Original article

Cochlear implant complications in 403 patients: Comparative study of adults and children and review of the literature

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A R T I C L E   I N F O

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Cochlear implant
Postoperative complications
Children
Adults
Device failures

A B S T R A C T

Objectives: The purpose of this study was to assess the postoperative complications related to cochlear implants and to discuss the differences observed between adult and paediatric populations. Cochlear implant complications were defined as any pathological events observed during the postoperative period, whether or not they were directly related to the surgical technique. We therefore recorded all complications, in the broad sense of the term, ranging from acute otitis media to cochlear explantation.

Study design: Retrospective analysis of cochlear implant patients.

Material and methods: All surgical procedures (unilateral or bilateral cochlear implantation, revision surgery) performed in our institution between March 1993 and January 2013 were reviewed. This population comprised 168 adults (median age at the time of implantation: 51.9 years) and 235 children (median age at the time of implantation: 4.5 years). All postoperative complications were classified as either major (requiring surgical revision or hospital management) or minor (requiring conservative management).

Results: The global complication rate was 19.9% (80/403 cases), comprising 5% of major complications (20 cases) and 14.9% of minor complications (60 cases). This complication rate was significantly higher in the adult population (P = 0.004).

Conclusion: Cochlear implantation is a safe hearing rehabilitation surgical technique associated with a low complication rate. However, surgeons must be familiar with these complications in order to ensure optimal prevention. Minor complications were mainly infectious in children (acute otitis media) and cochleovestibular in adults (tinnitus and vertigo). Major complications were mostly reimplantation following revision surgery or device failure. Only the minor complication rate was significantly higher in the adult population.

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1. Introduction

Unilateral or bilateral cochlear implantation is a well-defined and safe surgical procedure allowing hearing rehabilitation of patients with severe to profound sensorineural hearing loss. Since the introduction of this technique, many publications have reported complications occurring after cochlear implantation and various classifications have been proposed.

These complications are associated with either the surgical technique or implantation of a foreign body, or device failure. The majority of publications on this subject classify complications as minor complications (requiring conservative management or minimal surgery such as placement of transtympanic ventilation tubes) and major complications (requiring surgical revision or hospitalisation for medical treatment). Since the European Consensus Statement on Cochlear Implant Failures and Explantations in 2005, more recent publications have distinguished between minor complications, major complications and complications requiring cochlear reimplantation [1,2].

Since the article published by Cohen in 1991 (one of the first large series evaluating the complications after cochlear implantation), the global complication rate after cochlear implantation has regularly decreased as a result of improvement of surgical techniques with smaller incisions and the use of increasingly miniaturized and biocompatible implants [3]. The global complication rate, which was initially about 39%, is now only 9% [1–4].

Few studies have analysed age-related complications based on differences between adult and paediatric populations. The most
recent publication on large patient cohorts was published in 2010 [5].

The objective of this study was to analyse a series of 403 adult and paediatric patients implanted between 1993 and 2013 in a single centre by two operators according to the same surgical technique. The primary objective was to analyse complications after cochlear implantation and the secondary objective was to compare the complications observed in these two populations.

2. Material and methods

Quantitative variables are expressed as the mean or median (minimum–maximum), while ordinal variables are expressed as sample size (%). Children and adults were compared using Mann-Whitney test for quantitative variables and Chi-square test for ordinal variables. A $P$ value less than 0.05 was considered statistically significant. All statistical tests were bilateral and were performed by means of SPSS 17.0 software (SPSS Inc., Chicago, IL, USA).

Between March 1993 and January 2013, 403 patients (168 adults and 235 children) with sensorineural hearing loss were managed by cochlear implantation in our institution. Clinical and demographic characteristics are presented in Table 1.

The adult population comprised 80 men (47.6%) and 88 women (52.4%) with a median age of 51.9 years (range: 19.4 to 89 years) at the time of implantation. The paediatric population comprised 116 boys (49.4%) and 119 girls (50.6%) with a mean age of 4.5 years (range: 6 months to 17.6 years) at the time of implantation. No significant difference in terms of the sex distribution was observed between the two populations ($P=0.404$).

The mean duration of profound hearing loss before cochlear implantation was 8.1 years (range: 0.3–53 years) in adults and 3.2 years (range: 0.1–17 years) in children ($P=0.000$).

Adults presented postlingual hearing loss in 83.3% of cases, while children presented prelingual hearing loss in 94.9% of cases. The types and aetiologies of hearing loss of the implanted population are presented in Table 2. A similar distribution of genetic, acquired and unknown causes was observed in the two populations ($P=0.330$).

This series comprised 331 unilateral cochlear implants (134 [79.8%] in adults and 197 [83.8%] in children; $P=0.179$), and 72 bilateral cochlear implants (34 [20.2%] in adults and 38 [16.2%] in children), including eight cases of simultaneous implantation due to bacterial meningitis. The implant brands most commonly used were Nucleus® (62.5%), Med-EL® (19.6%) and Neurelec® (15.5%) in adults and Nucleus® (82.6%) and Med-EL® (15.7%) in children.

Cochlear implantation was performed after a standardized multidisciplinary assessment. The surgical procedure was performed under general anaesthesia by two experienced operators. The technique has been modified over the years with the use of an increasingly limited incision without preoperative shaving of the surgical site, and via a skin incision in the retroauricular sulcus since 2000. Implanted patients were reviewed every 6 months for the first year (apart from adjustment sessions) and then at the patient’s or implant fitter’s request if necessary. The median postoperative follow-up was 7.5 years between the first implantation and data collection (8 years for adults, and 7.1 years for children). Sixteen adults died from causes unrelated to cochlear implantation.

The complications observed in this series were classified as either major or minor. Minor complications were complications requiring outpatient medical treatment (e.g., transient facial nerve palsy, tinnitus, vertigo), prolongation of the hospital stay, or minor surgical revision (repeated wound dressing because of skin infection). Major complications were complications resulting in a serious medical condition (e.g. meningitis), or requiring major surgical revision (e.g., for cholesteatoma, retraction pocket, perforated eardrum, or reimplantation), or causing permanent disability (e.g., device failure with permanent implant dysfunction) [5].

3. Results

A total of 80 postoperative complications were reported in this series of 403 implants. The global complication rate was 19.9%, with 14.9% of minor complications (60 cases) and 5% of major complications (20 cases) (Table 3).
Table 2
Aetiology of hearing loss in cochlear implant patients (n = 403).

<table>
<thead>
<tr>
<th>Variables</th>
<th>Adults n = 168</th>
<th></th>
<th>Children n = 235</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>%</td>
<td>Number</td>
<td>%</td>
<td></td>
</tr>
<tr>
<td>Type of hearing loss</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Prelingual</td>
<td>25</td>
<td>14.9</td>
<td>223</td>
<td>94.8</td>
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<tr>
<td>Perilingual</td>
<td>3</td>
<td>1.8</td>
<td>6</td>
<td>2.6</td>
<td></td>
</tr>
<tr>
<td>Postlingual</td>
<td>140</td>
<td>83.3</td>
<td>6</td>
<td>2.6</td>
<td>0.000</td>
</tr>
<tr>
<td>Aetiology of hearing loss</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Genetic</td>
<td>64</td>
<td>38.1</td>
<td>70</td>
<td>29.8</td>
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<tr>
<td>Acquired</td>
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<td>29.2</td>
<td>98</td>
<td>41.7</td>
<td></td>
</tr>
<tr>
<td>Unknown</td>
<td>55</td>
<td>32.7</td>
<td>67</td>
<td>28.5</td>
<td>0.330</td>
</tr>
</tbody>
</table>

* P value, Chi-square test, < 0.05.

The median time to onset of complications was 17.9 months in the adult population (range: 0 to 10.1 years), and 16.9 months in the paediatric population (range: 0 to 16.3 years; P = 0.476).

3.1. Minor complications

Sixty minor complications were observed in 36 adults (21.4%) and 24 children (10.2%) (P = 0.002) and required outpatient medical treatment or prolongation of the hospital stay (Table 3).

Infectious complications were mainly observed in the paediatric population, with 14 cases of acute otitis media (AOM), two of which occurred during the first 2 months after implantation. All cases of AOM were treated by empirical oral antibiotic therapy (targeting *Pneumococcus* and *Haemophilus influenzae*) (amoxicillin-clavulanic acid 80 mg/kg/day or amoxicillin 70 to 100 mg/kg/day).

Myringotomy was performed for bacteriological reasons in four cases, demonstrating *Pseudomonas aeruginosa* in one case, *Haemophilus influenzae* in one case, and sterile culture in the other two cases. None of these cases of AOM in children were complicated by meningitis.

Complications related to the skin flap were mainly local super-infections of the wound caused by *Staphylococcus aureus* or *Pseudomonas aeruginosa* (five cases, including three adults). All cases of wound infection involved minimal retroauricular incisions and all resolved in response to systemic antibiotic therapy and repeated outpatient wound dressings.

Cochleovestibular complications included tinnitus in the implanted ear, reported by 7 adults, and corresponded to deterioration of tinnitus present prior to cochlear implantation (n = 5) or immediate postoperative (during the first 6 months) de novo

Table 3
Minor and major postoperative complications in cochlear implant patients (n = 403).

<table>
<thead>
<tr>
<th>Complications</th>
<th>Adults</th>
<th></th>
<th>Children</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>%</td>
<td>Number</td>
<td>%</td>
<td></td>
</tr>
<tr>
<td>Minor complications</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Related to skin flap</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ulcers</td>
<td>3</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Superinfections</td>
<td>3</td>
<td></td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infectious complications</td>
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<tr>
<td>AOM</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Labyrinthitis</td>
<td>0</td>
<td></td>
<td>2</td>
<td></td>
<td></td>
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<tr>
<td>Vestibular</td>
<td>13</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tinnitus</td>
<td>7</td>
<td></td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Device failure</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acquired</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spontaneous</td>
<td>3</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>CSF leaks</td>
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<td></td>
</tr>
<tr>
<td>Neurological complications</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Facial palsy</td>
<td>1</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Dysgeusia</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subtotal</td>
<td>36</td>
<td>21.4</td>
<td>24</td>
<td>10.2</td>
<td>0.002</td>
</tr>
<tr>
<td>Major complications</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Related to skin flap</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Superinfections</td>
<td>1&quot;</td>
<td></td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infectious complications</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Meningitis</td>
<td>1</td>
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<td></td>
</tr>
<tr>
<td>Mastoiditis</td>
<td>0</td>
<td></td>
<td>4</td>
<td></td>
<td></td>
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<tr>
<td>Tinnitus</td>
<td>1&quot;</td>
<td></td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Device failure</td>
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<td></td>
</tr>
<tr>
<td>Acquired</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spontaneous</td>
<td>5&quot;</td>
<td></td>
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<tr>
<td>Tympnic retraction pockets</td>
<td>0</td>
<td></td>
<td>1&quot;</td>
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</tr>
<tr>
<td>Cholesteatoma</td>
<td>1</td>
<td></td>
<td>1&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post-AOM perforated eardrum</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Explantation for another cause</td>
<td>1&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subtotal</td>
<td>10</td>
<td>6.0</td>
<td>11</td>
<td>4.7</td>
<td>0.364</td>
</tr>
<tr>
<td>Total</td>
<td>46</td>
<td>27.4</td>
<td>35</td>
<td>14.9</td>
<td>0.002</td>
</tr>
</tbody>
</table>

* P value, Mann-Whitney test, < 0.05.

" Major complications requiring explantation (n = 14).
tinnitus \((n = 3)\). No causal mechanism was identified. Vestibular complications were reported in 15 patients \((13\) adults and two children\), essentially loss of balance or non-positional vertigo, occurring immediately postoperatively and rapidly resolving in response to medical treatment \((\text{acytceleucine and corticosteroids})\). No specific cause \((\text{Ménière's disease, benign paroxysmal vertigo, or pneumolabyrinth})\) was identified.

Neurological complications such as transient facial nerve palsy were observed during the immediate postoperative period in two patients \((\text{one adult and one child})\) related to damage caused by drilling during posterior tympanotomy. Both cases resolved spontaneously. Neither of these patients presented an anomalous course of the facial nerve. Disorders of taste were reported during the immediate postoperative period by five adults and resolved spontaneously without medical treatment, and without the need to deactivate one or more electrodes. These cases of dysgeusia, like the cases of facial nerve palsy, could be due to intraoperative heating of the chorda tympani during posterior tympanotomy.

### 3.2. Major complications

The 20 \((5\%)\) major complications were observed in nine adults \((5.4\%) \text{ and } 11\) children \((4.7\%) \text{ \(P = 0.465\)}\). These major complications essentially consisted of infectious complications \((\text{five cases})\) and surgical revisions \((\text{15 cases})\) \(\text{Table 3}\).

Infectious complications related to meningitis were observed in a 47-year-old man: streptococcal meningitis complicating AOM ipsilateral to the implant, 3 months after implantation. The preoperative imaging assessment did not reveal any malformation of the inner ear. A Nucleus® cochlear implant was implanted with no intraoperative difficulties. A penicillin-susceptible strain of *Streptococcus pneumoniae* was isolated, allowing antibiotic therapy with cefotaxime 100 mg/kg/day and insertion of a transtympanic ventilation tube on the side of the otitis media. Antibiotic therapy \((\text{amoxicillin and rifampin})\) was continued for several weeks on an outpatient basis without explantation. No risk factor for severe pneumococcal infection was demonstrated.

Infectious complications related to mastoiditis, ipsilateral to the implant, were observed in four children. All cases were treated by myringotomy and intravenous antibiotic therapy in hospital without explantation. Bacteriological examination demonstrated methicillin-susceptible *S. aureus* in one case and no microorganisms were isolated in the other three cases.

Surgical revisions of the implantation site were required in 15 patients: two patients required surgical revision without explantation, two patients required explantation only, and 11 patients required explantation followed by ipsilateral \((n = 6)\) or contralateral \((n = 5)\) reimplantation \(\text{Table 3}\). The explantation rate was 3.2% \((13 \text{ out of } 403\) cases\) with 2.7% of reimplantations \((11 \text{ out of } 403\) cases\).

Two children required simple surgical revision: the first for myringoplasty to treat residual post-otitis perforated eardrum and the second for surgical management of iatrogenic cholesteatoma of the middle ear performed 3.5 years after the first implantation.

Two adults required explantation without reimplantation: the first for iatrogenic cholesteatoma surgery \((8\) years after the first cochlear implantation\) and the second for immediate postoperative onset of disabling tinnitus responsible for intolerable hemicranial pain.

Explantation with reimplantation was performed because of cochlear implant dysfunction \((9\) cases) or tympanic reinforcement surgery for retraction pocket in a context of deterioration of simple chronic otitis media 3 years after implantation \((\text{one child})\) or for repeated infections of the local skin flap responsible for wound dehiscence \((\text{local pedicled temporal muscle reconstruction in an adult patient who did not present any comorbidities or chronic skin disease})\).

Device failures were reported as major complications \((\text{failures inducing permanent implant dysfunction})\) and corresponded to two cases of failure induced by trauma \((\text{two children aged 3 and 4.6 years})\), and seven spontaneous failures confirmed by dysfunction on the implant integrity test \((\text{electronic problems, leaks, electrode problems, or other problems})\). In patients with permanent device failure, explantation was performed followed by reimplantation during the same operation with a mean interval after the initial implantation of 25.4 months in adults and 4 months in children with similar or better hearing results.

### 3.3. Comparison of complications as a function of age

A significant difference in global complication rate was observed between the adult \((45\) cases, 26.8\%) and paediatric populations \((35\) cases, 14.9\%) \(P = 0.002\). Analysis of minor complications, observed in 36 adult cases \((21.4\%) \text{ and } 24\) paediatric cases \((10.2\%)\), revealed a significant difference between the two populations \(P = 0.002\) in terms of infectious complications in children \((14\) cases of acute otitis media\), and cochleovestibular complications in adults \((20\) cases\).

No significant difference \(P = 0.465\) was observed for major complications requiring surgical revision \((8\) adult cases, i.e. 2\%; and 7 paediatric cases, i.e. 1.7\%\), whether or not they were accompanied by explantation with or without reimplantation.

Cases of acquired device failure were exclusively observed in children following trauma to the implant site \((\text{two cases})\), while spontaneous device failures were more frequently observed in adults \((\text{five cases})\) than in children \((\text{two cases})\), with a mean time to onset of 53.1 months \((2 \text{ to } 121\) months\) for adults versus 39.5 months \((7 \text{ to } 72\) months\) for children.

### 4. Discussion

Extension of the indications for cochlear implantation and the efficacy of this modality of hearing rehabilitation have contributed to a significant increase in the number of implanted patients all over the world. However, as this technology is indicated in increasingly young patients, the problem of complications has been the subject of particular interest.

Over the last 20 years, many publications have studied the complications occurring after cochlear implantation. One of the first articles describing surgical complications related to cochlear implantation was that published by Cohen in 1991 [6]. Fifty-five complications were described in a series of 459 Nucleus® implants, corresponding to a complication rate of 11.8%. The complications most commonly reported were skin flap necrosis, wound infections, incorrect electrode placement responsible for aberrant nerve stimulations and transient facial nerve palsy. In 1993, Hoffman reported a similar global complication rate of 12.2% with 7.4% of major complications in a series of 4969 implants [7]. The development of new implant technologies and progress in surgical techniques have led to progressive reduction of these complication rates.

The primary objective of this study was to analyse the minor and major complications observed after cochlear implantation between 1993 and 2013 in a large population of adults and children and to compare these results with data published in the literature. Complications were defined as the development of any pathological events during the postoperative period with no time limit, whether or not they were directly related to the surgical technique or to the cochlear implant itself. In this study, we decided to report all complications, in the broad sense of the term, ranging from acute otitis media to cochlear explantation.
Complication rates currently reported in the literature are 11.8% of minor complications, and 3.2% of major complications [1–4]. Similar results were observed in our series, with 14.9% of minor complications and 5% of major complications. Infection was the most common cause of postoperative complications, and was associated with a risk of explantation. Infection rates in the literature range from 1.7% to 12%, depending on the type of infections included [8,9]. The infection rate in our series was 7.2% (skin infections, meningitis, labyrinthitis, acute otitis media, or mastoiditis). Implanted children may develop acute otitis media, an acute episode of serous otitis media, or mastoiditis, responsible for extrusion, implant failure or meningitis. The risk of infection is higher than in children with normal hearing, as the inner ear may be contaminated by cochleostomy, especially during the first months after cochlear implantation. Leake demonstrated, in animal models, that acute otitis media occurring during the first 2 weeks after implantation induced serious cochlear lesions, responsible for deterioration of residual hearing, vestibular disorders, and cochlear ossification [10]. Otitis media ipsilateral to the implant was demonstrated in 50% of cases of post-implant meningitis [11,12]. This risk has therefore encouraged some teams to systematically perform insertion of transtympanic ventilation tubes (TVT) or adenoidecotomy before or during cochlear implantation in children with a history of acute otitis media or serous otitis media (SOM) [11–15]. In the present series, children with AOM and/or SOM were treated preoperatively by antibiotics, followed, in the event of failure, by adenoidecotomy and bilateral myringotomy with concomitant insertion of thiopeptiocal. No implants were inserted in the presence of TVTs.

Several risk factors for infection have been identified: age at implantation less than 2 years and more than 65 years, immunosuppression, otorrhoea or spontaneous or traumatic cerebrospinal rhinorrhoea, presence of neurosurgical prostheses, and history of meningitis [16]. Other risk factors are more directly related to the ear: inner ear malformations, history of otological surgery (stapedectomy), use of an electrode positioner [17].

However, we have observed one case of meningitis in an implanted adult with no underlying comorbidities and no inner ear malformation on preoperative computed tomography [18]. Post-implantation bacterial meningitis could potentially induce cochlear ossification, facial nerve stimulation and deterioration of the hearing results [19], but these complications were not observed in our case.

Since 2002, following a recrudescence of the post-cochlear implant meningitis rate attributed to the use of electrode positioners, the Food and Drug Administration in the USA has issued several recommendations: (1) imaging of petrous temporal bones must be performed systematically before cochlear implantation in children with congenital hearing loss and in all patients with profound hearing loss and a history of bacterial meningitis in order to identify inner ear malformations, cerebrospinal fluid (CSF) leak, or cochlear ossification. When a malformation associated with a high risk of “gusher” ear is identified, the cochleostomy must be closed meticulously, (2) ventilation tubes must be systematically inserted before cochlear implantation in patients with a history of AOM or persistent SOM, (3) systematic pneumococcal (PCV7 or PCV13) and type B Haemophilus vaccination, (4) annual influenza vaccination of implanted patients and their families, (5) systematic meningococcal vaccination [20,21].

Local skin complications (ulcer, infection, or wound dehiscence) were observed in 10 patients (2.5%), requiring medical care (9/10 cases) or surgical revision (one case required explantation followed by reimplantation). During the first 7 years of this experience (1993 to 2000), a large supra- and retroauricular skin incision was performed with creation of a large muscle flap. No local skin complications were observed in these patients. Since 2000, a smaller retroauricular incision in the sulcus has been used with a smaller musculoperiosteal flap, similar to that used in conventional tympanoplasty. The magnet was positioned underneath the peristosteum to limit the risk of subsequent mobilization and no postoperative drainage was used. Skin complications related to use of the implant (skin necrosis, ulcer) can be avoided by rigorous adjustment of the strength of the magnet and by performing an incision at a sufficient distance from the planned recipient site.

Gusher CSF leaks during cochleostomy were observed in two children with Mondini dysplasia, both who required external lumbar CSF drainage, one during the operation and the other 48 hours after the operation. All patients with Mondini dysplasia in our cochlear implantation centre systematically receive a medical protocol comprising intraoperative intravenous mannitol infusion designed to prevent severe CSF leak [22].

The incidence of transient facial nerve palsy was low (0.49%), comparable to the rates reported by Mosnier et al. (0.7%) or by the Cochlear company (0.4%) based on a larger series [23,24]. Cases of transient facial nerve palsy completely recovered after several months and were caused by various mechanisms (intraoperative heating of the facial nerve during cochleostomy or posterior tympanotomy, reactivation of viruses such as herpes simplex virus) [24]. This complication can be further limited by facial nerve neuromonitoring and precise preoperative assessment of the course of the facial nerve by CT scan of the petrous temporal bones.

Device failure related to cochlear implant dysfunction was the commonest cause for reimplantation. Ten of the 21 major complications (5.2%) observed in this series were related to device failure in 8 cases of spontaneous failure (1.98%). Analysis of post-implantation complications must therefore include those complications due to a technological problem affecting the implant itself. The classification used by Venail in 2008 evaluated the device failure rate to be 7.2% in 500 adult and paediatric patients [1]. The failure rate in our study was 2.48%. The hearing gain after reimplantation remained unchanged compared to the first implantation according to Migirov [13]. Implant dysfunction can be prevented by careful surveillance of implanted patients and detailed information of the parents of implanted children. A low rate of acquired device failure due to trauma in implanted children was observed in this study, as only two cases were observed in this cohort of 206 children.

The secondary objective of this study was to perform comparative analysis of the complications observed as a function of age. The global complication rate in the adult population was significantly higher than that observed in the paediatric population (26.8% versus 14.9%; \( P = 0.002 \)). This difference only concerned minor complications: 21.4% in adults versus 10.2% in children (\( P = 0.002 \)). Children mainly developed infectious complications (essentially AOM), while most of the cochlear vestibular complications (tinnitus and vertigo) were observed in adults. In contrast, no significant difference in terms of the major complication rate was observed between adults (5.4%) and children (4.7%; \( P = 0.465 \)).

Published studies comparing the complications observed in populations of implanted adults and children have reported variable results. Three retrospective studies reported similar complication rates, ranging from 13 to 29%, with a major complication rate ranging from 1.8 to 5.2%, with no significant difference between the two populations [2,5,25]. Our results for minor and major complication rates were similar to those reported in the literature.

In a French national multicentre study (PHRC), the incidence of disorders of balance, evaluated for 469 adults and children, was higher in adults (16%) than in children (3%). Vestibular complications, disorders of taste and tinnitus were predominantly reported in the adult population in our study [26]. However, these results must be interpreted cautiously as these rates are probably underestimated in the paediatric population, as children are more difficult to interview (difficulties expressing their symptoms) and examine.
Systematic analysis of vestibular function before and after cochlear implantation would allow more precise definition of the real incidence of these complications in the two populations, especially in patients undergoing bilateral implantation.

5. Conclusion

Cochlear implantation is a safe surgical technique for rehabilitation of severe to profound sensorineural hearing loss. The global complication rate comprised 14.9% of minor complications and 5% of major complications, 42.8% of which were due to implant dysfunction. The minor complication rate was significantly higher in the adult population, while a similar major complication rate was observed in the two populations, highlighting the fact that, with rigorous prevention of risk factors for complications, young children and elderly patients do not constitute contraindications to cochlear implantation.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

References