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Grafting Versus No Grafting in Canal Wall Down Mastoidectomy, Data-Based Study

Ammar Saied Abdelkarim Megahed[1], Wael Aly Al-Zamil[2], Raed Mohamed Abdellatife[3], Wael Shehata Mohamed[4]

[1]M.B.B.CH
[2]Professor of Otorhinolaryngology, Faculty of Medicine, October 6 University, Hearing and Speech Institute hospital
[3]Lecturer of Otorhinolaryngology, Faculty of Medicine, October 6 University
[4]Assistant Professor and Head of the Department of Otorhinolaryngology, Faculty of Medicine, October 6 University

ABSTRACT: **Background**: Canal wall down (CWD) mastoidectomy is a well-established surgical approach for cholesteatoma eradication; however, it frequently creates problematic open mastoid cavities requiring prolonged postoperative care and limiting patients' quality of life. The clinical benefit of adjunctive grafting remains controversial.

Aim: To compare the value of adding grafting to canal wall-down mastoidectomy and evaluate the associated operative and postoperative results, involving operative time, operative complications, and postoperative complications.

Patients and Methods: This retrospective, data-based comparative research comprised 100 adult patients who underwent CWD mastoidectomy for acquired cholesteatoma between 2019 and 2025 at two Egyptian tertiary centers. Cases have been separated into grafting (number=50) and non-grafting (number=50) groups. Operative time, intraoperative complications, cavity healing, and patient satisfaction were assessed and compared.

Results: The grafting group demonstrated significantly superior early outcomes, including dry ear at 1 month (74% vs. 0%) and 3 months (100% vs. 10%), complete epithelialization (100% vs. 0%), and dry healthy cavity at follow-up (84% vs. 0%) (all $P<0.001$). Cases satisfaction scores at six months were significantly higher with grafting (4.76 ± 0.59 vs. 3.32 ± 0.70, $P<0.001$). The non-grafting group had significantly shorter operative time (109.38 ± 20.53 vs. 130.78 ± 17.47 minutes, $P<0.001$). Non-significant variances have been found in hemorrhage during the operation or facial nerve exposure.

Conclusion: Grafting during CWD mastoidectomy provides significantly superior cavity healing, fewer postoperative complications, and higher patient satisfaction despite longer operative time, supporting its role as a valuable surgical adjunct.

INTRODUCTION

The middle ear cleft is influenced by the chronic inflammatory condition referred to as chronic otitis media (COM), that frequently last for over 3 months (1). Management of chronic otitis media and cholesteatoma involves clearance of illness and reproducing a sufficient ventilation pathway to avert the recurrence of tympanic membrane (TM) retraction or the development of cholesteatoma (2). Cholesteatoma is a condition in which there is a long-term inflammation of the middle ear cleft, and it is characterized by an unusual growth of a squamous epithelium that produces keratin (3). Operations for cholesteatoma are typically classified as CWD or canal wall up (CWU) procedures (4).

CWD is considered to be more effective in eliminating the cholesteatoma because it provides a wider view of the mastoid and middle ear structures. However, it may not result in a self-cleaning cavity and the patient must avoid water contact, which can limit their social activities (5). Drilling and smoothening the mastoid cavity and exenteration of all cells will enhance and accelerate this process of epithelialization. In patients with classic radical mastoidectomy who have no grafts, the squamous epithelium will reach the middle ear and may behave in two different ways (6). Many modifications were advocated to restore the posterior canal wall with bone grafts, cartilage, implants like titanium plate, obliteration methods or recently, applying the endoscope, either as an assistant instrument to the microscope or exclusively to eradicate cholesteatoma (7). Most alloplastic implant materials, like plastic mesh, proplast, and porous polypropylene, weren't successful long-term because of difficulties in the face of infection (8).

Although the initial enthusiasm for Proplast, it was subsequently revealed that the material induced a lasting giant cell reaction. Antibiotics were ineffective in clearing the infection when the organisms became harbored in the pores (9). Our research aimed to compare the value of adding grafting to canal wall-down mastoidectomy and evaluate the associated operative and postoperative results, comprising operative time, operative complications, and postoperative complications.

PATIENTS AND METHODS

This was a data-based, comparative, observational research designed to evaluate the role of grafting in CWD mastoidectomy for acquired cholesteatoma. The study compared two surgical approaches: CWD mastoidectomy with grafting versus CWD mastoidectomy without grafting. All data were extracted from existing hospital medical records; no new patients were recruited, and no prospective interventions were performed. This study was approved from the ethical committee (approval code O6U-ERC-001011) and registration number (SCCREIRB-MEDICIN6OCT-PU-001-121224-018). This data of patients who had done radical mastoidectomy with and without grafting from 2019 till 2025 was collected from: Data based records otorhinolaryngology department of October 6 University hospital, Cairo, Egypt. Data based records otorhinolaryngology department of Hearing and Speech Institute hospital, Cairo, Egypt.

Inclusion criteria: Adult patients, both sex groups and cases had acquired cholesteatoma.
Exclusion criteria: Complicated cholesteatoma e.g. (intracranial, cranial, as well as extracranial complications) or extensive destruction of posterior canal wall and mastoid cortex, cases operated prior to earlier CWD procedure and history of head trauma
Data Collection and Clinical Assessment A standardized data-extraction sheet was utilized to minimize bias. Data collected included:
Preoperative variables: Demographics, clinical history (duration of otorrhea, hearing loss), otomicroscopic/otoendoscopic findings, pure-tone audiometry (PTA) thresholds, and high-resolution computed tomography (HRCT) of the temporal bone.
Intraoperative variables: Operative time, intraoperative bleeding, and facial nerve exposure.
Postoperative variables: Patients were routinely followed up at 1 and 2 weeks, and 1, 3, 6, and 12 months postoperatively.
Surgical Techniques

Group A: Canal Wall Down Mastoidectomy Without Grafting (Non-Grafting Group)

This group comprised patients who underwent standard radical or modified radical mastoidectomy with the creation of an open mastoid cavity, without the application of any grafting material to the mastoid bowl or middle ear cleft. The surgical technique in this group consisted of: Complete removal of the posterior bony canal wall to the level of the facial nerve. Exenteration of all accessible mastoid air cells. Saucerization and smoothening of the mastoid cavity edges. Adequate widening of the external auditory meatus (meatoplasty). No placement of fascia, cartilage, perichondrium, periosteum, or any alloplastic material to line or obliterate the mastoid cavity. No reconstruction of the posterior canal wall. Healing of the mastoid cavity was allowed to occur by secondary intention, with epithelial migration proceeding centripetally from the margins of the enlarged meatus

Group B: Canal Wall Down Mastoidectomy With Grafting (Grafting Group)

This group included patients who underwent CWD mastoidectomy with the adjunctive use of grafting material applied to the exposed bone of the mastoid cavity. The grafting technique documented in the operative records could include one or more of the following:

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Temporalis fascia grafting: Placement of autologous temporalis fascia over the denuded bone of the mastoid bowl and/or the exposed middle ear mucosa. **Cartilage grafting:** Application of autologous tragal or conchal cartilage for: Partial reconstruction of the posterior canal wall defect. Obliteration of the mastoid tip or selected areas of the mastoid cavity. Coverage of the exposed facial nerve or lateral semicircular canal. **Perichondrial grafting:** Use of tragal or conchal perichondrium to line the mastoid cavity and promote epithelialization. **Periosteal flaps:** Rotation of local vascularized periosteal flaps (e.g., Palva flap) into the mastoid cavity. **Bone pâté or bone dust:** Application of autologous bone dust collected during drilling, with or without fibrin glue sealant. **Combined grafting techniques:** Any combination of the above-mentioned grafting materials

Outcome Measures

Primary outcomes: Achievement of a dry, self-cleaning, and well-epithelialized mastoid cavity at 1, 3, 6, and 12 months; incidence of persistent postoperative otorrhea or granulation tissue; and recurrence or residual cholesteatoma. **Secondary outcomes:** Operative time, intraoperative and postoperative complications, need for revision surgery or regular cavity suctioning, water intolerance, and patient satisfaction scores at 3 and 6 months.

Ethical Considerations

All the data of this study was approved by the otolaryngology department. Approval from research Ethics Committee, Faculty of Medicine October 6th University was taken (approval date: 27/10/2025). Because this was a retrospective record review, a waiver of informed consent has been granted by the ethics committee. All data were handled in strict compliance with the Declaration of Helsinki. Patient confidentiality was maintained by anonymizing data; identifiable private information was not used outside the study and was stored securely by the principal investigator. All data will not be used outside this study without otolaryngology department approval.

Statistical analysis:

The analysis of the information was conducted utilizing the Statistical Package for Social Sciences (SPSS) software. Qualitative information has been represented using percentages and numbers. Quantitative information has been presented as means [± standard deviation (SD)] for parametric parameters or medians (interquartile range; IQR) for non-parametric variables, as appropriate. The Shapiro-Wilk test was utilized to evaluate the normality of variable distribution. To compare groups, a t-test has been utilized for those with normal distribution, nevertheless the Mann-Whitney test has been applied for those lacking normal distribution. A Chi-square test has been conducted to compare qualitative parameters. The significance level has been established at 5% ($P \leq 0.05$).

RESULTS

Table (1): Comparison of baseline demographic and clinical characteristics between the two study groups.

	Group A Number=50	**Group B Number =50**	**Test**	**P value**
Age (years) Mean ±SD	47.52±10.05	48.78±8.73	t = 0.6693	0.5
Sex				
Male	28(56%)	31(62%)	X^2=0.372	0.5
Female	22(44%)	19(38%)		
Disease duration (years) Mean ±SD	4.24±2.02 4(1-9)	4.6±1.94 4(1-9)	U=1125	0.4
Right ear affected	26(52%)	40(80%)	X^2=8.734	0.003
Otorrhea	50(100%)	50(100%)	X^2=0	1
Hearing loss	45(90%)	50(100%)	X^2=5.263	0.02
Cholesteatoma extension to mastoid	50(100%)	50(100%)	X^2=0	1

P value >0.05: Not significant, P value <0.05 is statistically significant, p<0.001 is highly significant independent t test, x2chisquare.u mannwatney.

A statistically insignificant variances has been found among Group A and Group B as regards age, sex distribution, disease duration, otorrhea, or cholesteatoma extension to the mastoid (all P > 0.05), indicating that the 2 groups were generally comparable at baseline. However, right ear involvement was significantly more frequent in Group B compared to in Group A (80% vs. 52%, P = 0.003). In addition, hearing loss was present in all cases in Group B in comparison with 90% of cases in Group A, representing a statistically significant variance (P = 0.02). (Table 1)

Table (2): Comparison of intraoperative findings between the two study groups.

	Group A Number =50	Group B Number =50	Test	P value
Operative time (min) Mean ±SD	130.78±17.47	109.38±20.53	t = 5.6134	<0.001
Intraoperative bleeding	5(10%)	1(2%)	X^2= 2.837	0.09
Facial nerve exposure	3(6%)	2(4%)	X^2= 0.211	0.6

The mean operative time was significantly shorter in Group B in comparison with in Group A (109.38 ± 20.53 vs. 130.78 ± 17.47 minutes, P < 0.001). Although intraoperative bleeding was more common in Group A (10%) than in Group B (2%), the variance didn't reach statistical significance (P = 0.09). Similarly, there was a statistically insignificant variance between the 2 groups regarding facial nerve exposure (6% vs. 4%, P = 0.60). (Table 2)

Table (3): Comparison of early postoperative outcomes between the two study groups.

	Group A Number =50	Group B Number =50	Test	P value
Dry ear at 1 month	37(74%)	0(0%)	X^2= 58.73	<0.001
Dry ear at 3 months	50(100%)	5(10%)	X^2= 81.818	<0.001
Good cavity healing with epithelial lining	37(74%)	5(10%)	X^2= 42.036	<0.001
Incomplete healing	13(26%)	45(90%)	X^2=42.036	<0.001
Granulations / mucosal edema	13(26%)	45(90%)	X^2=42.036	<0.001
Well epithelialized graft vs Partial epithelialization	50(100%)	0(0%)	X^2=100	<0.001

Early postoperative outcomes were significantly better in Group A than in Group B. A dry ear at 1 month was achieved in 74% of patients in Group A compared to none of the cases in Group B (P under 0.001). At 3 months, all patients in Group A had a dry ear, whereas only 10% of patients in Group B achieved this outcome (P < 0.001). Good cavity healing with epithelial lining was significantly more frequent in Group A (74% vs. 10%, P < 0.001). Conversely, incomplete healing and granulations/mucosal edema were significantly more common in Group B in comparison with in Group A (90% vs. 26%, P below 0.001 for both). Furthermore, complete graft epithelialization was achieved in all patients in Group A, while none of the cases in Group B demonstrated complete epithelialization (P under 0.001). (Table 3)

Table (4): Comparison of late postoperative results and patient satisfaction among the 2 study groups.

	Group A Number =50	Group B Number =50	Test	P value
Dry healthy cavity (uneventful follow-up)	42(84%)	0(0%)	X^2=72.414	<0.001
Intermittent mild discharge	8(16%)	5(10%)	X^2=0.796	0.4
Persistent ear discharge	0(0%)	45(90%)	X^2=81.818	<0.001
Need for regular suction / cleaning	8(16%)	50(100%)	X^2=72.414	<0.001
Accumulation of wax/debris/keratin	8(16%)	50(100%)	X^2=72.414	<0.001
Return to normal life	50(100%)	38(76%)	X^2=13.636	0.0002
Water intolerance	8(16%)	45(90%)	X^2=54.958	<0.001
Satisfaction score (3 months)	4.3±0.65	2.82±0.77	t = 10.39	<0.001
Satisfaction score (6 months)	4.76±0.59	3.32±0.7	t = 11.12	<0.001

Late postoperative outcomes were significantly more favorable in Group A in comparison with in Group B. A dry, healthy cavity during follow-up was observed in 84% of cases in Group A, whereas none of the cases in Group B achieved this outcome

(P < 0.001). Persistent ear discharge was significantly more common in Group B (90% vs. 0%, P < 0.001). Likewise, the need for regular suction/cleaning, accumulation of wax, debris or keratin, and water intolerance were all significantly higher in Group B than in Group A (all P < 0.001). There was no statistically significant variance among the groups regarding intermittent mild ear discharge (16% vs. 10%, P = 0.40). Additionally, all patients in Group A returned to normal daily life compared with 76% of patients in Group B (P = 0.0002). Patient satisfaction scores at both 3 and 6 months were significantly higher in Group A than in Group B (4.30 ± 0.65 vs. 2.82 ± 0.77 and 4.76 ± 0.59 vs. 3.32 ± 0.70, respectively; both P < 0.001). (Table 4)

DISCUSSION

The current research illustrated that Group A and Group B were comparable regarding age, sex, disease duration, otorrhea, and mastoid extension of cholesteatoma (P > 0.05). However, right ear involvement and hearing loss were significantly more frequent in Group B in comparison with in Group A (80% vs. 52%, P = 0.003 and 100% vs. 90%, P = 0.02, respectively).

In agreement with Yusof et al.,(10), their study included 57 cases had cholesteatoma who had modified radical mastoidectomy, with a mean age of 40 years and a slight male predominance. Ear discharge was the most common presenting symptom (73.7%), followed by hearing loss (31.6%). The authors also reported frequent involvement of the mastoid air cells and antrum. These findings are partially consistent with the present study, which also showed a slight male predominance and universal mastoid involvement; however, otorrhea and hearing loss were more frequent in our patients, while right-ear involvement was significantly higher in Group B.

In supporting with Dhawan & Kumar,(11), their study compared cases having canal wall-down mastoidectomy with an open mastoid cavity versus mastoid cavity obliteration. The authors investigated postoperative cavity status and quality of life and found that mastoid obliteration was associated with better cavity healing and reduced postoperative cavity-related problems compared with the open cavity technique. The study population and surgical approach are consistent with the present study, which similarly compares CWD mastoidectomy with and without grafting.

The current study reported that operative time was significantly shorter in Group B compared to in Group A (109.38 ± 20.53 vs. 130.78 ± 17.47 minutes, P < 0.001), while no significant differences were found in intraoperative bleeding or facial nerve exposure (P = 0.09 and P = 0.60, respectively).

In agreement with Dhawan & Kumar,(11), who performed a prospective comparative research of 30 cases having modified radical mastoidectomy, with 15 patients undergoing mastoid obliteration and 15 undergoing surgery without obliteration. Their study demonstrated that mastoid obliteration was a safe technique and was associated with better postoperative cavity healing and fewer cavity-related problems. Although their study did not specifically report a significant difference in intraoperative bleeding or facial nerve exposure, their findings support the use of obliteration as an additional reconstructive step during CWD mastoidectomy. In the present study, grafting was related to a significantly longer operative time, while no significant variances have been found in intraoperative bleeding or facial nerve exposure.

In supporting with Hashmi et al.,(12), who evaluated 26 patients undergoing CWD mastoidectomy with primary mastoid obliteration using hydroxyapatite bone cement, the present study found that grafting/obliteration can be performed without a significant increase in major intraoperative complications. Hashmi et al. reported only minor postoperative complications, comprising external auditory canal granulation and post-aural wound dehiscence, with only one patient requiring complete explantation. They also described the technique as time-efficient. These findings are consistent with the present study, in which intraoperative bleeding and facial nerve exposure didn't vary significantly among the 2 groups.

In contrast to the present study, Fieux et al.,(13) compared two different filling materials, bone allograft and 45S5 bioactive glass, rather than grafting versus no grafting in CWD mastoidectomy. Their findings demonstrated differences in postoperative outcomes between the two materials, with recurrent otorrhea and revision surgery being more frequent in the bone-allograft group. Therefore, their results support the importance of graft selection in CWD reconstruction, although direct comparison with the present operative-time findings is limited by the different study design.

Our study revealed that Group A had significantly better early postoperative outcomes than Group B, with higher rates of dry ear, good cavity healing, and complete graft epithelialization, whereas incomplete healing and granulations/mucosal edema were significantly more common in Group B (all P < 0.001).

In supporting with Dhawan & Kumar,(11), the present study demonstrated significantly better early cavity healing following grafting during canal wall-down mastoidectomy. Maheshwari et al. compared open mastoid cavities with mastoid obliteration and reported better epithelialization and fewer cavity-related problems in the obliterated group. Similarly, in the present study, a dry ear and good cavity healing with epithelial lining were significantly more frequent in Group A, while incomplete healing was significantly more common in Group B. These findings support the beneficial role of mastoid obliteration in promoting early cavity healing.

In agreement with, Nikam et al.,(14), mastoid obliteration following CWD mastoidectomy was associated with satisfactory cavity epithelialization and a higher likelihood of achieving a dry and safe ear. The study also demonstrated that the type of obliteration material could influence cavity healing, with favorable epithelialization reported with autologous materials. These findings are consistent with the present study, in which grafting resulted in significantly better epithelialization and cavity healing, with complete graft epithelialization in all cases in Group A compared to none in Group B.

Similarly, the current research demonstrated a significantly higher rate of dry ears and better cavity healing in the grafted group. These findings suggest that adding an obliteration or grafting procedure to CWD mastoidectomy may facilitate cavity healing and reduce persistent cavity problems.

Supporting with, Liu et al.,(15), the recent study evaluating concentrated growth factors with hydroxyapatite for mastoid obliteration (2025), the present study demonstrated that grafting can enhance postoperative epithelialization following CWD mastoidectomy. The study evaluated complete epithelialization as the absence of granulation tissue, discharge, and swelling and found improved epithelialization with the addition of concentrated growth factors. Similarly, the present study showed complete graft epithelialization in all patients in Group A, whereas granulations/mucosal edema and incomplete healing were significantly more frequent in Group B.

Our results demonstrated that Group A had significantly more favorable late postoperative outcomes than Group B, with better cavity status, fewer postoperative complications, greater return to normal daily activities, and higher patient satisfaction (all $P < 0.001$), while intermittent mild ear discharge showed no significant difference ($P = 0.40$).

In supporting with, Kara et al., (16), mastoid obliteration was found to improve postoperative cavity hygiene and patient-related outcomes following CWD mastoidectomy. Their findings emphasized that obliteration can reduce cavity-related problems and postoperative care requirements, contributing to better quality of life.

Similarly, Salem et al., (16) their systematic review and meta-analysis illustrated favorable results following mastoid obliteration compared with non-obliterated CWD cavities. The authors particularly highlighted the reduction in persistent postoperative otorrhea and the overall improvement in cavity-related outcomes following obliteration.

In consistence with Pontillo et al., (17)mastoid obliteration has been related to satisfactory long-term quality-of-life outcomes after CWD mastoidectomy. Their study emphasized the importance of controlling chronic cavity problems and reducing the burden of postoperative care in improving patients' quality of life.

In agreement with Weiss et al.,(18), mastoid cavity obliteration lead to significant enhancement in disease-specific health-related quality of life. The authors attributed this improvement to better control of cavity-related symptoms and reduced requirements for repeated postoperative care, supporting the role of obliteration in improving long-term patient outcomes.

CONCLUSION

Grafting in canal wall-down mastoidectomy provides significantly better postoperative outcomes than the non-grafting technique. Although the no-grafting technique was associated with a shorter operative time, grafting resulted in faster and better cavity healing, a higher rate of dry ear, fewer postoperative complications, greater return to normal daily activities, and higher patient satisfaction. Therefore, grafting appears to be a valuable adjunct to canal wall-down mastoidectomy in cases had acquired cholesteatoma.

LIMITATIONS

The research has been performed at two centers, that can limit the applicability of the results to other settings. The monitoring duration was relatively limited for assessing long-term results and possible late recurrence of cholesteatoma. Differences in surgical technique and individual healing responses may have influenced postoperative outcomes.

REFERENCES

[1] da Costa SS, Paparella MM. Pathogenesis of chronic otitis media and the continuum: the basics, further and beyond. In: Textbook of otitis media: the basics and beyond. Springer; 2023. p. 337–62.
[2] Mansour S, Magnan J, Nicolas K, Haidar H. Cholesteatoma. In: Middle Ear Diseases: Advances in Diagnosis and Management. Springer; 2018. p. 311–81.
[3] Elbialy AS, Mahrous AK, Ismaiel WF. The outcome of canal wall up versus canal wall down mastoidectomy in cholesteatoma. Int J Med Arts. 2023;5(8):3561–71.
[4] Kuo CL, Liao WH, Shiao AS. A review of current progress in acquired cholesteatoma management. Eur Arch oto-rhino-laryngology. 2015;272(12):3601–9.
[5] Swain SK. Current practices of canal wall up versus canal wall down mastoidectomy: a review. Int J Res Med Sci. 2024;12(8):3117.
[6] Mohamed EF, Abdulghany AF, ALZAMIL WA. The Role of Grafting in Canal Wall down Mastoidectomy. Zagazig Univ Med J. 2024;30(3):698.
[7] Shewel Y, Abougabal A. Retrograde mastoidectomy with canal wall reconstruction with bone graft in acquired cholesteatoma. Egypt J Otolaryngol. 2020;36(1):11.
[8] Roland PS, Leach JL. POSTERIOR EAR CANAL. Middle ear mastoid Surg. 2004;81.
[9] Ramadan AS, El Senbawy AH, Askar SM, El Sayed MSAEA. Reconstruction of Posterior Meatal Wall After Canal Wall Down Mastoidectomy: Cartilage versus Bone Graft. Egypt J Hosp Med. 2022;88(1):2357–64.
[10] Yusof ANM, Boon WJ, Ali A, Tang IP. Outcomes of canal wall down mastoidectomy in cholesteatoma: a 5-year experience. Egypt J Otolaryngol. 2023;39(1):50.
[11] Dhawan R, Kumar S. Comparing the quality of life and surgical out come in open mastoid cavity and mastoid cavity obliteration in canal wall down mastoidectomy. 2025;
[12] Hashmi S, Hussain SZM, Matto O, Dewhurst S, Qayyum A. To evaluate the results of mastoid obliteration and reconstruction of posterior meatal wall after canal wall down mastoidectomy using ready-to-use, self-setting hydroxyapatite bone cement. J Laryngol Otol. 2025;139(6):458–63.
[13] Fieux M, Tournegros R, Hermann R, Tringali S. Allograft bone vs. bioactive glass in rehabilitation of canal wall-down surgery. Sci Rep. 2023;13(1):17945.
[14] Nikam S, Vedi J, Chandankhede V, Ekhar V, Shelkar R. Comparative study of various techniques of mastoid obliteration following canal wall down mastoidectomy. Indian J Otolaryngol Head Neck Surg. 2023;75(4):3457–60.
[15] Liu M, Zhang L, Zhang Q, Zeng N, Li S, Guo S, et al. Concentrated growth factors promote epithelization in the mastoid obliteration after canal wall down mastoidectomy. Braz J Otorhinolaryngol. 2025; 91:101561.
[16] Kara H, Sen C, Sonmez S, Celik M, Polat B. The effect of bony obliteration on quality of life after tympano-mastoidectomy surgery: A prospective observational controlled cohort study. Laryngoscope Investig Otolaryngol. 2023;8(4):1052–60.
[17] Pontillo V, Ciprelli S, Grillo R, Quaranta N. Quality of life after revision mastoidectomy with mastoid obliteration. Acta Otorrinolaringol (English Ed. 2023;74(6):352–8.
[18] Weiss NM, Bächinger D, Botzen J, Großmann W, Mlynski R. Mastoid cavity obliteration leads to a clinically significant improvement in health-related quality of life. Eur Arch Oto-Rhino-Laryngology. 2020;277(6):1637–43.