OTOSCLEROSIS: HEARING AND/OR SURGERY?

B. FRAYSSE
GOAL OF THE PRESENTATION

To discuss the various factors which may influence the decision in counselling patient between:

- Hearing aid
- Stapes surgery
- Auditory implant
CONDUCTIVE HEARING LOSS
DEGREE OF STAPES FIXATION
SENSORINEURAL HEARING LOSS
DEGREE OF HYALINIZATION
Pure cochlear otosclerosis

No stapes fixation, pure cochlear otosclerosis
DIAGNOSIS

- Progressive hearing loss
- Family history of otosclerosis
- Good understanding in noise
- Speaks softly
- Normal otoscopy

*Signe de Schwartz*
TUNING FORK TEST

- Weber: 256, 512, 1024, 2048 Hz
  compare the findings of the tuning fork with those found on pure tone

- Rinne Test negative indicates an air bone gap of at least 30 to 45 dB
The clinical application of bone conduction audiometry

Raymond CARHART, Ph. D.
SPEECH DISCRIMINATION

- Speech discrimination in quiet and in noise
- Normal tympanometry
- Stapedial reflex absent or ON/OFF
DO WE NEED A CT-SCAN IN THE DIAGNOSIS OF OTOSCLEROSIS?

The Role of Imaging in the Diagnosis and Management of Otosclerosis

*Jagdeep Singh Virk, *Arvind Singh, and †Ravi Kumar Lingam

*ENT Department, and †Radiology Department, Northwick Park Hospital, North West London NHS Trust, Harrow, U.K.

A Systematic Review of the Diagnostic Value of CT Imaging in Diagnosing Otosclerosis


*Department of Otorhinolaryngology – Head and Neck Surgery, and †Brain Center Rudolf Magnus, University Medical Center Utrecht, Utrecht, The Netherlands
These guidelines relate

- The technique of acquisition
- The normal anatomy
- The morphological modification
- The classification of lesions
TECHNIQUE OF ACQUISITION

- Slice thickness 0.3/0.6 mm
- Parallel to the lateral canal
- Axial and coronal reconstruction
- With magnification
CLASSIFICATION
INTEREST OF IMAGING IN THE EVALUATION OF OTOSCLEROSIS

1. To define a surgical strategy in case of
   - Anatomical difficulties
   - Negative CT-Scan

2. To anticipate the evolution of post operative bone conduction according to the extension and location of lesions

3. To analyse the cause of failure
ANATOMICAL DIFFICULTIES

- Small fenestra
- Obliteration footplate
- Facial déhiscence
FACIAL NERVE / OVAL WINDOW

- Partial obliteration
- Total obliteration
FACIAL NERVE
ANATOMICAL DIFFICULTIES

- Malleus fixation
- Incus fixation
- Stapedial artery
COUNSELING PATIENTS IN CASE OF NEGATIVE CT-SCAN

- Middle ear exploration **BUT**

- **Risk of mobile footplate x 5**
  - Early form with an incomplete fixation of the stapes

- **Possible inner ear conductive hearing loss due to:**
  - An enlarged vestibular aqueduct
  - Minor inner ear malformation
  - Superior semicircular canal dehiscence
  - Modiolus anomalies
POSSIBLE INNER EAR CONDUCTIVE HEARING LOSS

▲ Superior semicircular canal dehiscence
▲ Enlarged vestibular aqueduct
▲ Abnormal modiolus
MODIOLUS MALFORMATION

-3mm
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EXTENSION AND LOCATION OF LESIONS

Marx M., Lagleyre S., Escudé B., Demeslay J., Elhadi T., Deguine O., Fraysse B.
Correlations between CT-Scan findings thresholds in otosclerosis
Acta Otolaryngol 2011;131:351-57

Group 1

- Isolated fenestral otosclerosis
  foci restricted to the oval window

Group 2

- Extensive otosclerosis
  - Endosteal extension
  - Round window obliteration
  - IAC involvement
ENDOSTEAL EXTENSION AND POSTOPERATIVE BONE CONDUCTION

- Improvement > 10 dB of BC was considered significant

<table>
<thead>
<tr>
<th></th>
<th>Group 1</th>
<th>Group 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Without Endosteal n 150</td>
<td>With Endosteal n 33</td>
</tr>
<tr>
<td>% of ears with more than 10 dB improvement</td>
<td>30/150 (20%)</td>
<td>1/35 (3%)</td>
</tr>
</tbody>
</table>

\[ p < 0.05 \]

- The chance of improvement was lower in extensive foci than in isolated otosclerosis
INTEREST OF IMAGING IN THE EVALUATION OF OTOSCLEROSIS

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CAUSE OF FAILURE

- Persistence of conductive hearing loss
- Secondary conductive hearing loss
- Sensorineural complications
PERSISTENCE OF A CONDUCTIVE HEARING LOSS

- Prosthesis in place, no focus
- Dysjonction
- Malleus fixation
SECONDARY CONDUCTIVE HEARING LOSS

- Prosthesis displacement
- Lateralization syndrome
- Reossification
LATERALIZATION SYNDROME

Revision stapes surgery : the "lateralized piston syndrome"
LAGLEYRE S, CALMELS MN, ESCUDE B, DEGUINE O, FRAYSSE B.
SENSORINEURAL COMPLICATIONS

- Intravestibular prosthesis
- Fistula with air
- Labyrinthitis
FLOATING STAPES
CONE BEAM COMPUTED TOMOGRAPHY APPLICATIONS IN OTOSCLEROSIS

Cone Beam computed tomography is an X-Ray based volume acquisition method providing 3D images of the head. The spatial and density resolution appears to be equivalent or better than a CT high resolution, with:

- Lower radiation
- Lower cost
# Footplate and Stapes

- **CT-SCAN**

- **CONE BEAM**

<table>
<thead>
<tr>
<th>Structure</th>
<th>MSCT</th>
<th></th>
<th></th>
<th>CBCT</th>
<th></th>
<th></th>
<th></th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior footplate thickness</td>
<td>Mean</td>
<td>Median</td>
<td>SD</td>
<td>Mean</td>
<td>Median</td>
<td>SD</td>
<td></td>
<td>0.009</td>
</tr>
<tr>
<td></td>
<td>2.08</td>
<td>2.00</td>
<td>0.67</td>
<td>2.75</td>
<td>3.00</td>
<td>0.45</td>
<td></td>
<td></td>
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<tr>
<td>Posterior footplate thickness</td>
<td>Mean</td>
<td>Median</td>
<td>SD</td>
<td>Mean</td>
<td>Median</td>
<td>SD</td>
<td></td>
<td>0.009</td>
</tr>
<tr>
<td></td>
<td>1.91</td>
<td>2.00</td>
<td>0.70</td>
<td>2.73</td>
<td>3.00</td>
<td>0.65</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
THERAPEUTIC OPTION

- Medical treatment
- Hearing aid
- Surgery
- Auditory implants
  - BAHA
  - Middle ear implant
  - DACS
  - Cochlear implant
MEDICAL TREATMENT

Third-Generation Bisphosphonates for Treatment of Sensorineural Hearing Loss in Otosclerosis
*Alicia M. Quesnel, ‡Margaret Seton, *Saumil N. Merchant,
†Christopher Halpin, and †Michael J. McKenna
HEARING AID AMPLIFICATION IN
CONDUCTIVE AND MIXED HEARING LOSS

- The adaptation is easiest due to the good cochlear function
- The hearing aid amplification should
  - Compensate the sensorineural part of the loss
  - Additional gain at each frequency to correct the conductive loss
  - Due to the conductive component on low frequency an occluded ear mold may be used
SURGICAL TECHNIQUE
Laser vaporization of the stapedial crus: 1 W - 0.2 s
LENGTH OF THE PROSTHESIS AND COUPLING

- Incorrect prosthesis sizing 1 and crimping 2 are important causes of stapedotomy failure
SELF CRIMPING PROSTHESIS

Promising Clinical Results of an Innovative Self-Crimping Stapes Prosthesis in Otosclerosis Surgery

*Florian Schrötzlmair, **Fabian Suchan, *Ulrich Kissel, *John-Martin Hempel, †Ronald Sroka, and *Joachim Müller
DECISION MAKING

- Clinical history and examination
- Audiometrical evaluation and binaural function
- Anticipation of surgical difficulties and surgeon experience
CLINICAL HISTORY AND EXAMINATION

- Main complain and level of disability
- Patient expectation
  - PORMS
- Risk and benefit between hearing aid and surgery
- Otoscopic examination
AUDIOMETRICAL EVALUATION
CT-SCAN EXAMINATION

- Obliteration footplate
- Facial déhiscence
- RW obliteration
1 Hearing aid is the only option due to surgical contra indication

2 The two options are needed due to restaure binaural hearing

3 The two options are possible
SURGICAL CONTRAINDICATIONS

■ Absolute
  ▶ Severe tubal dysfunction
  ▶ Pure sensorineural hearing loss
  ▶ Patient refuse any risk
  ▶ History of sudden hearing loss

■ Relative
  ▶ Only hearing ear *
ONLY HEARING EAR IN THE ERA OF CI

Case 1
- M – 49 years old

Case 2
- W – 55 years old

Case 3
- W – 65 years old
SPEECH DISCRIMINATION WITH POWERFUL HEARING AID

In the range of cochlear implantation

Powerfull hearing aid

No improvement with BAHA Cordelle

All 3 patients in a range of cochlear implant
SURGICAL DECISION

First stage: CI
Second stage: Stapedotomy
SURGICAL RESULTS

Case 1

Case 2

Case 3

Cochlear Implant

Cl threshold
SPEECH DISCRIMINATION RESULTS

Before surgery

Bimodal

HA + stapedotomy

CI
Patient choice was always to select the worse ear for CI first.

The improvement of speech discrimination in noise was always significant in bimodal condition.

Quality of sound, music perception, melody recognition was better on the stapedotomry side.
3 CLINICAL SITUATIONS

Hearing aid is the only option due to surgical contra indication

Various options are needed due to restaure hearing

The two options are possible
VARIOUS OPTIONS ARE NEEDED TO RESTAURE HEARING

- Hearing aid + surgery to obtain binaural hearing
- Bone conduction, MEI
- CI in severe hearing loss
59 years old woman
- The optimal gain provide undesirable audiometric effects
- It is not possible to provide enough gain to compensate
SURGERY + HEARING AID

Gain par la prothèse
Gain par la chirurgie

HEAD SHADOW

HEAD SHADOW

SOMMATION

SOMMATION

SQUELCH

SQUELCH

DICHOTIC

DICHOTIC

DIOTIC

DIOTIC

INVERSE DICHOTIC

INVERSE DICHOTIC

Improve 8-10 dB

Binaural redundancy - Improve 2-3 dB

Binaural demasking - 2 dB
BINAURAL HEARING IN OTOSCLEROSIS

B. LESCURE: 39 unilateral otosclerosis

- Improvement of binaural effect in all cases even without a complete symmetrical hearing
- Strong correlation between gain and quality of live (SSQ)
BONE CONDUCTION

- JA…, 25 yo, stapedotomy + hearing aid failure
  - No gain
POST OPERATIVE CT-SCAN

- Prothesis in place
- Obliteration of RW
- Option bone conduction
MEI CODACS VS CI

Hear Res 2016
Indication of direct acoustic cochlea stimulation in comparison to cochlear implants
Kludt E and al

Otol Neurotol. 2013
Multicenter study with a direct acoustic cochlear implant
Lenarz T

Speech in noise: Hochmair-Schulz-Moser (HSM) sentence test at +10 dB SNR
CI IN ADVANCED OTOSCLEROSIS

Audiological criteria

▶ All patients within the cochlear implant range (guideline HAS)
  ● Pure tone average (PTA) > 85 dB
  ● Word discrimination score (WDS) ≤ 50% at 60 dB

Imaging criteria

▶ CT Scan evidence of otosclerosis focus
POPULATION

N : 66

Stapedotomy + CI
25 pts
38%

Stapedotomy alone
32 pts
48%

Cl alone
9 pts
14%

Preop data

<table>
<thead>
<tr>
<th></th>
<th>Air Conduction</th>
<th>Word Discrimination Score</th>
<th>Bone Conduction</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Group A</strong> :</td>
<td>104.5 dB</td>
<td>12%</td>
<td>64 dB</td>
</tr>
<tr>
<td>Stapedotomy</td>
<td></td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td><strong>Group B + C</strong></td>
<td>109 dB</td>
<td>12%</td>
<td>69.5 dB</td>
</tr>
<tr>
<td>Cl alone / Cl</td>
<td></td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td>CI + Stapedotomy</td>
<td></td>
<td>NS</td>
<td></td>
</tr>
</tbody>
</table>

p < 0.001
## OVERALL RESULTS

<table>
<thead>
<tr>
<th></th>
<th>Mean Word Discrimination Score</th>
<th>% Patients scoring ≥ 50%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Group A :</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stapedotomy</td>
<td>50.6%</td>
<td>60%</td>
</tr>
<tr>
<td><strong>Group B + C</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CI alone / CI + S</td>
<td>72.8%</td>
<td>89%</td>
</tr>
</tbody>
</table>

N : 22
Previous stapedotomy has no impact on Cochlear implant outcome
Success of stapedotomy cannot be predicted pre-operatively

Previous stapedotomy has no impact on cochlear implant results

ALGORITHM FOR MANAGEMENT

- Simple, safe, low cost
- Excellent predictable results

Stapedotomy

With Hearing aid

Cochlear implant
Hearing aid is the only option due to surgical contra indication.

The two options are needed due to restaure binaural hearing.

The two options are possible.
BOTH OPTIONS ARE POSSIBLE

- Risks due to surgery:
  - Information content to the patient
- No risk with hearing aid for a similar result?
  - Do we have to propose hearing aid in first intention?
- Economic data: Health cost support

*Editorial: Is Stapedotomy Ever Ethical?*
Matthew L. Howard
DO THE AUDIOLOGICAL RESULTS ARE COMPARABLE?

**Inclusion criteria**
- Patient candidate for surgery with a conductive hearing loss > 30 dB and normal contralateral ear. First two months HA and then surgery.

**Study design**
- Prospective longitudinal study comparing audiological outcomes with hearing aid then stapedotomy at 2 months on 30 patients.

**Evaluation**
- Preliminary results:
  - Main criteria: Improvement from 0 → 100 (GHSI) S
  - Secondary criteria: Hearing threshold S
  Sound localisation S
PRELIMINARY RESULTS

Significant improvement of quality of live after surgery
SOUND LOCALISATION

- Localisation
- Total score
- Root main square

Significant improvement of quality of sound localization

N = 22
BINAURAL HEARING / MATRIX
High resolution CT-Scan may be useful in the diagnosis of otosclerosis when the clinical symptoms are not indicative enough.

Imaging CT may also help in counseling patients with anatomical difficulties and extensive otosclerosis.
Thank you for your attention