

# Correlation of otosclerosis grading on computed tomography with stapes surgery outcomes

## Original Article

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### Abstract

**Objectives:** To investigate whether computed tomography (CT) findings in patients with otosclerosis influence the audiometric prognosis after stapedial surgery.

**Study design:** Retrospective.

**Material and methods:** Patients undergoing stapes surgery, who had undergone prior ear CT and pre- and postoperative pure-tone audiometry (PTA), were included. The degree of otosclerosis on CT was classified according to the Symons and Fanning scale. Therapeutic success was defined as an air-bone gap  $\leq 10$  dB HL.

**Results:** The surgical success rate was 91%, with an average improvement of 6.9 dB HL in bone conduction after stapes surgery. Similar results were found in patients with cochlear foci, grades 2-3, on CT (6.5 dB HL).

**Conclusion:** The presence of cochlear otosclerosis foci on CT does not seem to influence postoperative audiometric outcomes.

**Keywords:** Otosclerosis; Stapedial Surgery; Computed Tomography

### Introduction

Otosclerosis is a metabolic disease of the bone that mainly affects the otic capsule. The otospongiotic lesions occur in the active phase, while the late inactive phase involves lamellar bone deposition.<sup>1</sup> It may be caused by hereditary or hormonal factors.

Patients with otosclerosis most often present with conductive hearing loss, secondary to the development of abnormal foci of bone or fibrous growth on the stapes footplate following bone resorption<sup>2</sup>. Sometimes, patients present with mixed deafness or pure sensorineural hearing loss (SNHL).

The effect of otosclerosis on cochlear function remains controversial. Some authors have argued that no histological changes support

SNHL in otosclerosis or that the SNHL does not surpass age-related hearing loss<sup>3-5</sup>. Other authors have reported that the cochlear histology may be altered, with obstruction of the endolymphatic flow, degeneration of the spiral ligament, vascular blockages, and reduced endocochlear potentials<sup>6-8</sup>. Thus, osteodystrophy may progress to pure or mixed SNHL, possibly due to collagen deposition in the spiral ligament, resulting in its hyalinization<sup>9</sup>. Ear computed tomography (CT) is used in patients with an unclear otosclerosis diagnosis and during preparation for a stapedectomy. CT can detect the foci of otospongiosis or otosclerosis. Some studies have suggested that the severity of cochlear involvement on CT may be correlated with the degree of SNHL in otosclerosis<sup>11,12</sup>.

In this context, this study aimed investigate whether patients with otosclerosis and cochlear changes on CT have a worse audiometric prognosis after stapedectomy.

## Materials and Methods

This retrospective study included patients in whom stapedectomy was performed by different surgeons at the Beatriz Ângelo Hospital (*Hospital Beatriz Ângelo* – HBA), in Loures, Portugal, from January 2012 to January 2022. All patients underwent ear CT and pure-tone audiogram both pre- and postoperatively. Otosclerosis was classified according to the Symons and Fanning CT grading system<sup>13</sup>: grade 1 – solely fenestral, either sclerotic or spongiotic lesions; grade 2 – patchy cochlear disease (with or without fenestral involvement) localized to the basal cochlear turn (grade 2A),

middle/apical turns (grade 2B), or both the basal turn and middle/ apical turns (grade 2C); grade 3 – diffuse confluent cochlear involvement of the otic capsule. Grade 2C is differentiated from grade 3 by the patchy focal versus diffuse confluent involvement of the entire cochlea, respectively. In this study, the patients were classified into grades 2A, 2B, 2C, and 3 based on cochlear involvement.

Therapeutic success was defined as an air-bone gap (ABG) in the pure-tone audiogram  $\leq 10$  dB HL, without worsening of the bone conduction (BC) thresholds<sup>14,15</sup>. ABG was calculated using the pure-tone average (PTA) at 250, 500, and 1000 Hz frequencies. The most recent audiograms available were considered for analysis in this study.

## Results

The study population included a total of 46 patients, comprising 15 men (33%) and 31 women (67%), with a mean age of 47.5 ( $\pm 7.8$ ) years. The surgical success rate was 91% (n=42). Based on the classification of foci of otospongiosis on CT, the patients were distributed as follows: seven patients with grade 0; 32 patients with grade 1; and seven patients with grade 2–3. All patients with cochlear involvement on CT achieved therapeutic success. On an average, the most recent audiograms were performed 33 months after surgery, and there was no standardization of the time between the surgery and audiogram. The BC-PTA of the operated ear improved by 6.9 dB HL in patients with cochlear alterations and 6.5 dB HL in patients with cochlear foci on CT (grades 2–3).

**Table 1**  
Results

Foci of otospongiosis on CT - Symons and Fanning grading system		Patients with surgical success (ABG $\leq 10$ dB HL)
Grade 0	n=7	n=5 (71%)
Grade 1 (only antefenestral involvement)	n=32	n=30 (94%)
Grade 2–3 (cochlear involvement)	n=7	n=7 (100%)
<b>Total</b>	<b>n=46</b>	<b>n=42 (91,3%)</b>

CT, computed tomography; ABG, air-bone gap

## Discussion

The Symons and Fanning CT grading system showed a high inter- and intra-observer agreement in a previous study<sup>13</sup>. However, few studies have correlated the presence of foci of cochlear otosclerosis on CT with therapeutic success. In a study by Shint et al., who evaluated 437 cases of otosclerosis, otosclerosis was detected by CT in approximately 91% patients, although only 12% patients showed cochlear involvement<sup>11</sup>. These values are similar to those found in our study in which 15% (n=7) patients showed cochlear involvement (grade 2–3 on CT). Although the number of patients with cochlear involvement was small in our study, stapedectomy successfully closed the ABG in all patients. After surgery, the BC thresholds improved on an average by 6.9 dB HL. This “overclosure” is in line with the findings of previous studies, in which the BC thresholds improved between 2.5 and 8.3 dB HL in approximately 81–90% of patients who underwent surgery<sup>16,17</sup>. The patients with cochlear disease also showed a similar improvement in BC thresholds (6.5 dB HL), for a similar postoperative follow-up time. The patients with cochlear otosclerosis did not show increased BC degradation after stapedectomy.

In this study, stapedectomy was found to be an effective treatment for otosclerosis, regardless of whether the foci of otosclerosis were detected by CT. Even in long-term follow-up, no further deterioration in BC thresholds was observed after stapedectomy in these patients. However, this study has some limitations inherent to its retrospective design. For instance, audiometry was conducted at different points of time, and the surgeries were performed by different surgeons. Furthermore, the group of patients with grade 2–3 otosclerosis was small, which precluded comparative statistical analysis.

## Conclusion

Stapedectomy provided a high therapeutic success rate, regardless of whether cochlear otosclerosis alterations were detected by CT.

The presence of foci of cochlear otosclerosis on CT did not affect the postoperative audiometric outcomes in our study. However, future studies should be conducted with more patients to confirm these results.

## Conflicts of Interest

The authors declare that there is no conflict of interests regarding the publication of this paper.

## Data Confidentiality

The authors declare having followed the protocols in use at their working center regarding patients' data publication.

## Protection of humans and animals

The authors declare that the procedures were followed according to the regulations established by the Clinical Research and Ethics Committee and to the 2013 Helsinki Declaration of the World Medical Association.

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## Availability of scientific data

There are no datasets available, publicly related to this work.

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