiological findings, hearing loss etiology, surgical approach techniques and complications were evaluated retrospectively in 31 patients (35 ears) aged 14 months to 57 years, who underwent CI surgery from December 2013 to September 2019 at Trakya University. Bilateral CI surgery was performed in 4 of these 31 patients in different sessions. Scientific Research Ethics Committee of the Trakya University Faculty of Medicine approved the procedures of the study (protocol number: 2018/282, date: 07.08.2018). All protocols adhered to the tenets of the Declaration of Helsinki and informed consent was obtained from all subjects.

Selection of the Cases

During the review of patient files, the following were taken into account: the brand/number of electrodes in the device, the technique used to implant the CI receiver and the electrode; postoperative complications; preoperative tympanometry, audiometry, free field audiometry (FFA) and brainstem evoked response audiometry (BERA) tests; postoperative FFA, speech awareness threshold (SAT), speech reception threshold (SRT), speech discrimination score (SDS) and data on neural response telemetry (NRT) measurements performed by the relevant CI company postoperatively.

Eligible CI candidates were patients with bilateral severe or profound SNHL, who did not benefit from hearing aids and had an intact cochlear nerve and adequate internal ear development to allow electrode implantation as evidenced by magnetic resonance imaging (MRI) and/or high-resolution computed tomography (CT). Indications were established after an assessment by the CI committee, which included an earnosethroat (ENT) specialist, an audiologist, a pediatric audiologist and a psychologist. Behavioral and physiological evaluation results were compared in order to determine hearing sensitivity in patients who presented with a pre-diagnosis of hearing loss before cochlear implantation. For this purpose, pure tone audiometry in adult patients; airway hearing thresholds (250-8000 Hz), bone conduction hearing thresholds (500-4000 Hz), speech tests; SRT, SDS, immitansmetric evaluation, otoacoustic emissions (TEOAE, DPOAE) and BERA tests were applied. Behavioral test methods suitable for age, immitansmetric assessment (1000 Hz probe tone), otoacoustic

emissions (TEOAE, DPOAE) and BERA tests were applied in the behavioral evaluation of pediatric cases. Fine motor, personal-social development levels were evaluated and reported. Based on the results of the evaluation, the auditory rehabilitation process was initiated with a hearing aid, considering that people diagnosed with severe/profound hearing loss might be candidates for CIs. The cochlear implantation process was initiated for cases that could not gain sufficient level of hearing aid by evaluating the hearing aid thresholds after appropriate amplification. CI brand choice is made according to the rules determined by the Republic of Turkey Ministry of Health. Our clinic cannot make a decision on that matter.

Minimally invasive CI surgery technique was used in all patients. In this technique, a 4 cm Balkany et al.[8] incision is made 12 mm posterior to the retroauricular sulcus as the initial step. Posteroinferior-based periosteal flap follows the first step. Following a limited cortical mastoidectomy, posterior tympanotomy is performed and the electrode is introduced in the scala tympani through the round window after a vertical incision. In patients in whom the round window visualization is inadequate, the electrode is introduced in the scala tympani by means of cochleostomy. The processor is introduced and secured in the pocket created below the periosteum using Balkany et al.[8] subperiosteal temporal pocket technique. Subsequently, the number of electrodes in the cochlea is checked by NRT. Upon confirming an adequate number of electrodes in cochlea, electrodes are stabilized in the mastoid cavity with bone chips and tissue adhesive. The first telemetric measurements and programming of the device are usually performed in 1 month by the relevant implant company.

Statistical Analysis

The Shapiro-Wilk test was used to check the normal distribution. The paired dependent sample t-test was used for the comparison of dichotomous dependent groups. The paired independent sample t-test was employed to compare dichotomous independent groups. One-way analysis of variance was utilized in the comparisons of more than two independent groups. The means and standard deviations were presented as descriptive statistics. Level of significance was considered as $p<0.05$. All the statistical analyses were performed with the TURCOSA v.1.0 (Turcosa Analytics Ltd. Co., Kayseri, Turkey) statistical software.

RESULTS

Thirtyone patients, consisting of 13 adults and 18 children, were included in the study. The mean age was 19.2±20.3 years, and the median age was 7 years (14 months-57 years). While 11 of the children were in prelingual period (<4 years of age, mean 2.6±0.92 years), 7 were in the age group of 4-15 years (mean 9±3.87 years). The 4 prelingual patients underwent bilateral CI in different sessions within one year.

With regard to the etiological causes in these children, two patients had a history of meningitis (11 and 3 years before the operation), one had ototoxicity, one had Down syndrome, and one of the children had juvenile rheumatoid arthritis in addition to the history of SNHL with onset at 5 years of age. Another child had a history of spina bifida and chronic kidney failure, and another had chronic otitis media (COM) (previously operated from the same ear due to granular otitis). The remaining children had bilateral SNHL due to congenital hearing loss.

The etiological causes in adults included temporal bone fracture in one patient, brucellosis (7 years before the operation) in one patient, and COM in two patients. In one of the adult patients, left-sided temporal meningioma recurrence was suspected, and CI was therefore applied to the right ear. The remaining 8 adult patients were idiopathic.

According to the results of preoperative BERA and FFA with the device performed in all patients, 5 had bilateral severe SNHL and 26 had bilateral profound SNHL. None of the patients gained any benefit from the conventional hearing aid. The mean bone conduction threshold was 70±4.3 dB in 15 patients with implant, who underwent preoperative audiometry, and the mean airway threshold was 109.3±7.76 dB. The mean FFA with the device was 85.7±10.4 dB in the remaining 16 patients. Preoperative tympanograms were type A in all patients except the patients with COM. In preoperative BERA tests, 3 patients achieved the 5th wave at 100 dB, 2 at 90 dB and 5 at 80 dB, while the 5th wave was not achieved in BERA results of the other patients.

The preoperative radiological evaluations revealed a fracture line in the right temporal bone in a patient with posttraumatic bilateral severe SNHL and CI was therefore applied to the left ear. In a patient with facial canal dehiscence on the right and signs of chronic mastoiditis on the left, residual hearing was better in the right ear, and CI was applied to the right ear for this reason. Radiological images of another patient revealed type 1 incomplete partition findings. Atay and Sennaroğlu's[6] corktype electrode was used in this patient and no perilymphatic gusher or any other complication was observed. Postoperative changes were noted in the CT and MRI reports of 2 patients who underwent mastoidectomy and CI surgery in the same ear. The cranial MR report of a patient with a history of neurobrucellosis showed findings consistent with residual white matter alterations of neurobrucellosis in subcortical white matter. In this patient, the operation was terminated due to dura opening during the mastoidectomy procedure performed for the right ear, and CI was successfully completed in the left ear 2 months later. Since the imaging reports of a patient with a history of radiotherapy for left frontotemporal meningioma revealed findings in favor of the recurrence of the left frontotemporal meningioma, CI was applied to the right ear.

The electrodes were introduced through the round window in 21 ears and by cochleostomy in 14 ears. Cochleostomy was used to introduce the electrodes due to the absence of the round window in the visualized area in the ears of 8 patients (9 ears), ossification above or deep below the round window in 2 patients, several electrodes' being left out in the event of introduction through the round window in 2 patients, and the lack of round window development in 1 patient. While transmastoid approach was employed in 29 patients, combined surgical approach was applied in 2 cases due to high facial ridge. Transcanal approach was included in addition to the standard retroauricular approach in these patients.

Of the 35 ears operated in thirtyone patients, 23 were right and 12 were left ears. The ear with better residual hearing was operated first in 4 patients undergoing bilateral CI surgery. The 22electrode CI device of Cochlear® (Cochlear Co. Ltd., Sydney, Australia) was used in 7 ears while the 16electrode Advanced® (Advanced Bionics Co. Ltd., Santa Clarita, CA, US) CI was used in 4 ears and the 12electrode Medel® (Med-El GmBH, Innsbruck, Austria) CI device was implanted in 23 ears. Information on the brand and characteristics of the device could not be obtained in 1 patient.

In the perioperative measurements of 7 patients for whom twentytwo electrode devices were used, response was obtained in all electrodes in 6 patients while response was

Table 1. Number of electrodes with response in perioperative and postoperative measurements with the brand and models of devices in tabulated form

Patients undergoing implantation	Device brand/model	Number of electrodes with perioperative response	Number of electrodes with postoperative response
1	ADVANCED HIRES90K (HIFOCUS 1j Electrode - 16e)	16	16
2	ADVANCED HIRES90K (HIFOCUS 1j Electrode - 16e)	16	16
3	ADVANCED HIRES90K (HIFOCUS 1j Electrode - 16e)	16	16
4	ADVANCED HIRES90K (HIFOCUS 1j Electrode - 16e)	16	16
5	COCHLEAR NUCLEUS (CI24RE ST - 22e)	22	22
6	COCHLEAR NUCLEUS (CI24RE ST - 22e)	22	22
7	COCHLEAR NUCLEUS (CI24RE ST - 22e)	22	22
8	COCHLEAR NUCLEUS (CI24RE ST - 22e)	22	22
9	COCHLEAR NUCLEUS (CI24RE ST - 22e)	22	22
10	COCHLEAR NUCLEUS (CI24RE ST - 22e)	22	22
11	COCHLEAR NUCLEUS (CI24RE ST - 22e)	20	22
12	MEDEL OPUS 2 (SONATA TI100 - 12e)	12	12
13	MEDEL OPUS 2 (SONATA TI100 - 12e)	12	12
14	MEDEL OPUS 2 (SONATA TI100 - 12e)	12	12
15	MEDEL OPUS 2 (SONATA TI100 - 12e)	12	12
16	MEDEL OPUS 2 (SONATA TI100 - 12e)	12	12
17	MEDEL OPUS 2 (SONATA TI100 - 12e)	12	11
18	MEDEL OPUS 2 (SONATA TI100 - 12e)	12	11
19	MEDEL OPUS 2 (SONATA TI100 - 12e)	12	9
20	MEDEL OPUS 2 (SONATA TI100 - 12e)	11	10
21	MEDEL OPUS 2 (SONATA TI100 - 12e)	11	9
22	MEDEL OPUS 2 (SONATA TI100 - 12e)	10	11
23	MEDEL OPUS 2 (SONATA TI100 - 12e)	10	10
24	MEDEL OPUS 2 (SONATA TI100 - 12e)	8	8
25	MEDEL OPUS 2 (SONATA TI100 - 12e)	8	7
26	MEDEL Synchrony (Standard - 12e)	12	12
27	MEDEL Synchrony (Standard - 12e)	12	12
28	MEDEL Synchrony (Standard - 12e)	12	12
29	MEDEL Synchrony (Standard - 12e)	12	10
30	MEDEL Synchrony (Standard - 12e)	9	8
31	N/A	n/a	n/a

obtained in 20 electrodes in 1 patient. However, postoperative controls revealed response in all electrodes in these 7 patients. Response was obtained in all electrodes both in perioperative and postoperative measurements in all 4 patients for whom 16 electrode devices were used. The measurement results obtained in 19 patients for whom 12 electrode devices were used are shown in Table 1.

No postoperative complications were observed in any of the patients. Postoperative imbalance complaint ongoing for 1 month was noted in the patient who underwent scala vestibuli cochleostomy due to lack of round window development.

There were 24 patients who attended the control visits regularly with a mean implant duration of 3.48±2.30 years (4 months-8 years). The mean preoperative FFA of the patients, recorded and averaged at 500-1000-2000-4000 Hz frequencies, was 95.2±19.13 dB and the mean postoperative FFA was 37.8±8.46 dB (range: 25-55). A significant difference was noted in terms of hearing gain in the comparison of preoperative and postoperative audiological findings of the patients under follow-up (p<0.001) (Table 2).

Although we had a limited number of patients, we evaluated the postoperative results of CIs with different electrode numbers. Of these twenty four patients, 6 had 22 electrode implants, 4 had 16 electrode implants, and 14 had 12 electrode implants. Comparison of their postoperative FFA values revealed no statistically significant difference between the devices (p=0.340). Again, no statistically significant difference was noted in terms of SAT/SRT values (p=0.862) (Table 3).

Electrodes were introduced through the round window in 15 of twenty four patients and by means of cochleostomy in the remaining 9 cases. In the round window group, the mean preoperative FFA value was 92.66±20.16 dB, while the mean postoperative FFA value was 38.89±8.65 dB. In the cochleostomy group, these values were 99.44±17.57 dB and 35.97±8.30 dB, respectively. A significant difference was observed between the preoperativepostoperative FFA values of patients in the round window group (p=0.0001). Similarly, there was a significant difference between the preoperative and postoperative FFA values of the patients in the cochleostomy group (p=0.0001). No statistically significant difference was noted between the two groups in terms of postoperative FFA values (p=0.425) and SAT/SRT values (p=0.132) (Table 3).

DISCUSSION

Rehabilitation of deafness may be possible after CI surgery performed in patients with bilateral severe or profound SNHL, who do not gain any benefit from conventional hearing aids. The results of the study presented herein show a significant hearing gain in patients undergoing CI surgery. Relevant information should be provided for the families of adult patients and pediatric patients, including the importance of training and the rules to be followed after surgery so that children may develop speaking skills comparable to their peers with normal hearing[9]. Geers et al.[10] emphasized the importance of postoperative training to ensure maximum benefit from the implantation in their study, showing a comparable level of producing and understanding the English language in more than half of 181 children aged 8-9 years who were CI users. In our clinic, although the necessary information is provided and followup is initiated from the time of identifying CI candidates, we encounter patients who do not continue their follow-up in the long term, as reflected in the results of the present study.

The round window pathway is used to introduce electrodes in all cases eligible for this approach at our clinic. If the

Table 2. Statistical comparison of preoperative and postoperative hearing thresholds of patients

	n (number of patients)	Mean	Standard deviation	p value
Preoperative FFA thresholds	24	95.2083	19.1379	<0.001
Postoperative FFA thresholds	24	37.8	8.4656	

FFA: Free field audiogram

Table 3. Statistical comparison of postoperative hearing test results of devices with different number of electrodes and postoperative hearing test results of electrodes inserted by different techniques

		Postoperative FFA			Postoperative SAT/SRT		
Device	**n (number of patients)**	**Mean**	**Standard deviation**	**p value**	**Mean**	**Standard deviation**	**p value**
Advanced (16e)	4	38.3750	10.2744	0.340	35	7.0711	0.862
Cochlear (22e)	6	33.3750	7.9667		34.1667	12.8128	
Medel (12e)	14	39.5321	8.1027		36.4286	7.1867	
Technique							
Cochleostomy	9	35.9722	8.3099	0.425	32.2222	7.5462	0.132
Round window	15	38.8967	8.6512		37.6667	8.6327	

FFA: Free field audiogram, SAT: Speech awareness threshold, SRT: Speech receipt threshold

round window cannot be visualized conveniently through the facial recess or if ossification is present, then the electrodes may be introduced by cochleostomy. Electrode introduction through the round window results in less acoustic trauma as fewer drills are performed[11]. Richard et al.[12] demonstrated less intracochlear trauma with the round window approach for the introduction of electrodes. Jiam et al.[13] concluded that the round window approach allowed implanting the electrodes in closer proximity to the cochlear neural elements. On the other hand, no superiority was seen between the round window approach and cochleostomy in the review by Havenith et al.[14] in 2013. Results from the study by Rajput and Nilakantan[15] did not reveal any difference between the round window approach and cochleostomy in terms of electrode positioning based on the postoperative speech skills and hearing level of the patients. Helms and Moser[16] evaluated communication skills in patients for whom CIs of two different brands were used and found that one brand was more successful than the other. In the present study, both CI positioning techniques significantly improved postoperative hearing thresholds of the patients. Furthermore, no difference was observed in terms of postoperative hearing gain in patients who received implants of different brands with different number of electrodes. Considering these findings, we may conclude that both techniques are applied successfully without leading to difference in postoperative hearing gains obtained with the CI brands included in this study.

Balkany et al.[8] introduced the temporal pocket technique to the literature in 2009. They used this technique, which does not require drilling to introduce the receiver, in 171 patients and did not observe device migration or any intracranial complication throughout the followup of at least one year. Jethanamest et al.[17] also utilized the subperiosteal pocket technique and observed no perioperative complication or postoperative migration in any of 63 patients. In our clinic, we use Balkany et al.[8] method and we have not encountered any postoperative complications in our patients.

There are different applications for patients previously operated due to chronic suppurative otitis media. Some surgeons clear the epithelium in the mastoidectomy cavity and perform the implantation in the same session in the absence of infection, while some others perform tympanoplasty or tympanomastoidectomy in the first session and perform CI in a second session[18-20]. Cevizci and Bayazit[21] applied the "canal wall up" tympanomastoidectomy technique without cavity obliteration and concluded that it was a safe surgical method as they did not observe any complications or recurrent cholesteatoma during long-term follow-up. In the present study, chronic suppurative otitis media was eradicated with an appropriate surgical approach in the first session in three patients with this condition, and CI surgery was performed after a follow-up of at least 6 months. We performed tympanomastoidectomy for one of the patients due to adhesive otitis and in another one for granular otitis. At six months, no discharge was noted in the ears of these patients, their tympanic membranes were intact, and no sign of recurrence was observed in tomography images. In another patient, cholesteatoma was detected and "canal wall down" mastoidectomy was performed for pathological clearance, followed by cul de sac and external ear canal closure. CI surgery was performed in the same ear 9 months later. No recurrence of cholesteatoma was observed during the follow-up.

Brucellosis is a zoonotic disease that is endemic in Mediterranean countries[22]. This condition may manifest as neurobrucellosis involving the nervous system in 5% of affected patients. Guneri et al.[23] published for the first time in 2009 that they successfully performed CI surgery in a patient with neurobrucellosis. Subsequently, Ocak et al.[24] from our country in 2015 and Bajin et al.[25] in 2016 published their cases with neurobrucellosis undergoing CI surgery. In 2015, we successfully performed CI surgery in a 45 year old patient with paraplegia, history of meningitis, bilateral SNHL and history of neurobrucellosis.

A high prevalence of SNHL is observed in patients with rheumatoid arthritis[26,27]. Dekker and Isdale published a case report of CI surgery in a patient with juvenile chronic arthritis and bilateral progressive SNHL[28]. We also applied a CI to a 7 year old patient with juvenile rheumatoid arthritis and bilateral profound SNHL, and achieved an increased hearing threshold.

In 2012, Yorgancılar et al.[29] performed CI surgery in 33 children and 3 adults and introduced the electrodes through the round window in nearly all cases. None of these patients had any postoperative complications. Furthermore, Şahan et al.[30] evaluated the outcomes of CI surgery in 144 patients and reported successful outcomes, low complication rates and notable improvement in post-CI speech perception scores as well as audiological performance. Based on the results of the present study, we concluded that the temporal pocket bed approach we used in CI surgery was an effective and safe method. Postoperative hearing gains are significant. It can be said that the difference between the electrode insertion location and numbers has no effect on postoperative results. We believe that our study is important as it evaluates the first cases operated with the temporal pocket approach in the Thrace Region and the results demonstrate that none of the patients operated with this technique developed complications such as implant rejection or migration.

Study Limitations

The most important limitation of our study is the limited number of patients in the groups stratified by the type of implants used for the procedure. Although this translates into a low level of reliability, our findings are consistent with those previously reported in the literature.

CONCLUSION

Although we have a limited number of patients, the significant hearing gains in the postoperative period without any complications show the success of the surgical technique utilized in this study. In terms of post-operative hearing gains, it can be said that the difference in electrode insertion location and numbers does not affect the results. We also believe that the surgeon's ability to master different approaches is essential for successful surgery.

Ethics

Ethics Committee Approval: The study were approved by the Trakya University Faculty of Medicine Scientific Research Ethics Committee (protocol number: 2018/282, date: 07.08.2018).

Informed Consent: Consent form was filled out by all participants.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: S.G.G., C.U., Concept: S.G.G., C.U., M.T., E.D., Design: S.G.G., C.U., M.T., E.D., Data Collection or Processing: S.G.G., M.T., E.D., Analysis or Interpretation: S.G.G., C.U., M.T., E.D., Literature Search: S.G.G., M.T., E.D., Writing: S.G.G., C.U., M.T., E.D.

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