The Selective Therapeutic Strategy for Perilymphatic Fistula

Ken Hayashi and Atsushi Shinkawa
Department of Otolaryngology, Shinkawa Clinic

Abstract
A perilymphatic fistula (PLF) is a defect in the oval window (OW) or round window (RW). PLFs may also permit leakage of perilymphatic fluid from the labyrinthine compartment, and may result in permanent endorgan damage including hearing loss. The potential causes of this hearing loss associated with PLF have been postulated to include: Simms’ double-membrane break theory, perilymphatic hemorrhage, decrease in perilymphatic pressure, pneumolabyrinth by air bubbles and others. However, it is difficult to determine the diagnosis and operative adaptation of PLF in fact. Therefore, we had to identify the leakage of lymph fluid by experimental tympanic cavity open technique for confirmed diagnosis. In addition, the only treatment for PLF is to repair fistula sites surgically. Recently, it became possible to make a three-dimensional slice angle freely because of the development of the limited Cone-Beam X-ray CT (Accu-i-tomo). We confirmed air bubbles in cochlear of some of patients with PLF by Accu-i-tomo. In this study, we selectively apply the new surgical procedure to clear air bubbles from cochlea and the usual surgical procedure to close the labyrinthine fistula. The aims of this study were to confirm the efficacy of the selective therapy for PLF classified by the presence or absence of air bubble in cochlea.

Methods and Materials
A nonrandomized prospective clinical trial was performed for 18 patients with PLFs. The average age of the patients was 46.7 years (27-65). The male to female ratio was 1:1.7. The inner ear structures of 18 patients suspected of PLFs were observed by Cone-Beam CT (Accu-i-tomo), and evaluated by i-Views and i-Dixel-3DX. The perilymphatic reflux surgery was performed for 11 patients with air bubbles in their labyrinth, on the other hand, perilymphatic fistula repair was done for 7 patients without air bubble. Each patients were assessed for comparison of their pre- and post-operative hearing levels and fistula sign.

1. An incision is made with a lancet at 12 and 7 o’clock.
2. The meatal skin is elevated to the level of the fibrous annulus.
3. The bone edge of the posterior canal wall is removed little by little with chisel until oval window and round window are clearly visible. The middle ear is entered, and then the leakage of lymph fluid is confirmed.
4. The footplate perforator are slowly rotated to enlarge the control hole to the appropriate diameter.

5. A control hole was created in the central portion of the footplate.
6. Physiological saline was circulated inside the cochlea until air bubbles are removed.
7. The oval window or the round window was closed with Gelform®.
8. The skin flap was sealed with Fiblin sealant (Beriplast® P).

Table 1. The cause of perilymphatic fistula

<table>
<thead>
<tr>
<th>Cause</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>disc</td>
<td>5</td>
</tr>
<tr>
<td>air plate</td>
<td>3</td>
</tr>
<tr>
<td>acoustic trauma</td>
<td>1</td>
</tr>
<tr>
<td>unknown</td>
<td>2</td>
</tr>
<tr>
<td>total</td>
<td>11</td>
</tr>
</tbody>
</table>

Table 2. The efficacy of vertigo and fistula sign in the selective therapy

Evaluation of vertigo and fistula sign:
- Vertigo: P<0.01
- Fistula sign: P<0.01

Table 3. The efficacy of vertigo and fistula sign in the selective therapy

Evaluation of vertigo and fistula sign:
- Vertigo: P<0.01
- Fistula sign: P<0.01

Summary
We designed the therapy that the perilymphatic reflux surgery and the repair of perilymphatic fistula was performed selectively by the presence or absence of air bubble in cochlea.

- Air bubbles were noted in cochlea of 61.1% (11/18) of patients with perilymphatic fistulas.
- The total mean values of PTA before and after the selective therapy were 51.4 dB (26.8-85.6) and 27.4 dB (15.4-89.0).
- The total percentage with the successful selective therapy was 97.3%.
- The improvement including fistula sign was noted in 22 cases.
- The hearing pattern (57.1%) were noted in air bubble positive cases, while flat pattern (30.4%) were noted in air bubble negative cases.
- The delay to start the selective therapy for the patients with PLFs were not related to the hearing improvement.
- The postoperative complications were not confirmed.

Conclusion
- We confirmed Cone-Beam CT (Accu-i-tomo) was effective for the definite diagnosis of PLFs.
- We considered that the selective therapy by the presence or absence of air bubbles was a pivotal treatment for PLFs.

Selective Therapeutic Strategy for Perilymphatic Fistula

- The confirmation of air bubble in cochlea by Cone Beam CT
  - Air bubble (-) Air bubble (+)
    - Exploration
    - Perilymphatic fistula repair
    - Perilymphatic fistula repair

Image 1: Leakage of lymph fluid
Image 2: Confirmation of air bubble in cochlea
Image 3: Comparison between pre and post operative labyrinth by Cone-Beam CT
Image 4: Comparison between the presence or absence of air bubble and the fistula site
Image 5: Hearing improvement in the selective therapy
Image 6: Hearing results by the selective therapy
Image 7: Comparison of pure audiogram pattern by the presence or absence of air bubble in cochlea
Image 8: OPERATIVE PROCEDURE

Figure 1. The confirmation of air bubble in cochlea and density measurement by Cone-Beam CT

Figure 2. Comparison of cochlea structure between Cone-Beam CT and Helical CT

Figure 3. The comparison between pre and post operative labyrinth by Cone-Beam CT

Figure 4. The comparison between the presence or absence of air bubble and the fistula site

Figure 5. Hearing improvement in the selective therapy

Figure 6. The comparison of pure audiogram pattern by the presence or absence of air bubble in cochlea

Figure 7. Pre- and Postoperative air conduction improvement in air bubble negative and positive cases

Figure 8. Hearing results by the selective therapy

Figure 9. The confirmation of air bubble in cochlea and density measurement by Cone-Beam CT

Figure 10. The comparison between the number of successful cases to the hearing gain and operating time