



SURGERY OF OTOSCLEROSIS: AUDIOMETRIC RESULTS, PREDICTIVE FACTORS OF FUNCTIONAL FAILURE

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ARTICLE INFO

Article History:

Received 8th March, 2017

Received in revised form 19th

April, 2017

Accepted 10th May, 2017

Published online 28th June, 2017

Key words:

Otosclerosis, Surgery, Predictive Factors

ABSTRACT

The treatment of otosclerosis is essentially surgical. Several factors may influence the quality of postoperative functional outcomes. The aim of our study was to evaluate our audiometric results and to study the predictive factors of functional failure. Our study was retrospective involving 52 patients operated for otosclerosis in the ENT department of the Military Hospital Moulay Ismail of Meknes during a period of 7 years, from 1 January 2009 to 31 December 2015. Our series included 19 men and 33 women. The average age of our patients at intervention's time was 38 years. The mean preoperative thresholds for bone and air conduction were respectively 16,7 dB and 4,9 dB, and the average Air-bone gap was 32,7 dB. The footplate gesture was a total stapedectomy in 50% of cases, a partial stapedectomy in 26.79% of cases and a stapedotomy in 23.21% of the cases. At last year's control, the average postoperative Air-bone gap was 8.3 dB and the Air-bone gap's closure was obtained in 80,9% of cases. After multivariate study with logistic regression, we selected two significant predictors of functional failure factors: age (Odds Ratio: 2.4 / p: 0.0406) and Aubry's audiometric stage (Odds Ratio: 5.65 / p: 0.0098).

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INTRODUCTION

Otosclerosis is a primitive osteodystrophy of the otic capsule, when clinically manifested, is responsible of a conductive or mixed hearing loss by stapedo-vestibular ankylosis [1]. Its treatment is based essentially on surgery which techniques are currently coded but varied and which results are usually excellent [2]. Several factors may influence the quality of the functional results, acting as such in the surgical indication [3]. Our work was a retrospective study of 52 patients operated for otosclerosis, which aim was to evaluate our audiometric results and to study the predictive factors of functional failure with a view to a finer selection of surgical indications and more appropriate choice of surgical technique.

Patients and methods

Type of study

It was a retrospective study of 52 patients operated for otosclerosis in the ENT department of the Moulay Ismail Military Hospital of Meknes, during a period of 7 years, from 1 January 2009 to 31 December 2015.

Inclusion criteria

We included in our study the subjects whose diagnosis of otosclerosis was authenticated by the identification of a stapedo-vestibular ankylosis in preoperative and benefited from a preoperative tone audiometry (less than 1 month before surgery) and postoperatively (1 month, 6 months and 12 months after surgery). The CT- scan of the pars petrosa has not been performed in all surgical patients therefore it was not selected as a study criterion.

Data Collection

Clinical, para clinical, therapeutic and evolutive information gathered from patients' records were plotted on the form returns, previously drafted after literature review.

Surgical technique

All patients were operated under deep general anesthesia by Shambaugh's endaural approach (Fig. 1) according to 2 techniques for opening the footplate otosclerotic focus: partial or total platinectomy and platinotomy calibrated with trephine. The re-establishment of the transmission effect was achieved by a Teflon piston with a diameter of 0.4 mm or 0.6 mm and a length adapted to the distance between the long process of the incus and the window Oval, varying between 4.25mm and 5mm (Fig. 2). The interpositional material was an aponeurosis in all cases. At the end of the surgery, the

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stability and the correct position of the piston as well as the flexibility of its movements were tested.

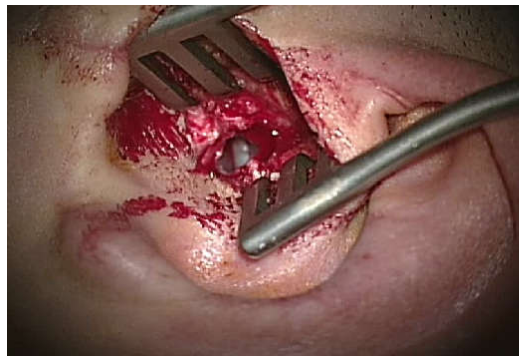


Figure 1 Surgical view (left ear) showing the endaural approach

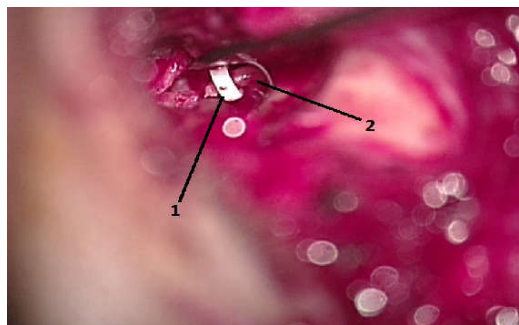


Figure 2 Surgical view (left ear) showing the Teflon piston 1. Teflon Piston in place 2. the long process of the incus

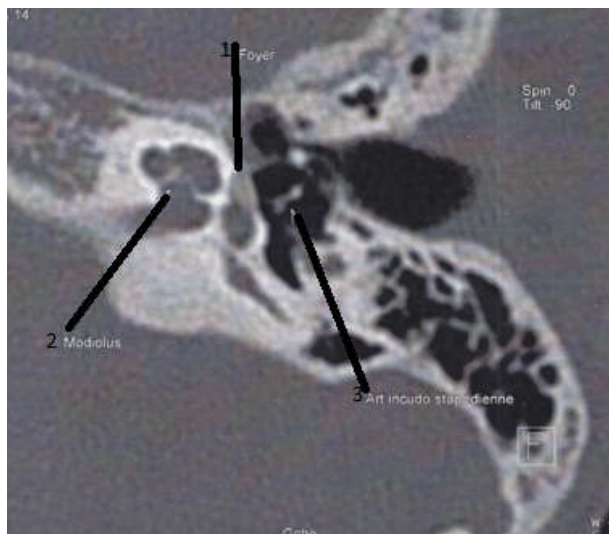


Figure 3 Axial CT scan showing the otosclerosis focus at the fissula ante fenestram associated with posterior involvement of the The footplate of the stapes 1. Otosclerosis focus 2. Modiolus or columella 3. Incudo-stapedial joint

Data analysis

The audiometric results were analyzed according to the recommendations of the American Academy of Otolaryngology Head and Neck Surgery. For each patient were studied:

- Postoperative Residual air-bone gap: Difference between the mean postoperative thresholds for air and bone conduction on the 500, 1000, 2000 and 4000 Hz frequencies. A surgical success was defined by a Postoperative Residual air-bone gap less than or equal to 10 decibels (dB).

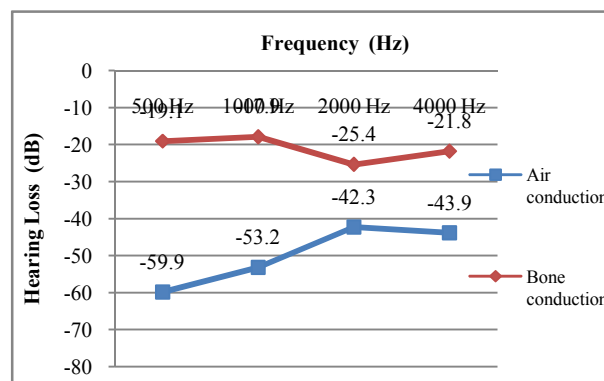
- The cochlear reserve: difference between the average of bone conduction thresholds on the 500, 1000, 2000 and 4000 Hz frequencies in pre and postoperative. A negative value of the cochlear reserve corresponds to an improvement in bone conduction. A positive value corresponds to a decrease in bone conduction or labyrinthization.

For the study of the predictive factors of functional failure, 6 variables were studied: Age, sex, Aubry's audiometric stage, footplate's gesture, the diameter of the piston used, the persistence of postoperative vertigo beyond the third day. The Fischer test was used to compare our results. For all our statistical analyzes, the significance level was set at 5%.

RESULTS

Our series included 19 men and 33 women, a sex ratio of 0.57. The average age of our patients at the time of surgery was 38 years with extremes ranging from 20 to 60 years. The most representative age range was between 30 and 50 years (71.15%). Hearing loss was the master symptom present and bilateral in 61.53% of cases. Tinnitus was present in 48% of cases. The vertigo was present in 17.30% of cases as rotatory vertigo crises or sensation of instability.

At tonal audiometry, mean thresholds for bone and air conduction were respectively 16.7 dB and 49.9 dB. The preoperative air-bone gap varied from 9 dB to 67 dB with an average of 32.7 dB (Graph. 1) and 42% of our patients had an average preoperative air-bone gap greater than 30 dB. According to Aubry's audiometric classification, 8.93% of patients were at stage I, 39.29% at stage II, 41.07% at stage III and 10.71% at stage IV. CT scan performed for 35 patients, showed the otosclerosis focus in 60% of the cases, as an hypodensity of seat: pre footplate at the level of the fissula ante fenestram with variable involvement of the anterior branch and the stapes footplate (71.42%) (Fig. 3), pure footplate (19.04%) and Peri-labyrinthine (9.54%).



Graphic 1 Average preoperative audiogram

All our patients were operated under general anesthesia according to the protocol of controlled hypotension. The minimal endaural or Shambaugh approach was chosen for all patients. The footplate's gesture was: total stapedectomy in 50% of cases, partial stapedectomy in 26.79% of cases, a stapedotomy in 23.21% of cases. The prosthesis used was a 0.4 and 0.6 mm Teflon piston respectively in 58.93% and 41.07% of cases. Prophylactic antibiotics and a vasodilator therapy, corticosteroid and anti-vertigo drugs were systematically initiated for all patients. It should be noted that 23% of our patients had a

transitory postoperative vertigo which progressed favorably under medical treatment. The persistence of tinnitus was reported in 32.96% of cases. Postoperative infection was observed in 2 patients (3.57%). The mean follow-up of our patients was 24 months.

Analysis of the postoperative audiometric data showed an average residual postoperative air bone gap of 7.8 dB with extremes of 5 dB to 39 dB and closure of the air bone gap (residual postoperative air bone gap \leq 10 dB) in 86% of cases (table 1).

Table 1 Residual postoperative air-bone gap at 3 months, 6 months and 12 months after surgery

Residual postoperative air bone gap	3 months	6 months	12 months
< 10 dB	86%	81%	80.9%
10 - 20dB	12%	13%	15%
>20dB	2%	6%	4.1%

After one year, the average residual postoperative air bone gap was 8.3 dB with extremes from 5 dB to 27 dB and air bone gap's closure was achieved in 80.9% of cases. The bone conduction's study showed an improvement in the cochlear reserve at 3 months, 6 months and one year after surgery respectively in 76%, 78% and 77% of cases with an average gain of 6.9dB. No postoperative cophosis were reported in our series. By comparing our audiometric results according to potential risk factors for functional failure and after univariate and multivariate studies with logistic regression, two variables were selected as having a significant relation to functional failure: age (Odds Ratio: 2.4 / p: 0.0406) and Aubry's audiometric stage (Odds Ratio: 5.65 / p: 0.0098) (Table 2).

Table 2 complete closure rate of air bone gap by Study Variables

Study Variables	Surgical success rate	Odds Ratio	P
Age	\leq 35 years	71.43%	2.4
	$>$ 35 years	85.71%	
Sex	Male	89.47%	1.17
	Female	87.87%	
Audiometric stage	Stages I - II	92.59%	5.65
	Stages III - IV	68.96%	
Footplate gesture	Stapedectomy	85.50%	1.01
	Stapedotomy	85.40%	
Piston diameter	0.4 mm	90.90%	0.67
	0.6 mm	86.95%	
Persistence of postoperative vertigo	Yes	83.33%	1.13
	No	85.00%	

Table 3 Proportion of air bone gap's closure according to the literature with a first control from 1 to 3 months.

authors	Number of ears operated	Surgical success rate
Mani [3]	306	87.3%
Mangham [3]	215	96%
Quaranta [3]	151	84.7%
Bourguinate [3]	67	73%
Herzog [3]	65	87%
Our series	56	86%

DISCUSSION

Surgical treatment is unquestionably the optional choice in the treatment of otosclerosis [4]. The surgical indication must be carefully applied and based on the analysis of auditory but also general factors [5]. For several authors, the moderate hearing loss for which an intervention is indicated is at least 30 dB [3]. In our series, the average of pre-operative air bone

gaps averages was 32.7 dB with extremes from 9 dB to 67 dB and 42% of our patients had an average pre-operative air bone gap greater than 30 dB.

The study of the large historical and recent series of the literature shows an improvement of the hearing obtained after surgery for approximately 75% of the patients, the surgical success rate was defined by most authors by a Residual Postoperative air-bone gap \leq 10 dB [6]. In our series, the surgical success rate of the first control at 3 months (86%) was closer to the ones reported in the literature series with a first control from 1 to 3 months (Table 3). Nevertheless, the success of otosclerosis surgery should not be judged only in the short term but also in the maintenance of the auditory results [1]. In our series, the proportion of the air bone gap's closure, at the last control for our patients, has been in the order of 80.9%, this proportion was also comparable to the ones reported in the literature [3].

The study of bone conduction of operated otosclerosis is crucial because it reflects cochlear function. It determines the importance of labyrinthine trauma unavoidable since there is a fenestration of the stapes footplate exposing the perilymph and the membranous vestibule. In the literature, the gains in bone conduction are a quasi-constant phenomenon. Improvement of bone conduction was observed in 80% of short-term cases for Beal [7], 91% for Dubreuil [8] and 78.8% for Mani [3]. The analysis of the gain in bone conduction for our patients showed an improvement in the cochlear reserve in 76% of cases with an average gain of 6.9 dB.

The age of the beginning of this disease is difficult to fix because it is determined by a clinical notion: Conductive hearing loss by footplate blocking. However, the histological injuries, leading to this blockage, gradually occurred and it is rather the average age at the time of the intervention which was generally retained. The average age found in most series is between 20 and 40 years [9]. For Besbes [3], a predominance of young adults was noted in 61.4% of cases with an age between 20 and 39 years. In our series, the average age at the time of surgery was 38 years and 71.15% of patients were between 30 and 50 years. The effect of age on the functional results is evaluated differently according to the authors. Several authors reported identical gains with respect to air bone gap and bone conduction regardless of age. Yet, there is a correlation between age and preoperative air bone gap, which would explain a higher gain in the elderly [1]. In our study series, we found the same results because the best ones were obtained for subjects over 35 years with air bone gap's closure in 85.71% of cases compared to 71.43% of subjects under 35 years.

Clinical otosclerosis affects 1.6 to 2 women for a man.. Some authors explain this feminine preponderance by endocrine factors. On the other hand, there is no gender difference in histological otosclerosis [10]. In our series, a female predominance (63.46%) was found and the sex ratio M / F was 0.57. The majority of the authors did not find any significant gender difference in audiometric results [3], which is the case for our series (Odds Ratio: 1.17 / p: 0.4039). The evolutionary stage of otosclerosis has been retained by many authors as a predictive factor of functional failure [11]. For Besbes [12], the complete closure rate of air bone gap was 47.4% in stage I and 27.5% in stage IV where there was a high bone conduction impairment. For Mani [3], this rate was

94% for stages I - II and 55.6% for stages III - IV. The rate of complete closure of the air bone gap in our study has decreased from 47.4% in Stage I and II of Aubry to 27.5% in stage III and IV of Aubry. Our findings are consistent with those of many authors in favor of a significant influence of the disease's stage on the surgical results.

The choice of the appropriate surgical attitude to adopt for otosclerosis is an intense debate. There are currently no studies which claim that a surgical technique is better than the other. Rondini-Gilli. [14] and Esquivel [3] found no statistically significant difference between stapedectomy and stapedotomy for residual air bone gap on medium frequencies. In our series, we found no significant difference in the audiometric results between the total stapedectomies (complete closure rate of air bone gap = 85.5%) and stapedotomies (complete closure rate of air bone gap = 85.4%).

The diameter of the piston is also a subject of much debate. By comparing the results of piston 4/10, 6/10 and 8/10 mm, the authors concluded that the enlargement of the diameter piston increases the detection limit of low frequencies and a reduction in this diameter leads to a detecting improvement for high frequencies. Other authors have reported that the 0.6 mm piston occupies the most part of the oval window and therefore reduces the transmitted energy hence the advantage of the 0.4 mm piston. On the other hand, others [1] found that the diameter of the piston does not affect the audiometric result as our series (Odds Ratio: 0,67 / p: 0,6040).

Vertigo is frequently reported during the first postoperative days. Dubreuil [8] and Simoncelli [3] found disabling vertigo in respectively 2.2% and 1% of cases. For Mani [3], air bone gap's closure was better in the absence of persistent postoperative vertigo, but this difference was not significant ($p = 0.051$). In our series, postoperative vertigo was not retained as a significantly predictive factor of functional failure (Odds Ratio = 19.06 / $p = 0.0001$)

CONCLUSION

The surgical success rate in our series is comparable to the numbers published in the literature, with constant and sufficient functional results during the first postoperative year. From our review arise two independent factors which are significantly predictive of functional failure: an intervention age beyond 35 years and Aubry's audiometric stage III or IV. However, these factors do not contraindicate the surgical treatment which remains beneficial and allows, amongst other, a better audio-prosthetic adaptation.

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- Nabil touihem: Iconography
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State of knowledge on the subject

- Otosclerosis is one of the principal aetiologies of acquired hearing loss for adults, with a clinical incidence of 0.2 to 1%.
- The treatment of otosclerosis is essentially surgical; the choice of surgical technique was known as a predictive

factor of functional failure, while other factors were not evaluated in the literature

Contribution of our study to knowledge

- The follow up of otosclerosis by two different techniques allowed us, as many authors have done before, to estimate the qualities of the two-footplate opening processes
- The evaluation of our audiometric results according to certain factors considered predictive of functional failure allowed us to retain 2 factors: the age and the Aubry's audiometric stage.
- The two factors selected appear to influence the quality of the results obtained but do not contraindicate the surgical treatment, which remains beneficial and allows, amongst others, a better audio-prosthetic adaptation.

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How to cite this article:

Hicham Attifi *et al* (2017) 'Surgery Of Otosclerosis: Audiometric Results, Predictive Factors Of Functional Failure', *International Journal of Current Advanced Research*, 06(06), pp. 4265-4269.
DOI: <http://dx.doi.org/10.24327/ijcar.2017.4269.0478>
