Scholars Journal of Medical Case Reports
Abbreviated Key Title: Sch J Med Case Rep
ISSN 2347-9507 (Print) | ISSN 2347-6559 (Online)
Journal homepage: https://saspublishers.com

OPEN ACCESS

Otorhinolaryngology

Otosclerosis Surgery: Predictive Factors of Functional Results: 21 Cases

Belasri Anas[1*], Achraf Amine Sbai[1], Drissia Benlfadil[1], Azzedine Lachgar[1], Adil Abdnbestein[1], Fahd Elayoubi[1]

[1]Department of Otorhinolaryngology and Cervico-Facial Surgery, Mohammed VI University Hospital of Oujda

DOI: 10.36347/sjmcr.2023.v11i10.037 | **Received:** 13.09.2023 | **Accepted:** 23.10.2023 | **Published:** 27.10.2023

***Corresponding author:** Belasri Anas
Department of Otorhinolaryngology and Cervico-Facial Surgery, Mohammed VI University Hospital of Oujda

Abstract **Original Research Article**

Introduction: Otosclerosis is an osteodystrophy of the otic capsula which is anatomically expressed by a stapedo-vestibular ankylosis. The objective of this work is to evaluate the audiometric result and to determine the predictive factors of functional failure. ***Materials and methods:*** we conducted a retrospective study about 21 ears operated for otosclerosis, within the department of otolaryngology and cervicofacial surgery CHU Mohammed VI Oujda over a period of 3 years (2016-2020). Epidemiological, clinical of patients and preoperative and postoperative audiometry at 12 months were analyzed. Surgical success was defined by a postoperative Rinne (RPO) ≤ 10db. ***Results:*** The mean age of the patients was 37,76 years. Female gender was predominant with a sex ratio of 2. The mean time to consultation was 4.2 years. The clinical picture was dominated by deafness which was constant in all patients. Tinnitus was present in 62% of cases. We retained 2 independent factors significantly predictive of functional failure: an age at surgery over 40 years and an audiometric stage III or IV of Aubry. ***Conclusion:*** Early post-operative air-bone gap is useful to detect early failure of stapes surgery. Although advanced otosclerosis was considered a negative factor for hearing gain, thanks to stapes surgery patients with advanced otoscle- rosis can better benefit from appropriate hearing aids.

Keywords: Otosclerosis, surgery, results, predictive factors.

INTRODUCTION

Otosclerosis is a primary osteodystrophy of the otic capsule, it combines phenomena of osteolysis and bone reconstruction responsible for the formation of otospongiosa foci. It represents the main cause of acquired deafness with a normal eardrum. The diagnosis is suspected in the face of the progressive appearance of conductive deafness with a normal eardrum, and can be confirmed by CT scan of the rock. Audiometry is essential for a positive diagnosis as well. than postoperative monitoring. The choice of surgical technique has been widely studied in the literature as a predictive factor of the quality of the functional result of surgery. Other factors such as age, consultation time, delay in treatment, preoperative audiometric stage, which therefore play a role in the operative indication. The aim of our study was: to evaluate the audiometric results and to determine the predictive factors of functional failure.

MATERIAL AND MÉTHODS

Retrospective study of patients operated on for otosclerosis in the otolaryngology surgery department over a period of 4 years (January 2016-January 2020), 21 files of operated patients were collected, Pure-tone audiometry performed preoperatively at less than 1 month. before surgery and postoperatively. The study consisted of two parts: An analysis of the pre and postoperative audiometric results taken at 12 months. The results were expressed by calculating the postoperative residual Rinne (RRPO): difference between the average of the postoperative thresholds in air conduction (AC) and bone conduction (CO). Surgical success was defined by an RRPO less than or equal to 10 decibels, and by evaluating bone conduction gain: difference between the average pre- and post-operative CO thresholds. An improvement in bone conduction resulting in a positive gain, and by evaluating gain in air conduction: the difference between the thresholds in pre-postoperative AC a positive value of the gain testifying to an improvement in AC and gain in Rinne: Preoperative Rinne – Postoperative Rinne, positive Rinne gain: improvement in Rinne. A study of the predictive factors of functional failure: 3 variables were studied:

1-Age
2-Sex
3- Aubry audiometric stage

Data entry and processing were carried out using Microsoft Office Excel 2013 software.

Quantitative variables were expressed as average (+- standard deviation), qualitative variables as percentage. Validation of the results obtained was carried out by a Student's t test for the quantitative variables and by a KHI-2 test for the qualitative variables. The significance threshold was set at 0.05.

RESULTS

The average age of our patients at the time of surgery was 37.76 years (extremes of 21 and 64 years). A female predominance was noted with 14 (68%) female patients compared to 7 (32%) male patients. The sex ratio was 2 for women. According to the Aubry audiometric classification, 2 patients (9.5%) were at stage I, 10 patients (48%) at stage II, 53 patients (28.5%) at stage III and 3 patients (14%). at stage IV. The average preoperative Rinne was 30.6db. All our patients were operated on under general anesthesia: from 2016 to June 2018 via the intracanal conduit. From July 2018 by Endoscopy surgery. The platinum gesture was: a platinectomy in 3 cases (20%). a Calibrated platinotomy in 18 cases (80%). The prosthesis used was a Teflon piston of 0.6mm caliber whose length was adapted to the distance between the descending branch of the anvil and the oval window using a measurer it varies between 4.25mm and 4 .5mm. The duration of hospitalization in our department essentially depends on the condition of the patient (It is 2 days in our series). Prophylactic antibiotic therapy for 48 hours unless there are complications, using amoxicillin-clavulanic acid systemically and 2nd generation fluoroquinolones locally as well as corticosteroid treatment is prescribed in order to reduce the inflammation created in the eardrum and anti-vertiginous, antiemetics in case of dizziness or postoperative nausea. Persistent post-operative dizziness was reported by 5 patients, Tinnitus in 14.2% of cases. It was transient in 4.7% of patients. No facial paralysis or post-operative dysgeusia was noted in our series. At one year, the RRPO was on average 8.6 dB, with an average gain in Rinne of 21.8 db. Closure of the Rinne was obtained in 80.9% of cases, the cochlear reserve showed: by calculating the gain in CO (Preoperative CO-Postoperative CO), an improvement in the cochlear reserve of 4 db. The results are obtained on the frequencies 0.5 and 1, 2 and 4 khz. 2 variables are retained as having a significant relationship with functional failure: these are age and Aubry audiometric stage (table 1).

Table 1: Complete closure rate of the Rinne depending on the factors studied

Study variable		Percentage	P
Age	≤ 40	91,7%	
	> 40	66 ,8%	0,07
Sex	Masculin	85,7%	
	Féminin	78,5%	0,633
Aubry audiometric stage	Stade I – II	83, 3%	
	Stade III – IV	77 ,8%	0,005

DISCUSSION

Pathology affects between 0.5% and 1% of the world population, presents bilateral involvement in 70% to 85% of cases. Prevalence rates are higher in women and subjects aged 30 to 40 years. The average age of the patients was 37.76 years with extreme ages (16-64) in our series. A female predominance of clinical otosclerosis has been found in most series [19-23]. a female predominance was found with 14 women for 7 men, the sex ratio was 2 for women. No significant influence of sex on the quality of the functional results obtained was found. The main clinical symptom described by the patients is hearing loss was present in all our patients and was bilateral in 62% followed by tinnitus present in 62% of our cases while 14% of the cases in our series presented dizziness and paracusis of willis present in 4% of our study. These rate is comparable to that reported in series in the literature (table 2).

Table 2: Clinical signs according to the literature

Functional symptoms	Crompton [7]	Dubreuil [17]	M. Ben Amor [26]	Our series
Deafness	100%	85%	100%	100%
tinnitus	68%	40%	83%	62%
Dizziness	31%	10 a 25%	1 ,62%	14%
Paracusis of willis	-	10%	17%	4%

The treatment of otosclerosis is mainly based on surgery. For several authors, the average hearing loss at which intervention is indicated is at least 30 dB (1.2). In our series, the mean preoperative Rinne was 30.6 dB. The success rate, defined by most authors by an RRPO ≤ 10 dB, was obtained in our series at 12 months in 80.9% of cases. It varies between 62% and 95.5% in the literature [37, 20]. This rate is comparable to that reported in series in the literature (table 3).

Table 3: Complete Rinne closure rate according to the literature

Authors	Number of ears	Success rate
MANI *et al.*, [40]	310	87,3%
Salmon [41]	182	66,5%
Garcia Iza, [42]	116	92,2%
Souza *et al.*, [43]	210	87,6%
Notre série	21	80,9%

The study of CO in the results of otosclerosis is important, because it is a reflection of cochlear reserve [17]. The rise in CO post-operatively on low frequencies 1000 or 2000 Hz is almost constant, also contributing to the operative decision in bilateral forms determining the most damaged ear. Dubreuil [17] noted one or more conservation of CO in 91% of cases, Mani *et al.*, (78.8% of cases), Moscillo [20] obtained 95% gain whatever the operating technique. In our series Analysis of the significantly higher average gain on the 2000Hz frequency 9.8dB at 12 months. The study of air conduction is important in the evaluation of functional results, since the gain of the air curve represents the benefit directly felt by the patient. Beal [19] noted CA gain of 28.5 dB in 47 cases. Alberti *et al.* [43] gain in CA 16.1% on 2 30 cases, In our series the analysis of the average gain in CA 31.4 dB at 12 months. The effect of age on functional results is assessed differently depending on the authors. The onset of otosclerosis is often difficult to specify; it is rather the age at the time of the operation that is generally used. Mani *et al.* [40] found better results in patients under 35 years old with closure of the Rinne in 89%, for Bourguinat [13] the gain in CO and CA as well as the postoperative Rinne were not correlated with age. In our series we obtained better results in subjects under 40 years of age with Rinne closure in 91.7% of cases compared to 68.8% of cases in subjects over 40 years of age. a female predominance of clinical otosclerosis was found in most series [24, 25].

On the other hand, in histological otosclerosis, the difference between the two sexes is not significant [26-27]. In our series, a female predominance was found with 14 women for 7 men, the sex ratio was 2 for women. We did not find any significant influence of sex on the quality of the functional results obtained. Vartiainen [28] also did not notice any correlation between the closure of the Rinne and sex even in our study no significant influence of gender on audiometric results, bourguinate [13] found the best postoperative results in women with a significant difference in the evolution of average bone conduction. The audiometric results vary depending on the progressive stage of the otosclerosis disease. In our series, Aubry stage III or IV was retained as a significantly predictive factor of functional failure with complete Rinne closure rate increasing from 83.3% in AUBRY stages I-II to 77.8%. in stages III-IV. For Besbes [12], the complete closure rate of the Rinne increases from 47.4% in stage I of Aubry, to 27.5% in stage IV of Aubry. Causse [29], by operating on patients at the subcophotic stage, was able to observe that the results are excellent provided that during the intervention there is no excessive movement of the labyrinthine fluids, and that the intervention is only considered when there is exists a bony weber still lateralized towards the deafest ear, and to prescribe vascular and enzymatic medical treatment). The choice of approach depends on the surgeon's habits and local anatomical conditions [32-33]. In our series the approach was an intra-ductal route (from 2016-June 2018), and by endoscopic surgery (from July 2018. We did not find any significant difference in audiometric results between these two ways. In our series, we did not find any significant difference in audiometric results between total platinectomies and platinotomies.

Marquet [44] did not observe any significant difference between platinotomy and platinectomy in all postoperative audiometric parameters.Sedwick *et al.* [45] ont montré que la platinotomie et platinectomie donnaient les même résultats sur la fermeture de Rinne. The nature of the graft used also depends on the habits of the surgeon and the approach used [32-33]. In our series we used a Teflon piston of 0.4mm caliber and whose length adapted to the distance between the descending branch of the anvil and the oval window varies between 4.25mm and 4.5mm. In a large series of 2527 patients, Vincent *et al.* [21] reported a rate of 5.8% of severe postoperative sensorineural hearing loss explained by the presence of a postoperative peri-lymphatic fistula only without 8 cases. Mann *et al.* [46] in a series of 1229 cases reported severe deafness (1.62%), including 12 progressing towards cophosis (1%). In our study, 3 of our patients presented with tinnitus, 2 of which were persistent tinnitus, according to Lescann [47] tinnitus disappeared in almost 97% of cases at 3 months and 1 year. Martin [48] only has 6% of tinnitus postoperatively. Postoperative dizziness is common, it is increased to 15% [54], Dubreuil [17] notes systematic dizziness on the first postoperative day and is all the more significant as the size of the platinum breakage is large, Quaranta who finds dizziness in 10.4% of cases [49], in our study series noted 5 cases of postoperative dizziness improved after symptomatic treatment. The absence of postoperative Rinne closure for Quaranta *et al.* [49] was 7.7%. The explanation for which can be varied, lysis of the long incus process (34%), dislocation of the prosthesis is noted by Ayach [36] in 20.8% of cases, displacement of the prosthesis it is 82% for Derlacky [50], in our series we had a case of displacement of the prosthesis by revision surgery after 1 year.

CONCLUSION

From our study emerge 2 independent factors significantly predictive of functional failure: an age at intervention beyond 40 years and an audiometric stage III and IV of Aubry. Early postoperative audiometry would therefore be useful to detect early surgical failure in one part and to predict the final functional result of another part.The surgical success in our series is comparable to the figures published in the literature with stable and satisfactory functional results during the first postoperative year. Regarding the pre-operative audiometric stage, the percentage of closure of the Rinne less good in cases of advanced otosclerosis (audiometric stage III or IV) does not contraindicate surgery which always remains differential to allow, among other things, better audio- prosthetic.

REFERENCES

1. Portmann, M., Bebear, J. P., & D'Arc, M. B. (1982). The history of otosclerosis from the 19th century to 1952. *Acta oto-rhino-laryngologica Belgica*, *36*(2), 297-305.
2. Shea Jr, J. J. (1998). A personal history of stapedectomy. *Otology & Neurotology*, *19*(5), S2-S12.
3. Mudry, A. (2006). Adam Politzer (1835-1920) and the description of otosclerosis. *Otology & Neurotology*, *27*(2), 276-281.
4. Tange, R. A., & Dreschler, W. A. (1992). Predictive value of high frequency audiometry in otosclerosis. *Revue de Laryngologie-Otologie-Rhinologie*, *113*(2), 91-93.
5. Häusler, R. (2007). General history of stapedectomy. In *Otosclerosis and stapes surgery* (Vol. 65, pp. 1-5). Karger Publishers.
6. House, H. P. (1993). The evolution of otosclerosis surgery. *Otolaryngologic Clinics of North America*, *26*(3), 323-333.
7. Crompton, M., Cadge, B. A., Ziff, J. L., Mowat, A. J., Nash, R., Lavy, J. A., ... & Dawson, S. J. (2019). The epidemiology of otosclerosis in a British cohort. *Otology & neurotology: official publication of the American Otological Society, American Neurotology Society [and] European Academy of Otology and Neurotology*, *40*(1), 22.
8. Trotoux, J. (2000). Un siècle d'otospongiose ou «le siècle» de l'otospongiose?. In *Annales d'oto-laryngologie et de chirurgie cervico-faciale* (Vol. 117, No. 4, pp. 226-231).
9. Mangham Jr, C. A. (1993). Reducing footplate complications in small fenestra microdrill stapedotomy. *Otology & Neurotology*, *14*(2), 118-121.
10. Herzog, J. A. (1991). 0.4 mm stapedotomy: a consistent technique for otosclerosis. *Otology & Neurotology*, *12*(1), 16-19.
11. Quaranta, N., Besozzi, G., Fallacara, R. A., & Quaranta, A. (2005). Air and bone conduction change after stapedotomy and partial stapedectomy for otosclerosis. *Otolaryngology-head and neck surgery*, *133*(1), 116-120.
12. Besbes, G., Akrout, A., Belcadhi, M., Chehoub, B., El Khedim, A., & Hachicha, S. (1994). L'otospongiose: données épidémiologiques, résultats du traitement. *Revue de laryngologie, d'otologie et de rhinologie (1919)*, *115*(1), 49-52.
13. Bourguignat, E., Roulleau, P., MARTIN, C., & ELBAZ, P. (1994). Otospongiose: étude de l'évolution de l'audition post-opératoire dans les cinq premières années et recherche de certains facteurs pronostiqués: à propos d'une série de 67 cas. Discussion. In *Annales d'oto-laryngologie et de chirurgie cervico-faciale* (Vol. 111, No. 1, pp. 13-21).
14. Mangham Jr, C. A. (1993). Reducing footplate complications in small fenestra microdrill stapedotomy. *Otology & Neurotology*, *14*(2), 118-121.
15. Herzog, J. A. (1991). 0.4 mm stapedotomy: a consistent technique for otosclerosis. *Otology & Neurotology*, *12*(1), 16-19.
16. Quaranta, N., Besozzi, G., Fallacara, R. A., & Quaranta, A. (2005). Air and bone conduction change after stapedotomy and partial stapedectomy for otosclerosis. *Otolaryngology-head and neck surgery*, *133*(1), 116-120.
17. Dubreuil, C., Bouchayer, M., Boulud, B., Di Brango, P., & Reiss, T. (1994). Otospongiose: platinectomie ou platinotomie. Etude comparative à long terme: a propos de 1279 cas. In *Annales d'oto-laryngologie et de chirurgie cervico-faciale* (Vol. 111, No. 5, pp. 249-264).
18. Bouzouita, J., Amari, F., Gassab, I., Sayadi, S.J., Gassab, A. (2001). Platinotomie versus pla- tinectomie dans le traitement de l'otospongiose : 94 interventions. *J Tun ORL, 7*, 21-4.
19. Beal, C., Poncet-Wallet, C., Frachet, B., & Ouayoun, M. (1992). A propos de l'effet carhart, étude de l'évolution post-opératoire de 47 otospongioses opérées. In *Annales d'oto-laryngologie et de chirurgie cervico-faciale* (Vol. 109, No. 2, pp. 76-79).
20. Moscillo, L., Imperiali, M., Carra, P., Catapano, F., & Motta, G. (2006). Bone conduction variation poststapedotomy. *American journal of otolaryngology*, *27*(5), 330-333.
21. Vincent, R., Sperling, N. M., Oates, J., & Jindal, M. (2006). Surgical findings and long-term hearing results in 3,050 stapedotomies for primary otosclerosis: a prospective study with the otology-neurotology database. *Otology & Neurotology*, *27*(8), S25-S47.
22. Millman, B., Giddings, N. A., & Cole, J. M. (1996). Long-term follow-up of stapedectomy in children and adolescents. *Otolaryngology–Head and Neck Surgery*, *115*(1), 78-81.
23. Romanet, P., Morizot, B., & Creuzot, J. (1990). L'otospongiose juvénile, réflexions à propos d'une statistique personnelle. *Revue de laryngologie, d'otologie et de rhinologie (1919)*, *111*(1), 19-22.
24. Salvinelli, F., Casale, M., Di Peco, V., Greco, F., & Trivelli, M. (2003). Stapedoplasty in patients with small air–bone gap: why not?. *Medical Hypotheses*, *60*(4), 535-537.
25. Simoncelli, C., Ricci, G., Trabalzini, F., Gullà, M., Faralli, M., & Molini, E. (2005). Stapes surgery: A review of 515 operations performed from 1988 to 2002. *Mediterr J Otol*, *1*, 1-6.
26. Arab, B., Besbes, G., & Hachicha, S. (2001, February). Otosclerosis in populations living in northern Tunisia:

epidemiology and etiology. In *Annales D'oto-laryngologie et de Chirurgie Cervico Faciale: Bulletin de la Societe D'oto-laryngologie des Hopitaux de Paris* (Vol. 118, No. 1, pp. 19-25).

27. Khalifa, A., El-Guindy, A., & Erfan, F. (1998). Stapedectomy for far-advanced otosclerosis. *The Journal of Laryngology & Otology*, *112*(2), 158-160.
28. Vartiainen, E. (1999). Sex differences in patients with hearing impairments caused by otosclerosis. *European archives of oto-rhino-laryngology*, *256*, 431-433.
29. Causse, J. B., Causse, J. R., Fontaine, J. P., Canut, Y., Resseguier, P., & Michat, M. (1990). Subcophoses et otospongioses: traitement médical et chirurgical. In *Annales d'oto-laryngologie et de chirurgie cervico-faciale* (Vol. 107, No. 6, pp. 411-417).
30. Satar, B., Şen, D., Karahatay, S., Birkent, H., & Yetişer, S. (2007). Effect of cochlear reserve on postoperative outcome in otosclerosis. *European archives of oto-rhino-laryngology*, *264*, 489-493.
31. Zaki, Z., Wiener, V., Corré, A., & Ayache, D. (2006). Far-advanced otosclerosis. *Revue de Laryngologie-Otologie-Rhinologie*, *127*(3), 127-130.
32. Bordure, P., Robier, A., & Malard, O. (2005). Chirurgie de la platine du stapes. *Chirurgie otologique et oto-neurologique. Paris: Masson*, 119-36.
33. Mani, R., Makhlouf, T., Kermani, W., Bellakhdhar, M., Harrabi, I., Zeglaoui, I., ... & Bouzouita, K. (2008). Resultats du traitement chirurgical de l'otospongiose notre experience a propos de 310 cas. *Journal Tunisien d'ORL et de Chirurgie Cervico-Faciale*, *21*.
34. Rondini-Gilli, E., Grayeli, A. B., Boutin, P., TORMIN BORGES CROSARA, P. F., Mosnier, I., & Bouccara, D. (2002). Otospongiose: techniques chirurgicales et résultats: à propos de 150 cas. In *Annales d'oto-laryngologie et de chirurgie cervico-faciale* (Vol. 119, No. 4, pp. 227-233).
35. Esquivel, C. R., Mamikoglu, B., & Wiet, R. J. (2002). Long-Term Results of Small Fenestra Stapedectomy Compared With Large Fenestra Technique. *The Laryngoscope*, *112*(8), 1338-1341.
36. Ayache, D., Sleiman, J., Tchuente, A. N., & Elbaz, P. (1999, April). Variations and incidents encountered during stapes surgery for otosclerosis. In *Annales D'oto-laryngologie et de Chirurgie Cervico Faciale: Bulletin de la Societe D'oto-laryngologie des Hopitaux de Paris* (Vol. 116, No. 1, pp. 8-14).
37. Ballester, M., Blaser, B., & Häusler, R. (2000). Stapedotomy and anatomical variations of the facial nerve. *Revue de Laryngologie-Otologie-Rhinologie*, *121*(3), 181-186.
38. Daniel, R., Krieger, L., & Lippy, W. (2001). The other ear: Findings and results in 1,800 bilateral stapedotomies. *Otol Neurotol*, *22*(5), 603-7.
39. Couvreur, P. H., Baltazart, B., Lacher, G., FILIPPINI, J., & Vincey, P. (2003). Geyser lors de la chirurgie de l'otospongiose. *Revue de laryngologie, d'otologie et de rhinologie (1919)*, *124*(1), 31-37.
40. Mani, R., Makhlouf, T., Kermani, W., Bellakhdhar, M., Harrabi, I., Zeglaoui, I., ... & Bouzouita, K. (2008). Resultats du traitement chirurgical de l'otospongiose notre experience a propos de 310 cas. *Journal Tunisien d'ORL et de Chirurgie Cervico-Faciale*, *21*.
41. Salmon, C., Barriat, S., & Lefebvre, P. P. (2018). Stapes surgery for otosclerosis in patients presenting with mixed hearing loss. *Audiology and Neurotology*, *23*(2), 82-88.
42. García-Iza, L., Navarro, J. J., Goiburu, M., Pérez, N., & Altuna, X. (2016). Study of the improvement in bone conduction threshold after stapedectomy. *Acta Otorrinolaringologica (English Edition)*, *67*(5), 268-274.
43. Alberti, A., Figuerola, E., Romero-Farina, G., Quer, M., & Larrosa, F. (2018). Long-term hearing outcomes following stapedotomy in patients with otosclerosis and preoperative small air-bone gap. *Audiology and Neurotology*, *22*(6), 350-355.
44. Somers, T., Marquet, T., Govaerts, P., & Offeciers, E. (1994). Statistical analysis of otosclerosis surgery performed by Jean Marquet. *Annals of Otology, Rhinology & Laryngology*, *103*(12), 945-951.
45. Sedwick, J. D., Louden, C. L., & Shelton, C. (1997). Stapedectomy vs stapedotomy: Do you really need a laser?. *Archives of Otolaryngology–Head & Neck Surgery*, *123*(2), 177-180.
46. Singhal, S. K., Datta, U., Panda, N. K., & Gupta, A. K. (1999). Genetic correlation in otosclerosis. *American journal of otolaryngology*, *20*(2), 102-105.
47. Lescanne, E., Robier, A., Soin, C., Manceau, A., Benlyazid, A., & Beutter, P. (1999). Chirurgie de l'otospongiose: A propos de 227 cas introduction de la platinotomie laser CO2. In *Annales d'oto-laryngologie et de chirurgie cervico-faciale* (Vol. 116, No. 1, pp. 28-36).
48. Ch, M., Messary, A., Bertholon, P., & Prades, J. M. (2003). Failure of regain full function after surgery for otosclerosis: causes, diagnosis and treatment. *Revue de Laryngologie-Otologie-Rhinologie*, *124*(1), 23-29.
49. Quaranta, N., Besozzi, G., Fallacara, R. A., & Quaranta, A. (2005). Air and bone conduction change after stapedotomy and partial stapedectomy for otosclerosis. *Otolaryngology-head and neck surgery*, *133*(1), 116-120.
50. Derlacki, E. L. (1985). Revision stapes surgery: problems with some solutions. *The Laryngoscope*, *95*(9), 1047-1053.