



## Management of surgical difficulties during cochlear implant with inner ear anomalies



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### ABSTRACT

**Objective:** To review the difficulties that can occur during cochlear implant surgery in patients with inner ear abnormalities and the management thereof.

**Methods:** A retrospective chart review of 316 patients who received cochlear implants was conducted. The data collected included the types of inner ear anomalies, intraoperative findings, and the clinical management strategies. A review of the literature was also performed.

**Results:** A total of 24 patients with inner ear malformations who underwent 28 total cochlear implant procedures were identified. The anomalies included isolated large vestibular aqueducts in 8 (33.3%) patients, isolated semicircular canal dysplasia in 8 (33.3%) patients, classical Mondini malformation in 7 (29.1%) patients, and cochlear hypoplasia in 1 (4.1%) patient. Four (14.2%) patients exhibited intraoperative cerebrospinal fluid (CSF) gushers. One patient experienced delayed facial nerve paralysis, and an electrode was partially inserted into one patient. In 2 (7.14%) cases, the surgeries were aborted because of difficulties.

**Conclusion:** Cochlear implantation for inner ear anomalies can be performed safely. Special attention should be given to preoperative imaging to anticipate the potential intraoperative risks that can occur in inner ear anomaly cases. Every surgery should be planned with a safe approach and specific requirements, e.g., regarding electrode type, and the surgeries must be performed by experienced surgeons who are capable of modifying their technique according to the surgical findings.

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## 1. Introduction

Cochlear implants are the treatment modality of choice for patients with profound cochlear hearing loss, particularly patients who have experienced minimal or no benefit from hearing aids. Cochlear implants were first utilised in the 1980s following the introduction of single-channel devices [1] and the subsequent introduction of multi-channel devices [2]. These devices were implanted to restore the sense of audition and became the standard of care for cochlear hearing loss. Until the last decade, many cochlear implant centres refused to implant devices in children with anomalous inner ears because of concerns related to surgical difficulties and performance expectations [3]. Over time, however,

as the experience of the surgeons who performed these surgeries increased, a greater number of children with inner ear anomalies were considered as candidates for surgery. Operating on a patient with an inner ear anomaly is associated with greater risks of surgical complications, such as facial nerve injury, labyrinthine fistula, and cerebrospinal fluid (CSF) gushers. Moreover, few reports have addressed the surgical risks and complications encountered during cochlear implantation in patients with inner ear anomalies in our region. Therefore, the purpose of this study was to evaluate the surgical aspects of cochlear implantation, including the intraoperative findings, surgical difficulties and post-operative complications, and to review the management of these cases.

## 2. Materials and methods

A retrospective chart review was conducted at the Department of Otolaryngology and Head and Neck Surgery of King Abdul-Aziz University Hospital in Riyadh from January 2009 to January 2013

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after obtaining IRB approval from the ethics committee at King Saud University Medical City. The patients' ages ranged from 12 months to 15 years. A total of 316 patients were included. All of the patients underwent a preoperative evaluation that included high-resolution computed tomography (HRCT) scans of the temporal bone and magnetic resonance imaging (MRI). Patients with identified inner ear anomalies were included in the study. The surgical data were reviewed for the following intraoperative findings: any difficulties encountered during surgery (e.g., perilymph gusher, abnormal facial nerve anatomy and the number of inserted electrodes). Patients with incomplete data were excluded. In total, 24 patients with inner ear malformations who underwent 28 total cochlear implant procedures were included.

### 3. Results

Twenty-four patients with inner ear malformations were identified. Their ages ranged from 12 months to 15 years; the mean age was 4.02 years. The anomalies included semicircular canal (SCC) dysplasia in 8 (33.3%) patients, large vestibular aqueducts (LVAs) in 8 (33.3%) patients, Mondini malformation in 7 (29.1%) patients, and cochlear hypoplasia in 1 (4.1%) patient.

A total of 28 cochlear implantations were performed. Twenty patients underwent unilateral cochlear implants, and 4 patients underwent bilateral cochlear implants (1 of these 4 procedures was performed in a single stage, and 3 were performed sequentially). The standard facial recess approach was used in 20 (71.4%) of the cochlear implantations. Five (17.8%) cochlear implants were performed using transaditus approaches (i.e., the anterior tympanotomy and a transantral approach without an open facial recess). Three (10.7%) of the cochlear implantations were performed with a combined approach (i.e., the anterior tympanotomy and facial recess approach, i.e., the combined technique) because of limited facial recess exposure. One of these patients exhibited dehiscence of the tympanic part of the facial nerve (Fig. 1).

Nineteen (67.8%) of the surgeries were uneventful. Four (14.2%) patients exhibited intraoperative CSF gushers (1 patient had an LVA, and 3 patients had incomplete partition type II (IP-II) Mondini malformations), and the insertion of the electrode was incomplete in one patient (Fig. 2). Three of the procedures were associated with surgical difficulties. In one patient, the cochleostomy to the scala tympani did not allow the insertion of the electrode because of fibrosis; thus, the cochleostomy was widened superiorly to the

scala vestibuli, and the electrode was fully inserted. Two surgeries were aborted because of intraoperative difficulties related to identifying the round window or performing the cochleostomy with distorted anatomy; revisions were performed by the senior otologist and were uneventful. In these cases, the initial difficulty with the procedures could be explained by the previous surgeons' lack of experience with unusual anatomy.

### 4. Discussion

Cochlear implants in patients with inner ear anomalies carry a risk of intraoperative difficulty and possible complications. Such complications can occur because of abnormal landmarks and anatomy. Cochlear implants were previously contraindicated for patients with cochleovestibular anomalies [3], and prior to advancements in radiological imaging technologies, many programmes only identified inner ear anomalies incidentally after the implanted patients experienced acceptable outcomes [4]. Cochlear implantation is a challenging operation, particularly when associated with inner ear anomalies, which increase the risk of potential perioperative complications [5] and surgical difficulty. Therefore, special attention must be paid to unexpected situations, such as the intraoperative identification of abnormalities, and the surgical technique must be altered accordingly.

#### 4.1. Surgical approach

The standard facial recess approach can be used in the majority of cases with inner ear anomalies, and we used this approach in 71% (20 cochlear implants) of our cases. Three (11%) cochlear implant procedures were performed with a combined facial recess and anterior tympanotomy approach because of the presence of narrow facial recesses and increased cochleostomy difficulty caused by limited exposure. Five (18%) surgeries utilised a combined approach that involved the transaditus approach (as opposed to the facial recess approach). This approach was used in one case because the patient had a high jugular bulb above the round window; in the other 4 cases, this approach was the surgeon's preference. According to the literature, the facial recess approach is the primary approach used for cochlear implantations. However, a variety of approaches can be used when facing difficulties. These other approaches began to be reported in the early 2000s with the introduction of several modifications, such as the total transcanal

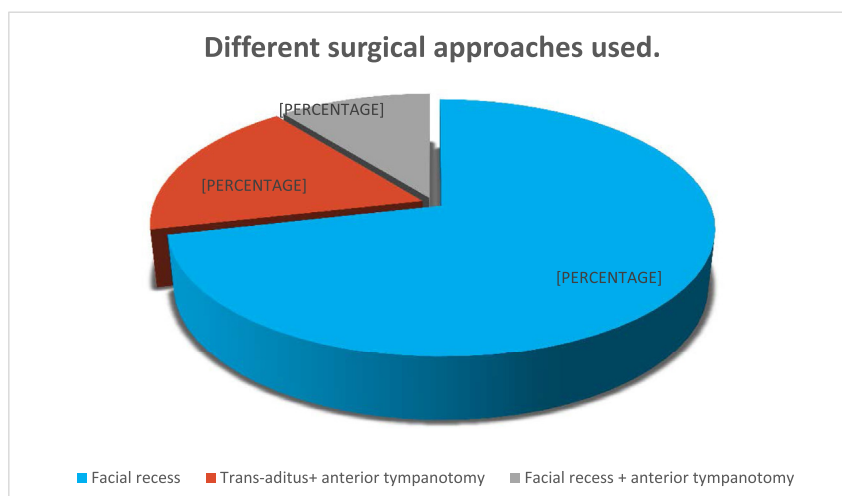


Fig. 1. The different surgical approaches used.

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