International Journal of Research in Medical Sciences
Santosh SK. Int J Res Med Sci. 2024 Aug;12(8):3117-3123
www.msjonline.org
pISSN 2320-6071 | eISSN 2320-6012

DOI: https://dx.doi.org/10.18203/2320-6012.ijrms20242254

Review Article

Current practices of canal wall up versus canal wall down mastoidectomy: a review

Santosh K. Swain*

Department of Otorhinolaryngology and Head and Neck Surgery, All India Institute of Medical Sciences, Sijua, Patrapada, Bhubaneswar, Odisha, India

Received: 06 July 2024
Revised: 12 July 2024
Accepted: 15 July 2024

***Correspondence:**
Dr. Santosh K. Swain,
E-mail: santoshvoltaire@yahoo.co.in

ABSTRACT

To achieve a disease-free and dry ear is the goal of mastoidectomy in chronic otitis media (COM) with or without cholesteatoma. The operating surgeon, the patient, and the disease process all have a role in the surgical procedure selection. In the case of cholesteatoma with COM, the surgeon has significant hurdles in the prevention of recurrent disease and the maintenance of hearing. Canal wall up (CWU) and canal wall down (CWD) are the surgical methods used for treatment of the COM with cholesteatoma. The importance of surgical method outcomes has been highlighted in recent surgical works, not only in terms of technical success but also in connection to the impact of therapy on patients' quality of life and welfare. The surgical procedures of CWP and CWD usually alter the middle ear structures which affect the transmission of sound from the tympanic membrane to the cochlea. The kind of disease, the depth of the pathology, and the patient's overall condition all have a role in the decision to use a surgical technique like CWU or CWD in COM. Due to improved audiometric results and simpler postoperative care, the CWU approach is frequently preferred despite having a greater probability of revision surgery. CWD surgical techniques usually lower the residual/recurrent rates of cholesteatoma. With regard to the surgical management of COM with cholesteatoma, this review article compares the effectiveness and current procedures of CWU mastoidectomy and CWD mastoidectomy.

Keywords: Cholesteatoma, Canal wall up, Canal wall down, Hearing, Tympanomastoid surgery

INTRODUCTION

The middle ear cleft is affected by the chronic inflammatory condition known as chronic otitis media (COM), which often lasts longer than three months.[1] There has been discussion on the surgical therapy of COM both with and without cholesteatoma for many years.[2] It is generally agreed upon that COM with cholesteatoma nearly always requires surgical intervention.[3] The goal of COM surgery is to clean up the middle ear cleft of disease and create a dry, healthy ear. The mastoid operations for COM fall into two categories: canal wall down (CWD) and canal wall up (CWU) mastoidectomies. In CWD, the external auditory canal's posterior wall is removed, creating a shared cavity from the mastoid and ear canal, whereas in CWU, the ear canal's posterior wall is left intact. The surgical modifications of the middle ear, mastoid, and external auditory canal in CWU and CWD mastoidectomies can alter the transmission of sound from the tympanic membrane to the cochlea. However, it can be challenging to distinguish between the symptoms of coexisting middle ear disease and the acoustic impact following surgical alterations in a typical clinical context. The debate for these two techniques is in debate still in current years.[4] There are advantages and disadvantages associated with these techniques. This review article focuses on current practices of CWU versus CWD mastoidectomy.

METHODS

We used many methods to look for research publications comparing canal wall up to canal wall down mastoidectomy. We began by doing an online search of the Scopus, Pub Med, Medline, and Google Scholar databases. PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analysis) criteria were used to design a search strategy. While other research publications were manually found from the citations, our search method identified the abstracts of published works. The eligibility of randomized controlled trials, observational studies, comparative studies, case series, and case reports was assessed. There were a total number of articles 68 (22 case reports; 12 cases series; 34 original articles) (Figure1). The specifics of canal wall up versus canal wall down mastoidectomy are discussed in this article. In the area of canal wall-up versus canal wall-down mastoidectomy, for which there are relatively few studies, this review paper provides a baseline from which future perspective trials might be built.

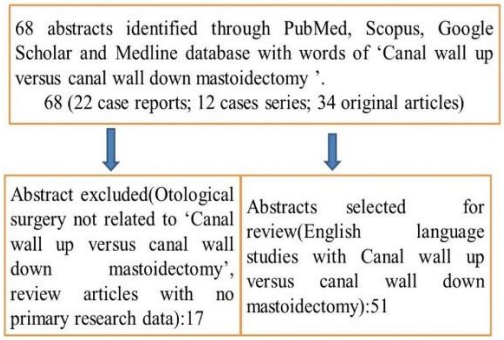

Figure 1: Methods of literature search.

From simple surgery like trephination to the canal wall-preserving mastoidectomy, mastoid surgery has evolved. The most effective surgical procedures for COM with cholesteatoma as intact canal wall or canal wall up mastoidectomy devised in the decade following the widespread adoption of the operating microscope in 1953 have been the subject of continuous discussion.[5] House introduced the CWU mastoidectomy in 1958. He also pioneered the use of retractors and the suction irrigation technique in mastoid surgery. The combined approach of mastoidectomy with posterior tympanotomy was the CWU surgical procedure as it was initially described by Jansen and Sheehy. Later, it was referred to as a mastoidectomy with a canal wall-up (CWU).[6] This technique was very popular as it ensured the clearance of pathology from the middle ear space and mastoid along with ossiculoplasty and preservation of shape and size of the external auditory canal with avoidance of cavity problems.

EPIDEMIOLOGY

A prevalent clinical entity, COM affects 0.5% to 30% of all populations globally, with poorer nations accounting for the majority of cases.[7] The prevalence of COM is mostly influenced by the patient's age, poor socioeconomic level, congestion, and the availability of medical services. Today, COM and its complications show a globally diversified disease with heterogenous epidemiology, governed by the socio-economic condition of a country. 8 COM is significantly less prevalent in non-indigenous populations, particularly in more economically developed countries in relation to less economically developed countries.[9] The prevalence of COM varies from 2% to 4% in low prevalence populations to 43% in high prevalence populations.[10] Mastoidectomy is a procedure used in COM to treat cholesteatoma of the middle ear or mastoid in cases of suppurative otitis media. In COM, CWU mastoidectomy is usually designed to maintain normal anatomical contours of the ear canal. CWD mastoidectomy is a widely used surgical technique for COM with cholesteatoma.[11]

COM AND MASTOIDECTOMY

Surgery is used to treat COM with cholesteatoma due to the condition's progressive nature, possibility for functional loss, and side effects.[12] Surgery for COM with cholesteatoma seeks to cure the condition and achieve acceptable hearing.[13] The surgical procedures used to treat COM with cholesteatoma are CWD and CWU. Both WU and CWD mastoidectomy have different indications, advantages, and disadvantages. The external ear canal is mostly what sets apart these two surgical procedures. The middle ear and mastoid are simpler to approach since the ear canal has been greatly widened.[14] In the CWD surgical approach, a self-cleaning cavity is not frequently achieved, and the patient is typically advised to avoid contact with water, which has a negative societal impact. The CWU surgical approach often avoids these issues since the anatomy is retained. There is still residual disease present, and CWU methods may result in more recurrences than CWD methods.[15] In addition to this, hearing outcome with CWU is considered to be better than CWD.[16] The necessity of routine cavity maintenance is a key drawback of CWD mastoidectomy, whereas CWU mastoidectomy has access issues and requires revision surgery.[17]

CANAL WALL DOWN (CWD) MASTOIDECTOMY

As it enables a wide-angle assessment of the middle ear and mastoid cavity, CWD is regarded as a very efficient method for eliminating cholesteatoma. A shared cavity including the mastoid and ear canal is created after a CWD mastoidectomy after the posterior canal wall has been removed. The ear canal is much broader, which makes it simpler to access the mastoid and middle ear.[18] When it comes to seeing the middle ear subsites, especially the sinus tympani, posterior crura of stapes, and lateral epitympanum, the CWD approach is noticeably superior to the CWU technique.[19] CWD mastoidectomy alters the architecture of the ear canal. So,

hearing may be reduced to some degree because of these changes in architecture. In CWD mastoidectomy, the middle ear space is reduced significantly because of the connection between the mastoid cavity and middle ear, and communication is made between the mastoid cavity and the external auditory canal. The mastoid cavity made in the CWD technique usually fills with ear wax which frequently requires cleaning of the ear canal, protection from water, and possible alteration of the hearing. One study showed that the development of complications such as conductive hearing loss, persistent ear discharge, and developing fistula are found in the CWD technique in comparison to CWU mastoidectomy.[20] High facial ridge, stenotic ear meatus, bony overhanging that prevents the cavity from self-cleaning and thus promotes the disease process, failure to isolate the cavity of the mastoid from the eustachian tube orifice and middle ear, and poor execution of the surgical procedure are the major factors contributing to the failure of CWD surgery.[21]

CANAL WALL-UP (CWU) MASTOIDECTOMY

In CWU, the objective is to maintain the tympanic membrane in its normal position as well as the external canal wall and middle ear volume. The term "complete mastoid operation" refers to a mastoidectomy that involves the removal of the whole temporal bone lateral to the otic capsule, together with the canal wall. Tympanoplasty and ossicular chain reconstruction are typically done in conjunction with it. To get around some of the CWD mastoidectomy's drawbacks, the CWU mastoidectomy (Figure 2) was created. The CWU mastoidectomy was developed to overcome some of the CWD mastoidectomy's limitations, which included greater recurrence rates.[22] In the postoperative phase following CWU surgery, direct otoscopic inspection of the cavity is typically not possible. This is a significant disadvantage for monitoring the recurrence of cholesteatoma. Consequently, a second opinion operation for any lingering illness may be necessary.[23]

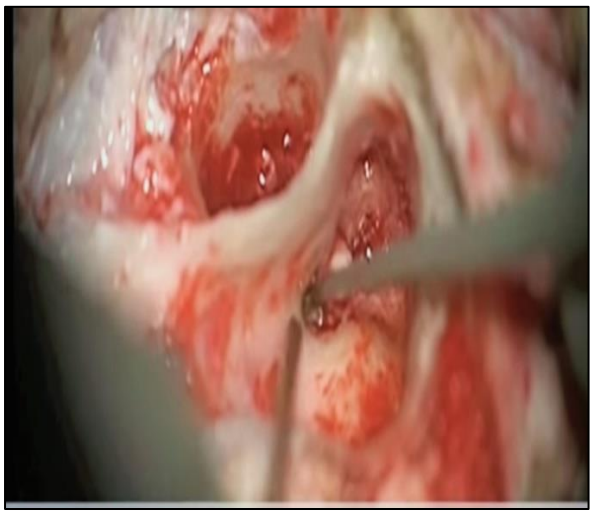

Figure 2: Methods of literature search.

CWU mastoidectomy often provides limited exposure, specifically in cases with less developed zygomatic root cells and lower down tegmen.[24] In one randomized, blind study, authors suggested that with CWU, the chance of recurrence was significantly higher in comparison to the rate after CWD mastoidectomy.[25] Following CWU mastoidectomy, the obliteration of the mastoid cavity with soft tissue or abdomen fat has shown superior outcomes to the air space reservoid approach in terms of hearing and neo-tympanic membrane retraction.[26] In this approach, a retraction pocket is still created in the residual epitympanic region. Only a few surgeons have attempted to completely block off the mastoid cavity by inserting a bone septum at the level of the antrum, but this procedure was unsuccessful due to the absorption of the bony septum, which left an incomplete blockage between the middle ear and the mastoid cavity.[27] One study published 532 cases of CWU mastoidectomy over 10 years study showed 13% recurrences during the first year: 22% during the second year and up to 53% during the fifth year.[28] In recent years, the use of the cartilage graft replaced the temporalis fascia for repairing hearing loss of bone and tympanic substance in cholesteatoma surgery and is also widely used in tympanic membrane perforation surgery. Cartilage graft is more resistant to middle ear retraction and provides functional quality of ossiculoplasty.[29]The major localizations where cholesteatoma recurrence arises are the facial recess and the sinus tympani.[30] In the CWU surgical approach, it is usually difficult to see these parts of the middle ear cleft through the mastoid cavity or ear canal. However, with the CWU surgical approach, posterior tympanotomy is useful to have direct access to the facial recess and sinus tympani for eliminating the cholesteatoma.[31] Following a CWU mastoidectomy, several surgeons have tried to fill the mastoid cavity with abdominal fat or soft tissue in an effort to achieve better hearing and neo-tympanic membrane retraction outcomes than the air gap reservoid approach.[32] CWU mastoidectomy helps to avoid both the requirement for frequent ear clearing and the elimination of keeping the ear away from water.

RESIDUAL/RECURRENT DISEASES

Residual/recurrent diseases may occur after CWU or CWD mastoidectomy, most commonly in the regions where difficult to visualize the disease process such as epitympanum and posterior tympanum. Due to inadequate intraoperative exposure, residual/recurrent illness is more common in CWU surgery.[25] The creation of posterosuperior retraction pockets is the primary cause of recurrent cholesteatoma, which often affects the CWU. 33 In one retrospective study of 433 patients with cholesteatoma over 7 years, 12.4% of CWD and 42% of CWU mastoidectomies revealed recurrent/residual diseases.[34] Even if there is evidence of an elevated incidence of recurrence/residual cholesteatoma and revision surgery, it is difficult to see in a CWU mastoidectomy.[35] Recurrent diseases can be found easily in an outpatient department due to the communication of

the external ear, middle ear, and mastoid cavity in case of CWD mastoid surgery. Revision mastoidectomies can be considered in confirmed cases of recurrences and always total number of surgical procedures is needed to be less. CWD mastoidectomies should be considered in frail patients or patients with different comorbidities who are not thought to be fit for more than one surgical procedure.

HEARING OUTCOMES

Achieving effective hearing outcomes after tympanomastoid surgery in patients of COM is based on multiple criteria. Due to structural alterations, the forms of mastoid surgery like CWU and CWD are believed to be one of these variables.[36] The clinical documentation pertaining to this circumstance, however, have generated debate. Because of comorbid disease and the middle ear, it is sometimes challenging to evaluate the hearing success of surgical procedures for COM. Tympan mastoidectomy results in individuals with COM who have satisfactory hearing outcomes relying on a variety of variables. The forms of mastoid surgery, such as CWU and CWD, are thought to be significant determinants of postoperative anatomical alterations that influence hearing.[37] The hearing outcomes are better after CWU than CWD.[38] The middle ear risk index (MERI) includes preoperative and intraoperative risk factors that determine the prognosis of tympan mastoidectomies. These risk factors are otorrhea, tympanic membrane perforation, middle ear granulation, cholesteatoma, revision surgery, and ossicular status.[39]

Black developed the SPITE (surgical, prosthetic, infection, tissues, and eustachian tube) score, which consists of the twelve main aspects that include surgical, prosthetic, infection, tissue, and eustachian tube variables.[40] In a CWU mastoidectomy, the air cells from the mastoid are usually removed, and this cavity is connected to the middle ear directly through the aditus and antrum. Consequently, the middle ear cavity's volume is expanded. However, in CWD mastoidectomy, the canal wall and mastoid cells are removed with a shallow and decreased middle ear. Along with decreased middle ear volume, the external canal and mastoid cavity are made into one larger cavity.

Both the external ear resonance and the middle ear anatomy may change as a result of these two distinct surgical methods. According to one study, the gain was unaffected, but the frequency of the first peak in the external resonance after CWD mastoidectomy was substantially lower than that after CWU mastoidectomy.[42] In this study, there was no discernible difference in the CWU and CWD mastoidectomy groups' hearing outcomes after the second phase of ossiculoplasty. Even if the external auditory canal's resonance and middle ear volume are both altered, clinical settings may not detect these alterations.

COMPLICATIONS

The CWD procedure has common potential problems in changing the anatomy and physiology of the middle ear and mastoid. The rate of major complications documented in mastoid surgery was 7% for CWD, 4% for CWU, and 6% for CWD with an obliteration surgical procedure. Facial nerve paralysis and dead ears can occur in CWD surgery.[43] These complications may relate to the disease extent, surgeon’s experience, and other factors and cannot simply be associated with the surgical technique itself.[20] Reconstruction of the external canal wall is an important option to make it free from long-term mastoid cavity problems after CWD mastoidectomy. Hearing loss (sensorineural hearing loss) can occur due to injury to oval window area or touching of drill burr to ossicles. A change in taste can happen due to injury of the chorda tympani nerve that lasts for several months(dysgeusia). The major drawbacks with CWD mastoidectomy include cavity problems such as otorrhea, granulations, wax, keratin accumulation, difficulty in prescribing hearing aids, dizziness, and narrow meatus encountered postoperatively. Persistent or intermittent ear discharge following CWD mastoidectomy gives the patient a social handicap.[44] The differences between CWU and CWD mastoidectomy is given in Table 1.

QUALITY OF LIFE IN CWD VERSUS CWU MASTOIDECTOMY

Historically, CWD mastoidectomy has been associated with a poor quality of life in comparison to CWU mastoidectomy because of the limitations of a large neo-mastoid cavity.[44] Personal satisfaction and social functioning in relation to the quality of life are important issues in the tympan mastoid surgeries. The most prevalent restrictions in CWD are the buildup of keratin debris and the requirement for regular cleaning, the increased risk of infection with water contact, the potential for unexpected disorientation linked to changes in external ear temperature, and discomfort with hearing aids.[45] The objectives of CWU mastoidectomy are achieved by preservation of the external auditory canal wall, middle ear volume, and maintenance of the tympanic membrane's physiological position. There are restrictions on keeping the ear out of water and a lack of regular cleaning.[46] Due to improved audiometric results and simpler post-operative care, many patients prefer CWU surgery despite the increased risk of revision surgery in CWU mastoidectomy cases.[11] In certain instances, the meatoplasty in CWD is so extensive as to noticeably change the area of the conchal bowl and the meatus. When doing a meatoplasty in CWD, consideration should be given to the surgical procedure's aesthetic component. An economic comparison of both CWU and CWD is also important in affecting quality of life. Costs of these procedures are calculated from the payer perspective, with procedure, hospital, clinic, and surgeon fees derived from Medicare reimbursement. Quality-adjusted life years (QALYs) are used to represent

the effectiveness and utility. One-way and probability sensitivity analyses (PSAs) are usually conducted during the cost comparison of these two surgical procedures. One study showed the cost-effectiveness of CWU versus CWD mastoidectomy showed cost-effectiveness of both procedures with CWD being cost-effective 54.8% of the time at a willingness to pay (WTP) threshold of $50,000.[47]

Table 1: Differences between canal wall up and canal wall down mastoidectomy.

Features	Canal wall up	Canal wall down
Indication	Limited attico antral disease	Extensive attico antral disease
Posterior bony meatal wall	Intact	Removed
Post-operative recurrent infections of the cavity, pain granulations, or polyp formations	Rare	Common
Post-operative hearing	Better	Worse
Incidence of recurrence	High	Low
Anatomical contour of ear canal	Maintained	Anatomical contour lost
Hearing aid fitting	Can be done	Not possible
Examples	Cortical mastoidectomy, Combined approach tympanoplasty (CAT)	Modified radical mastoidectomy, atticotomy, and atticoantrostomy

FOLLOW UP

COM with cholesteatoma is a burdensome disease for a patient.[48] The ideal treatment of COM with cholesteatoma is often a one-stage surgical procedure that can completely eradicate the disease and prevent the recurrence of cholesteatoma.[49] In one series, 28% of patients required two CWD operations and 3% even needed three operations, in addition to multiple visits to the outpatient department.[50] Long-term post-operative follow-up is usually required in CWD mastoidectomy as serial debridement is needed, where the ear maintains its natural anatomy and heals quickly following CWU mastoidectomy.

CONCLUSION

CWU and CWD mastoidectomy surgical procedures have their own indications, benefits, and pitfalls. CWD technique has a higher chance of curing the patient of COM with cholesteatoma but with higher rates of post-surgical complications. CWU surgical technique has the advantage of maintaining a near-normal anatomy of the ear canal but with a higher chance of residual or recurrent cholesteatomas. The choice of surgical technique depends on the extent of pathology, the general health of the patient, and the preference of the surgeon. Mastering the surgical techniques of mastoidectomy and understanding their principles are important tasks for providing the best output to patients with COM.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: Not required

REFERENCES

1. De Azevedo AF, Pinto DC, De Souza NJ, Greco DB, Gonçalves DU. Sensorineural hearing loss in chronic suppurative otitis media with and without cholesteatoma. Brazilian journal of otorhinolaryngology. 2007;73(5):671-4.
2. Trinidade A, Page JC, Dornhoffer JL. Therapeutic Mastoidectomy in the Management of Noncholesteatomatous Chronic Otitis Media: Literature Review and Cost Analysis. Otolaryngol--Head Neck Surg off J Am Acad Otolaryngol-Head Neck Surg. 2016;155(6):914-22.
3. Sahu MC, Swain SK. Surveillance of antibiotic sensitivity pattern in chronic suppurative otitis media of an Indian teaching hospital. World Journal of Otorhinolaryngology-Head and Neck Surgery. 2019;5(02):88-94.
4. Shirazi MA, Muzaffar K, Leonetti JP, Marzo S. Surgical treatment of pediatric cholesteatomas. The Laryngoscope. 2006;116(9):1603-7.
5. Heywood RL, Narula A. The pros and cons of canal wall up versus canal wall down mastoidectomy for cholesteatoma. Otorhinolaryngologist. 2013;6(3):140-3.
6. Jansen C. Cartilage tympanoplasty. Laryngoscope. 1963;13: 1288-1302.
7. Gupta P, Varshney S, Kumar SK, Mohanty A, Jha MK. Chronic suppurative otitis media: A microbiological review of 20 years. Indian Journal of Otology.2020;26(2):59-67.
8. Khalid-Raja M, Tikka T, Coulson C. Cholesteatoma: A disease of the poor (socially deprived)? Eur Arch Otorhinolaryngol. 2015;272: 2799-805.
9. Oliveira KA, Esper MT, Oliveira ML, Tofoli MH, Avelino MA. Correlation between cow's milk protein allergy and otitis media: a systematic review. Brazilian Journal of Otorhinolaryngology. 2022;88:803-11.
10. Park M, Lee JS, Lee JH, Oh SH, Park MK. Prevalence and risk factors of chronic otitis media: the Korean National Health and Nutrition

Examination Survey 2010-2012. PloS one. 2015;10(5):125905.
11. Stevens SM, Walters ZA, Babo K, Peddireddy N, Tawfik KO, Samy RN. Canal reconstruction mastoidectomy: Outcomes comparison following primary versus secondary surgery. The Laryngoscope. 2019;129(11):2580-7.
12. Chole R. Chronic otitis media, mastoiditis, and petrositis. In: Flint PW, Haughey BH, Lund, VJ, Niparko JK, Robbins KT, Thomas JR, Lesperance MM. Cummings Otolaryngology: Head and Neck Surgery. 6th ed. Philadelphia, PA, USA: Elsevier Mosby. 2015;2139-54.
13. Swain SK, Pati BK, Mohanty JN. Otological manifestations in pregnant women-A study at a tertiary care hospital of eastern India. Journal of Otology. 2020;15(3):103-6.
14. Harvey SA, Fox MC. Relevant issues in revision canal-wall-down mastoidectomy. Otolaryngology-Head and Neck Surgery. 1999;121(1):18-22.
15. Kerckhoffs KG, Kommer MB, van Strien TH, Visscher SJ, Bruijnzeel H, Smit AL, et al. The disease recurrence rate after the canal wall up or canal wall down technique in adults. The Laryngoscope. 2016;126(4):980-7.
16. Eliçora S, Erdem D, Dinç A, Damar M, Bişkin S. The effects of surgery type and different ossiculoplasty materials on the hearing results in cholesteatoma surgery. European Archives of Oto-Rhino-Laryngology. 2017;274(2):773-80.
17. Deniz M, Uslu C, Koldas C, Deniz B. Which technique is better for cholesteatoma surgery? B-ent. 2015;11(2):109-15.
18. Harvey SA, Fox MC. Relevant issues in revision canal-wall-down mastoidectomy. Otolaryngology--Head and Neck Surgery. 1999;121(1):18-22.
19. Hulka GF, McElveen JT Jr. A randomized, blinded study of canal wall up versus canal wall down mastoidectomy determining the differences in viewing middle ear anatomy and pathology. Am J Otol. 1998;19(5):574-8.
20. Mustafa SR. Comparison of Efficacy of Canal Wall up Mastoidectomy with Canal Wall Down Mastoidectomy in Surgical Management of Otitis Media with Cholesteatoma. Journal of Islamabad Medical and Dental College. 2017;6(2):78-82.
21. Bhatia S, Karmarkar S, DeDonato G, Mutlu C, Taibah A, Russo A et al. Canal wall down mastoidectomy: causes of failure, pitfalls and their management. J Laryng Otol. 1995;109(7):583-9.
22. Kim M-B, Choi J, Lee JK, Park J-Y, Chu H, Cho Y-S et al. Hearing Outcomes According to the Types of Mastoidectomy: A Comparison between Canal Wall Up and Canal Wall Down Mastoidectomy. Clin Exp Otorhinolaryngol. 2010;3(4):203-6.
23. Jansen CW. Intact canal wall for cholesteatoma. Am Jour Otol. 1985;6(1):3-4.
24. Dornhoffer JL. Retrograde mastoidectomy. Otolaryngol Clin North Am. 2006;39(6):1115-27.
25. Hulka GF and McElveen JT Jr. A randomised blinded study of canal wall up versus canal wall down mastoidectomy determining the differences in viewing middle ear anatomy and pathology. Am J Otol. 1998;19(5):574-8.
26. Montandon P, Benchaou M, Guyot JP. Modified canal wall-upmastoidectomy with mastoid obliteration for severe chronic otitismedia. ORL J Otorhino Relat Spec. 1995;57(4):198-201.
27. Villarejo PL, Banos EC, Ramos J.The antrum exclusion technique in cholesteatoma surgery. J Laryngol Otol. 1992; 106(2):120-3.
28. Smyth GD. Postoperative cholesteatoma in combined approach tympanoplasty: Fifteen-year report on tympanoplasty Part I. The Journal of Laryng and Otolog. 1976;90(7):597-621.
29. Duckert LG, Müller J, Makielski KH, Helms J. Composite autograft "shield" reconstruction of remnant tympanic membranes. Otolo and Neuro. 1995;16(1):21-6.
30. Sheehy JL, Brackmann DE, Graham MD. Cholesteatoma surgery: residual and recurrent disease. A review of 1,024 cases. Ann Otol, Rhino and Laryn. 1977;86(4):451-62.
31. Basonbul RA, Ronner EA, Kozin ED, Lee DJ, Cohen MS. Systematic review of endoscopic ear surgery outcomes for pediatric cholesteatoma. Otol and Neuro. 2021;42(1):108-15.
32. Møller PR, Pedersen CN, Grosfjeld LR, Faber CE, Djurhuus BD. Recurrence of cholesteatoma-a retrospective study including 1,006 patients for more than 33 years. International Archives of Otorhino. 2020;24(01):18-23.
33. Brackmann DE. Tympanoplasty with mastoidectomy: canal wall up procedures. Am J Otol. 1993;14(4):380–2.
34. Bhatia S, Taibah A, Karmarkar S, Saleh E, Russo A, DeDonato G, et al. Cholesteatoma surgery: the individualized technique. Annals of Otology, Rhinology and Laryngol. 1995;104(8):591-5.
35. Kerckhoffs KG, Kommer MB, van Strien TH, Visscher SJ, Bruijnzeel H, Smit AL, et al. The disease recurrence rate after the canal wall up or canal wall down technique in adults. The Laryngoscope. 2016;126(4):980-7.
36. Whittemore KR Jr, Merchant SN, Rosowski JJ. Acoustic mechanisms: canal wall-up versus canal wall-down mastoidectomy. Otolaryngol Head Neck Surg. 1998;118(6):751-61.
37. Tos M, Lau T. Hearing after surgery for cholesteatoma using various techniques. Auris Nasus Larynx. 1989;16(2):61-73.
38. Van der Toom HF, van der Schroeff MP, Metselaar M, van Linge A, Vroegop JL, Pauw RJ et al. Treatment outcome of the bony obliteration tympanoplasty versus nonobliterative techniques in cholesteatoma surgery: a retrospective analysis. Otol and Neuro. 2021;42(9):1366-74.
39. Black B. Ossiculoplasty prognosis: the spite method of assessment. Am J Otol 1992;13(6):544-51.

40. Evans RA, Day GA, Browning GG. Open-cavity mastoid surgery: its effect on the acoustics of the external ear canal. Clin Otolaryngol Allied Sci. 1989;14(4):317-21.
41. Cho YS, Seo IS, Woo HC, Kang MK, Chung WH, Hong SH. Changes in external ear resonance after 3 types of surgery in the patients with chronic otitis media. Otolaryngol Head Neck Surg. 2001;125(4):364-9.
42. Swain SK. Delayed facial nerve paralysis following tympanomastoid surgery. Annals of Indian Academy of Otorhinolaryngology Head and Neck Surgery. 2021;5(2):52-6.
43. Quaranta N, Iannuzzi L, Petrone P, D'Elia A, Quaranta A. Quality of life after cholesteatoma surgery: intact–canal wall tympanoplasty versus canal wall–down tympanoplasty with mastoid obliteration. Annals of Otology, Rhinology & Laryngology. 2014;123(2):89-93.
44. Kurien G, Greeff K, Gomaa N, Ho A. Mastoidectomy and mastoid obliteration with autologous bone graft: a quality-of-life study. Journal of Otolaryngology-Head & Neck Surgery.2013;42:1-7.
45. Lucidi D, De Corso E, Paludetti G, Sergi B. Quality of life and functional results in canal wall down vs canal wall up mastoidectomy. Acta Otorhinolaryngologica Italica. 2019;39(1):53.
46. Bu DD, Schwam ZG, Kaul VF, Wong K, Fan C, Wanna GB, et al. Cost-effectiveness of canal wall-up vs canal wall-down mastoidectomy: A modeling study. Otolaryngology Head and Neck Surgery. 2022;167(3):552-9.
47. Swain SK, Agrawala R. Mastoid surgery: a high-risk aerosol generating surgical procedure in COVID-19 pandemic. Int J Otorhinolaryngol Head Neck Surg. 2020;6(10):1941-6.
48. Swain SK, Lenka S, Dubey D, Jena PP. Microbiology of chronic otitis media-A review. DY Patil Journal of Health Sciences. 2022;10(2):67-72.
49. Vartiainen E. Ten-year results of canal wall down mastoidectomy for acquired cholesteatoma. Auris Nasus Larynx. 2000;27(3):227-9.

Cite this article as: Santosh K. Swain. Current practices of canal wall up versus canal wall down mastoidectomy: a Review. Int J Res Med Sci 2024;12:3117-23.