

Cochlear Implant Electrode Misplacement

Koklear İmplant Elektrodunun Yanlış Yerleştirilmesi

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ABSTRACT In the period 2014-2017, we performed secondary cochlear implantation (CI) surgery on 37 patients whose primary CI was performed in other clinics at different times. We report 3 cases of improper administration of the active electrode into the cochlea. Of these, 2 cases recorded in children aged 3-6 years with ossification of the labyrinth, and 1 case of active electrode extrusion in a 13-year-old patient with normal anatomy of the temporal bone. All these cases had repeated surgery.

Keywords: Cochlear implantation; electrode misplacement; complication; ossification of the labyrinth; inner ear malformation

ÖZET 2014-2017 döneminde primer koklear implantasyonu (KI) farklı zamanlarda başka kliniklerde uygulanmış 37 hastaya tekrar KI cerrahisi uyguladık. Aktif elektrodun kokleada yanlış uygulanmasına ilişkin 3 olgu bildirdik. Bunlar arasında, labirentin ossifikasyonu ile 3-6 yaş arası çocuklarda kaydedilen 2 olgu ve temporal kemiğin normal anatomisi olan 13 yaşında bir hastada aktif elektrot ekstrüzyonu olgusu bulunmaktadır. Bütün bu olgular tekrar ameliyat edildi.

Anahtar Kelimeler: Koklear implantasyon; elektrodu yanlış yerleştirme; komplikasyon; labirentin kemikleşmesi; iç kulak malformasyonu

Cochlear Implantation (CI) is an effective and doable alternative to restore hearing in cases of bilateral severe to profound hearing loss in patients who do not benefit from using an individual sound amplification device.^{1,2}

According to various authors by far the most common causes of recurrent CI is the migration of the implant and/or extrusion, technical failure and implant misplacement of the electrode array in the spiral canal of the cochlea. In general, the rate of complications is low. In the presence of abnormalities of the inner ear the risk of improper administration of the active electrode into the cochlea increases.³ This complication according to some authors is 0.17-2.12%.⁴

CASE REPORT

CASE 1

A child at the age of six years was admitted to the hospital with a diagnosis of bilateral severe sensorineural hearing loss (SHL), a condition after CI on

the left ear (2 months ago). The child had suffered viral encephalitis against acute respiratory viral infection and then noticed a hearing loss at the end of the 1st year of life. The audiological research revealed severe bilateral SHL at the age of three and the child had hearing aided in both ears without any positive effect. The child had been recommended CI in both ears. Temporal bone computer tomography (CT) revealed bone obliteration of basal turn more than 5 mm on the left ear and partially ossified second turn of cochlea on the right ear. The obliteration of the round window of the cochlea and the lumen of the basal turn of cochlea on the left ear had been found on the first operation and only two electrodes had been introduced in the field of round window (Figure 1a, b).

The reoperation was made on the left ear by scars. The cochlear implant was removed and mastoid cavity and posterior tympanotomy expanded. We removed the bridge, incus and stapes front leg, and then canopy the round window. In the round window projection made lower cochleostomy. We failed to reach the spiral channel lumen of cochlea, because of the ossification the ascending portion of the basal turn. After imposing upper cochleostomy in front of the front foot stapes and below the processus cochleariformis, we accessed to the second turn (Figure 2).

We removed the section promontorial wall which separating the two cochleostomy. After insertion of the implant in the bed of the active electrode was inserted through the released portion of the basal turn into the top cochleostomy. Intraoper-

ative resistance impedance of the electrodes are within the reference range (Figure 3).

The active electrode completely fills the second and initial parts of the basal turn according to the post-operative CT scan of the temporal bone (Figure 4).

Informed Consent: Written informed consent was obtained from the patient for publication of this case report and accompanying images.

CASE 2

A child at the age of 3 years old was ex-admitted to the hospital with a diagnosis of bilateral severe SHL, post-clinical trials on the right ear (1 month ago). The neonatal hearing screening was not carried out, the parents had noticed the lack of response to sounds at the age of 1 year. The audiological research revealed severe bilateral SHL and the child had hearing aided without any effect. Bilateral abnormality of the inner ear (cochlea incomplete separation of Type I) and the extended lumen of the internal auditory canal (IAC) to both sides was determined on temporal bone CT. The first CI operation had been performed by classical access with mastoidectomy and posterior tympanotomy. Liquorrhea had been emerged while cochleostomy imposing, after full implementation of the active electrode. The liquorrhea had been stopped by tamponed automuscles. The wound had been sutured in layers. The patient had been discharged from the hospital on the ninth day without any complication. Postoperative temporal bone CT (Figure 5a-c). Signs of postoperative

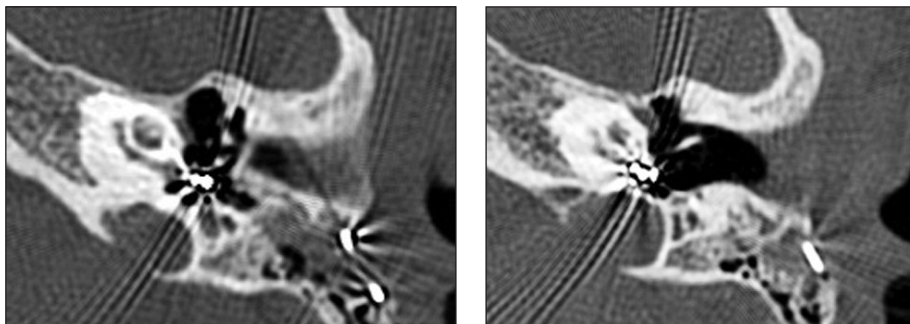


FIGURE 1a, b. CT of the left temporal bone, the axial projection. The display ossified cochlea, the electrode array is introduced only in the initial parts of the basal turn.

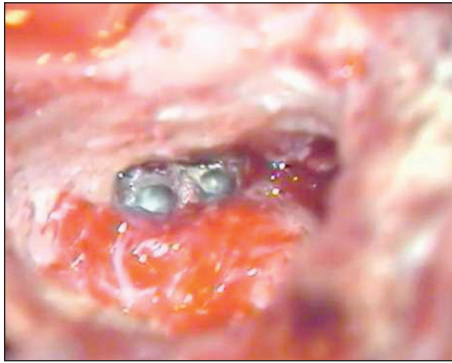


FIGURE 2. Intraoperative photograph. Mastoidectomy and posterior tympanotomy was made and removed the bridge, incus and stapes. Submitted two cochleostomy: in the basal turn (small arrow) and the second helix (large arrow).

changes the right temporal bone, found the introduction of the active electrode in the middle cranial fossa through the IAC. Recommended re-CI right.

Reoperation was made. The active electrode implant was removed. We extended posterior tympanotomy and the cochleostomy along the course of the basal turn and removed of the ossified area. A spontaneous cerebrospinal fluid (CSF) was appeared during the operation (Gasher syndrome). After taking a break during the operation for 5 minutes with the raised position of the patient's head, the liquorrhea was decreased. The same implant was laid in a bed. To provide a good visualization of the lumen of the spiral cochlear duct (due to aspiration of entering CSF) and to prevent ingress of the electrode array in the IAC installed suction at the inferior part of window of the cochlea or cochleostomy formed so that the aspirator tip closed in the course of the IAC (Figure 6).

It was possible to enter the 10 electrodes from 12. Cochleostomy was tamponed with fragment of automuscles and, the liquorrhea was stopped. During electrophysiological testing of the implant, acoustic reflexes of the tendon of the stapes muscle were not obtained. The resistance of the majority of impedance of the electrodes within the reference range (Figure 7).

The wound was sutured in layers. Intraoperative temporal bone CT indicates the correct administration of the active electrode into the cochlea (Figure 8 a, b).

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CASE 3

A child at the age of 13 years old was admitted to the hospital with a diagnosis of chronic suppurative otitis media on the right after cochlear implantation (9 years ago). The child has bilateral severe SHL and complaining recurrent purulent discharge from the right ear in the last 2 months. The purulent discharge from the right ear was not amenable to conservative treatment began after 8 years from cochlear implantation. The back wall defect in the external auditory canal (EAC) and posterior-lower quadrant of the tympanic membrane through which the electrode was visualized and observed purulent discharge (Figure 9).

The tympanoplasty was performed with cleaning and re-implantation of the electrode array. The incision was made through scar tissue behind the ear. Exfoliated soft tissues were taken. The fascial flap and a fragment autotilage ear was prepared..

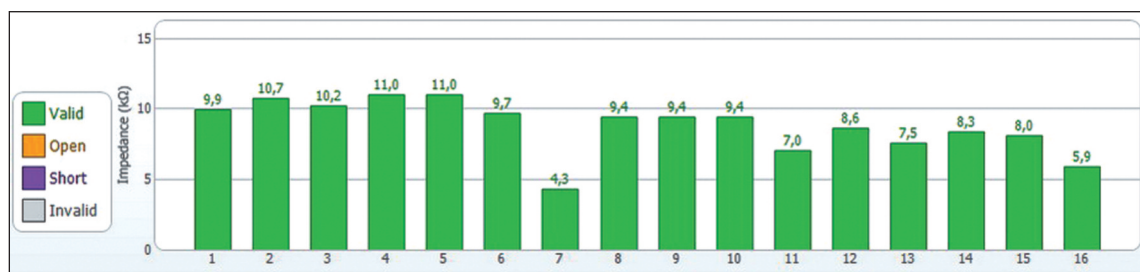


FIGURE 3. Intraoperative impedancometry.



FIGURE 4. CT of the left temporal bone. Electrode array inserted into the second turn.

We observed the bone defect of the posterior wall of the EAC in the posterior tympanostomy, through which the active electrode goes into the EAC. The epidermis was spreaded on the electrode into the mastoidal cavity. The pearl of cholesteatoma and granulation was seen into the mastoidal cavity. Abnormal tissue was removed from mastoidal cavity. The skin of the posterior wall was peeled off to the EAC annulus tympanicus. The revision of the tympanic cavity was completed. Stapes superstructure was saved. Granulation and scarring of the tympanic cavity was removed. The active electrode was separated from the scars and removed from cochleostomy and mastoidal cavity and retracted into the temporo-parietal region and cleared of the epidermis. Cochleostomy was tamponed by autotissue. Smoothed the posterior wall of the EAC, in the posterior tympanostomy was formed for electrode array. Cochleostomy was extended and the electrode array was placed into the cochlea reintroduced. The electrode was delimited by fascial

flap plate autotissue. The back-ear wound was sutured in layers. The resistance of the electrode impedance was within the reference range intraoperatively (Figure 10).

The patient had a successful speech processor connection. The tympanic membrane and the posterior wall of EAC had no problem after 45 days of surgery by otoscopy (Figure 11a, b).

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DISCUSSION

The location of the electrode array in to the scala tympani of the cochlea is true and standart way. Improper placement of the electrodes is major complication of the cochlear implantation, which causes failure and repeated surgery, a rare condition in modern ear surgery.⁵ Extracochlear displacement of active electrode is an infrequent complication. The published literature incidence rate of 0.2% to 5.8%, and an average of 0.37%.⁶ However, this range is likely underestimated, and the true incidence may remain unknown until universal centralized database for recording such cases.

Terry et al. reviewed 11 studies with a total of 1740 patients undergoing cochlear implantation in whom 32 (1.9%) had electrode array issues that led to explantation. Based on the reports, electrode issues included individual electrode failure, electrode migration, electrodes slipping out, nonauditory stimulation, and electrode exposure.⁷ Mecca et al. described case the electrodes pass from the scala tympani into the scala vestibuli by piercing the

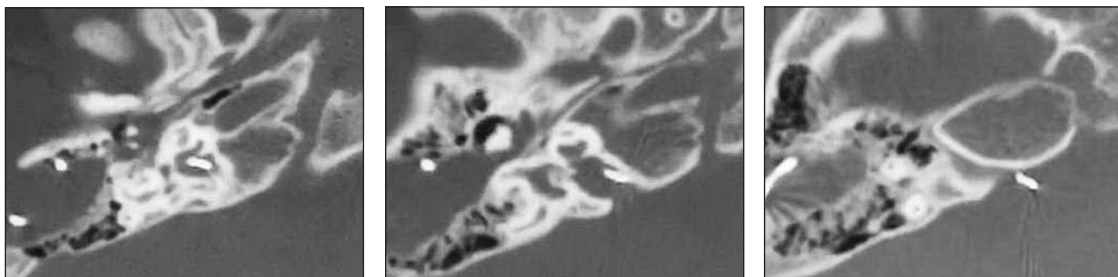


FIGURE 5a-c. CT of the right temporal bone, the axial projection. The lack of separation between the cochlea and IAC. The active electrode observed through the IAC to the cerebellopontine angle.

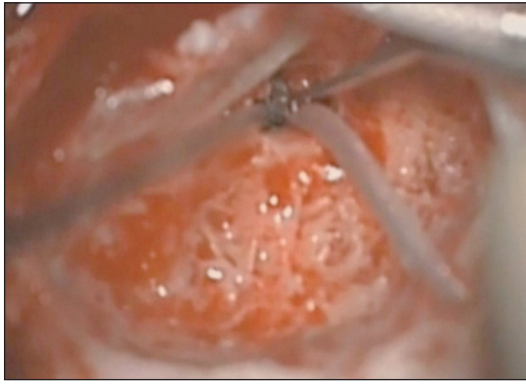


FIGURE 6. Intraoperative photograph. The process of administration of the active electrode into the spiral canal of the cochlea in the background liquor-rhea.

basilar membrane. It may enter the vestibule and pass into the superior semicircular canal, which can cause significant vestibular symptoms.⁸ Ikeya et al. described 4 patients with electrode problems, all

had to undergo reimplantation.⁹ Carlson et al. found that 9.0% of all CIs showed at least 1 failed electrode. Schow et al. demonstrated that, individual electrode failure led to only 3 explantations (0.9% of patients). One individual electrode does not cause noticeable effects, but cumulative malfunction of electrodes can cause a decrease in the hearing benefit. Older studies have reported a higher incidence of electrode problems, including an incidence of 4.3% in 4969 patients and an incidence of 6.5% in 153 patients.⁷

Improper administration of the active electrode can be attributed to unidentified abnormality of the inner ear, including the possible anatomic changes of the cochlea basal turn and surgeon mistake during the operation in the step of forming the posterior tympanotomy. As mentioned above

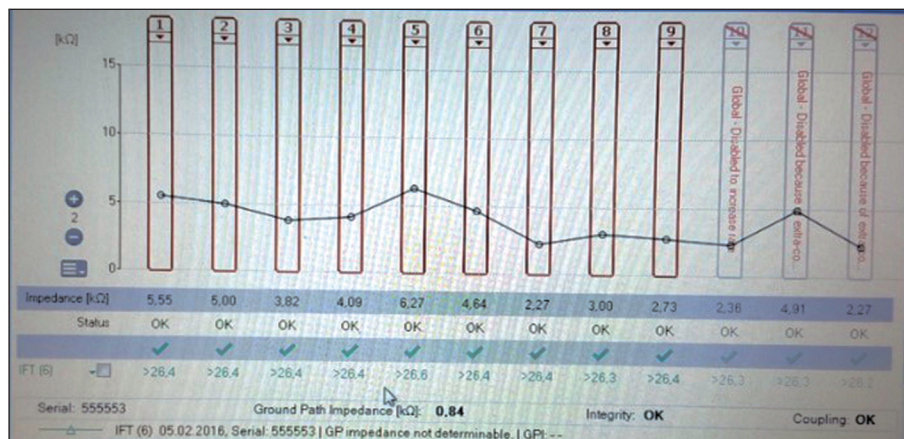


FIGURE 7. Intraoperative impedancometry.

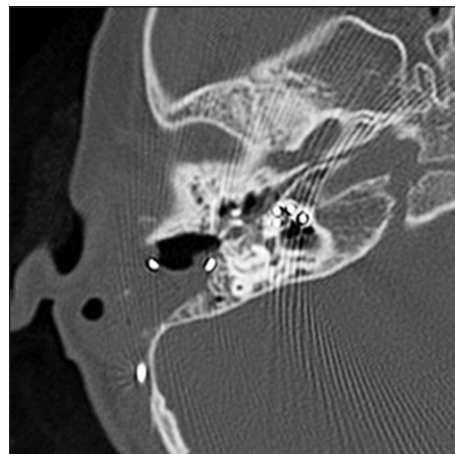


FIGURE 8a, b. CT of the right temporal bone, the axial projection. The electrode array into the cochlea is correct.



FIGURE 9. Otoendoscopy of the right EAC. the posterior wall of the auditory canal defect, extrusion of the electrode array, muco-purulent discharge from the EAC.

fourth clinical cases of improper performance of a surgeon posterior tympanotomy and therefore improper administration of the active electrode over the annulus tympanicus in the tympanic cavity caused further development of chronic otitis media with the lack of opportunities to use the implant. Preoperative radiographic examination could help to avoid complications associated with developmental abnormalities.¹⁰ However, normal preoperative temporal bone CT does not exclude the presence of developmental abnormalities of the inner ear malformations such as osseous spiral lamina, which could lead to a non-standard location active electrode. In addition to congenital abnormalities of the inner ear, the analysis of preoperative temporal bone CT helps to the surgeon to identify other possible anatomic limitations such as

fractures of the temporal bone, otosclerosis or ossification of the labyrinth. The most common mistake is unintentional implantation in hypotympanic cells, which is more likely if the window niches border cochlea are not clearly defined. This can occur even in experienced hands, if there is a fibrous or bony obliteration niche. Thus, it is important not only the phase of the correct execution of the posterior tympanotomy, but also after its implementation are important landmarks in all of the middle ear (position of oval window, processus cochleariformis, pyramidal process).⁶

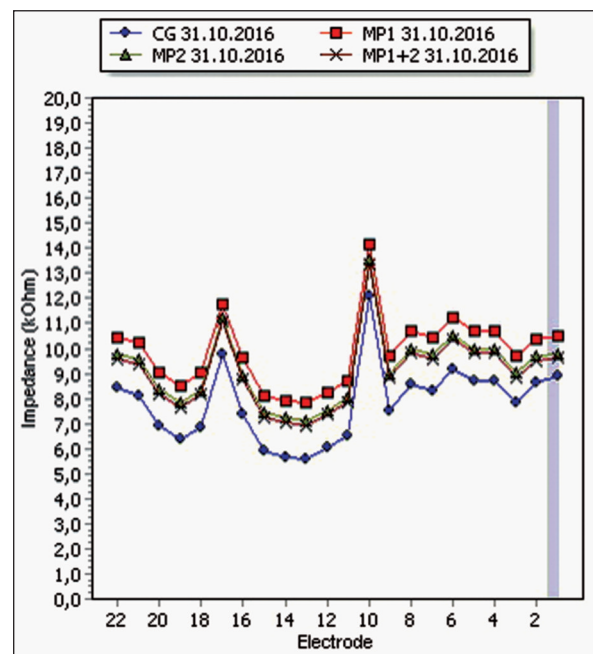


FIGURE 10. Intraoperative impedancometry.

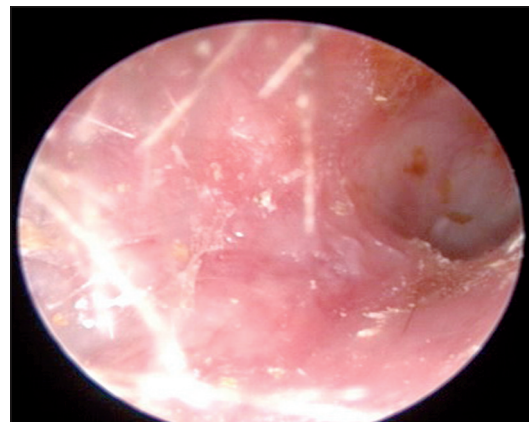
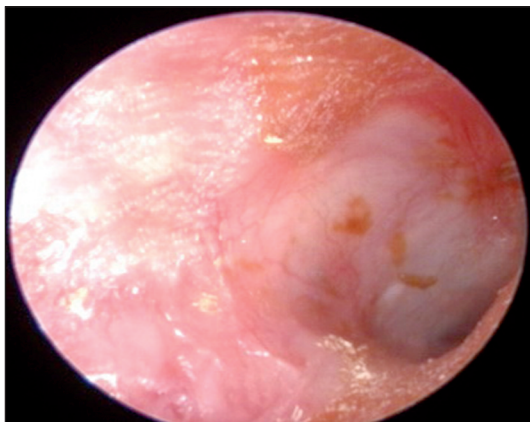


FIGURE 11a, b. Otoendoscopy of the right EAC 45 days after surgery.

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