https://doi.org/10.34883/PI.2026.16.1.029

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Outcome of Canal Wall Up Mastoidectomy in the Treatment of Active Chronic Otitis Media

Conflict of interest: nothing to declare.
Authors' contribution: Mustafa Abdulrahman Ismaeel – conceptualization, investigation, data curation, project administration, methods, resource, writing – original draft, software, and editing; Musaid Al-Badri – conceptualization, method, project administration, data curation, investigation, writing – original draft.
Ethics statement: the Medical Ethical Committee of The Medical City Complex approved this study (no. 5 on 12/2/2022).
The article is published in author's edition.

Submitted: 10.11.2025
Accepted: 26.02.2026
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Abstract

Introduction. Intact canal wall mastoidectomy is designed to eliminate disease and improve function while maintaining normal anatomy.
Purpose. To evaluate cases of active chronic otitis media (COM) treated surgically with Canal Wall Up mastoidectomy and to assess the results of Canal Wall Up mastoidectomy with respect to dryness of the middle ear according to the duration of the postoperative period.
Materials and methods. A prospective study was planned for a one-year period from February 2022 to February 2023, involving 32 patients (18♂ and 14♀), aged between 10–42 years; with chronic suppurative otitis media (CSOM). Intact canal wall mastoidectomy was performed for all cases and followed up for 1, 3, 6, and 9 months.
Results. Subtotal Tympanic membrane perforation (TMP) was observed in eight cases (25%). Central perforation was found in six cases (18.75%). Attic perforation was observed in 8 cases (25%). Marginal perforations were observed in 10 patients (31.25%). Chronic epithelial disease was observed in 12 (37.5%) patients. Chronic mucosal disease was observed in 20 (62.5%) patients. Out of 21 (65.6%) patients with dry ears, 6 (46.1%) had Active squamous disease (ASD) and 15 (78.9%) had Active mucosal disease (AMD). Out of 11 (34.4%) cases with discharged ears, 7 (53.9%) had ASD and 4 (21.1%) had AMD. The results of Canal Wall Up Mastoidectomy with respect to dryness of the middle ear were significantly better for AMD than for ASD ($p<0.05$).
Conclusion. Due to the nature, severity, and pathological process of the disease, the outcome of canal wall up mastoidectomy is variable, and dryness is a good criterion of success. Canal wall-up mastoidectomy yielded better results with AMD than with ASD (78.8% and 46.1%, respectively). Canal wall-up mastoidectomy is the most desirable surgical procedure and can be used for both AMD and ASD.
Keyword: canal wall up mastoidectomy, active mucosal disease, active squamous disease, chronic middle ear disease, otitis media

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Результаты мастоидэктомии с сохранением стенки наружного слухового прохода при лечении обострений хронического среднего отита

Конфликт интересов: не заявлен.
Вклад авторов: Мустафа Абдулрахман Исмаил – концепция, проведение исследований, обработка данных, ведение проекта, методология, ресурсы, написание чернового варианта статьи, редактирование; Мусаид Аль-Бадри – концепция, методология, ведение проекта, обработка данных, проведение исследований, написание чернового варианта статьи.
Этическое заявление: исследование одобрено комитетом по медицинской этике Медицинского городского комплекса (№ 5 от 02.12.2022).
Статья опубликована в авторской редакции.

Подана: 10.11.2025
Принята: 26.02.2026
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Резюме

Введение. Мастоидэктомия с сохранением стенки наружного слухового прохода проводится с целью устранения очага заболевания и улучшения работы органа слуха при сохранении его нормальной анатомии.
Цель. Оценить результаты лечения обострений хронического среднего отита (ХСО) с применением мастоидэктомии с сохранением стенки наружного слухового прохода, а также определить эффективность данной методики в отношении отсутствия отделяемого из среднего уха в зависимости от продолжительности послеоперационного периода.
Материалы и методы. Было проведено плановое проспективное исследование продолжительностью один год (с февраля 2022 по февраль 2023 г.) с участием 32 пациентов (18 мужчин и 14 женщин) в возрасте от 10 до 42 лет с хроническим гнойным средним отитом. Все пациенты подверглись мастоидэктомии с сохранением стенки наружного слухового прохода. Динамическое наблюдение осуществляли через 1, 3, 6 и 9 месяцев.
Результаты. Частичная перфорация барабанной перепонки наблюдалась в 8 случаях (25%), центральная перфорация – в 6 (18,75%). Перфорацию аттика регистрировали в 8 случаях (25%), краевые перфорации – в 10 (31,25%). Хронический эпитимпанит отмечен у 12 (37,5%) пациентов, хронический мезотимпанит – у 20 (62,5 %). Из 21 (65,6%) пациента с отсутствием выделений из уха у 6 (46,1 %) диагностированы обострения хронического гнойного эпитимпанита (ASD), а у 15 (78,9 %) – мезотимпанита (AMD). Из 11 (34,4%) пациентов с выделениями из ушей у 7 (53,9%) был выявлен ASD, а у 4 (21,1%) – AMD. Результаты мастоидэктомии с сохранением стенки наружного слухового прохода в отношении отсутствия отделяемого из среднего уха были достоверно лучшими у пациентов с AMD по сравнению с пациентами с ASD ($p<0,05$).
Заключение. В зависимости от характера, тяжести и патологического процесса заболевания результаты мастоидэктомии с сохранением стенки наружного слухового прохода варьируются; отсутствие выделений является показателем успешности лечения. Мастоидэктомия с сохранением стенки наружного слухового прохода

показала лучшие результаты при AMD, чем при ASD (78,8% и 46,1% соответственно). Мастоидэктомия с сохранением стенки наружного слухового прохода является наиболее предпочтительной хирургической процедурой, которая может применяться как у пациентов с AMD, так и у пациентов с ASD.
Ключевые слова: мастоидэктомия с сохранением стенки наружного слухового прохода, хронический гнойный мезотимпанит, хронический гнойный эпитимпанит, хронические заболевания среднего уха, средний отит

■ INTRODUCTION

Chronic otitis media (COM), both with and without cholesteatoma, is a leading cause of mastoid surgery in otology [1]. Surgical interventions for chronic middle ear infections have been performed for over a century. Initially, surgeons primarily focused on opening the antrum and facilitating drainage of the mastoid, but it did not take long for a more invasive radical operation with an open cavity to gain favor, a procedure that has been widely used in the past years [2]. Canal wall-up mastoidectomy entails removing the mastoid air cells lateral to the facial nerve and otic capsule, while keeping the posterior and superior walls of the external auditory canal intact. This method allows access to the epitympanum and preserves the natural separation between the external auditory canal and the mastoid cavity. In pediatric cases, this technique is generally preferred because it avoids long-term complications associated with the canal wall-down approach [3]. Only a small group of surgeons, primarily those with extensive otological experience, prefer this approach. It is technically challenging and requires considerably longer operating time. Moreover, it typically necessitates at least one additional surgery later on [4]. Complications of the intact canal wall procedure include some shared by other procedures and some that are unique, such as serous OM and canal wall resorption. The incidence of postoperative cholesteatoma varies from less than one percent to 26 percent [3, 5]. The elimination of cavity problems and the reported incidence of better hearing results have increased the use of intact canal wall procedures [6].

The pathology of active CSOM includes active mucosal COM, which is characterized by perforation of the tympanic membrane with persistent otorrhea. This condition involves chronic inflammation within the mucosa of the middle ear and mastoid, leading to varying degrees of edema, submucosal fibrosis, hypervascularity, and infiltration of inflammatory cells. These changes contribute to the ongoing inflammation and dysfunction in the affected areas [7, 8], and active squamous epithelial COM (cholesteatoma), the hallmark of cholesteatoma, is the retention of keratinous debris. Therefore, the term "keratoma" would be more accurate histologically. Cholesteatomas are considered potentially dangerous because of their ability to induce bone resorption, which can lead to serious complications, including both intratemporal and intracranial issues. The expansion of cholesteatomas can damage surrounding structures, increasing the risk of hearing loss, facial nerve paralysis, and even life-threatening infections. Active COM (both mucosal and squamous subtypes) is often associated with the resorption of resorptive osteitis (ossicular chain). The long process of the incus, stapes crurae, body of the incus, and manubrium of the malleus are involved in that order of frequency when cholesteatomas cause erosion. The long process of the incus is the most commonly affected structure, followed by the

stapes crurae, body of the incus, and manubrium. This pattern of involvement reflects the proximity of these structures to the cholesteatoma and the extent of bone resorption induced. The first two bones are most frequently affected because of their delicate structure, location, and tenuous blood supply [8]. The mechanisms of bone erosion are similar in both types of COM [9].

COM can be classified into five main pathological categories. These include healed COM, such as tympanosclerosis or healed perforations; inactive mucosal COM, where perforations are present but not active; active mucosal COM, marked by persistent inflammation; active squamous epithelial COM, which is commonly associated with cholesteatoma; and inactive squamous epithelial COM, which often results in retraction of the tympanic membrane [10].

The common mastoid operations performed for CSOM are of two major types: the intact canal wall (closed or canal wall up) technique (cortical mastoidectomy, combined approach tympanoplasty, and tympanoplasty with mastoidectomy), and open or canal wall down techniques (Atticotomy, Radical mastoidectomy, Modified radical mastoidectomy (Bondy), Mastoid obliteration procedure and Mastoid reconstruction procedure) [11]. Complications include facial nerve palsy, wound infection, vertigo, conductive deafness, sensorineural hearing loss, tinnitus, and intracranial infection [12].

■ PURPOSE OF THE STUDY

To evaluate cases of active chronic otitis media (COM) treated surgically with Canal Wall Up mastoidectomy and to assess the results of Canal Wall Up mastoidectomy with respect to dryness of the middle ear according to the duration of the postoperative period.

■ MATERIALS AND METHODS

Study Design and Setting

This prospective study included 32 cases with a diagnosis of CSOM, who were planned and admitted for canal-up mastoidectomy at the Department of Otolaryngology, Hospital of Specialized Surgeries, Medical City, between February 2022 and February 2023. A questionnaire was formulated for data collection, and when the case was received, the patient's condition was assessed by history, clinical examination, and investigations.

Data Collection

These included age, occupation, residence, telephone number, aural symptoms recorded, ear discharge and its duration, hearing impairment and its duration, Tinnitus, Otalgia, Headache, Facial nerve paralysis, and vertigo.

Examination

A comprehensive otolaryngological assessment focusing specifically on the affected ear was performed. This included inspection using an aural speculum, otoscopy, and oto-microscopy. The examination was expanded to evaluate the facial nerve, assess the presence and severity of nystagmus, and conduct a fistula test using tragal pressure. Additionally, pneumatic otoscopy (using a Seigale speculum) was employed along with testing for cerebellar function and general medical evaluation.

Investigation

Radiological studies: CT and X-ray. Audiological: Pure-tone audiograms were performed in all cases. ECG and Hematological: assessment of hemoglobin, blood sugar, blood urea, and serum creatinine.

Preoperative Preparation

Preoperative follow-up included dry mopping of the discharge and cleaning of the ear canal from debris and crustation. Identification and treatment of any associated problems in the nose, throat, or chest. Written informed consent was obtained from each patient. On the day of the operation, the hair was shaved around the ear to be operated on.

Intra-Operative Period

The procedures were attended whenever possible, the details of the operations were recorded, and the findings were documented.

Postoperative Care

Standard mastoid dressings were used in all cases. Facial nerve function was assessed once the patient recovered from anesthesia. Close monitoring was carried out for at least six hours post-operation, focusing on any signs of dizziness, changes in facial nerve function, hemorrhage, and vital signs. Antibiotics, including Ceftriaxone and Metronidazole, were administered throughout the hospital stay, along with oral analgesics.

The day after surgery, the initial tight mastoid dressing was replaced. A Weber test was performed to rule out a dead ear, and the patients remained hospitalized for 5 to 7 days. Daily dressing changes were performed, and sutures were removed between the 7th and 10th postoperative day. Upon discharge, patients were given a course of oral antibiotics along with a local antibiotic ointment (fucidin) for the wound. Both treatments were continued for one week.

Patients were instructed to follow up after one week, then at one, three, six, and nine months post-surgery. At each follow-up visit, a thorough examination was conducted, including inspection of the ear using an aural speculum or microscope. Any debris, discharge, or wax was removed by suction or dry mopping.

Statistical Analysis

Data analysis was performed using SPSS version 26. Numerical data are presented as mean±SD, along with percentages and frequencies. The chi-squared test was applied, and statistical significance was set at $p<0.05$.

■ RESULTS

In this study of 32 patients with CSOM, 18 (56.25%) were male and 14 (43.75%) were females aged from 10–42 years with a mean of 25.7 year (Table 1). The cases complained for durations ranging from 2 years to more than 12 years, with a mean of 6.4 year (Table 2).

All the patients had a wet ear (unilateral). Scanty discharge was reported in 3 cases (9.4%), moderate discharge in 11 cases (34.3%), and profuse discharge in 18 cases (56.3%). The color of discharge was yellow in 8 cases (25%) and yellow to green in 6 cases (18.75%), while blood-stained discharge was found in 18 cases (56.25%). The discharge odor was offensive in 13 cases (40.6%), whereas no offensive odor was found in 19 cases (59.4%) (Table 3).

Table 1
Distribution of age and gender of study case

Age (years)	Gender		Total
	Male	Female	
<20	8	4	12 (37.5%)
20–29	5	3	8 (25%)
30–39	4	5	9 (28.1%)
40–50	1	2	3 (9.4%)
Total	18 (56.25%)	14 (43.75%)	32 (100%)

Table 2
Duration of ear disease in study cases

Duration (years)	No. (%)
2–5	12 (37.5)
6–9	16 (50)
>10	4 (12.5)
Total	32 (100)

Table 3
Character of ear discharge in study cases

Amount of discharge	No. (%)
Scanty	3 (9.4)
Moderate	11 (34.3)
Profuse	18 (56.3)
Colour of discharge	
Yellow	8 (25)
Yellow to green	6 (18.75)
Bloody	18 (56.25)
Odour of discharge	
Offensive	13 (40.6)
Not offensive	19 (59.4)

Chronic epithelial disease was found in 12 cases (37.5%), chronic mucosal disease in 20 cases (62.5%), and evidence of ossicular erosion in 18 cases (56.25%) (Table 4).

Table 4
Physical examination preoperatively

Signs	No. (%)
I. TM perforation	
Subtotal	8 (25)
Central	6 (18.75)
Attic	8 (25)
Marginal	10 (31.25)
II. Middle ear	
Chronic epithelial disease	12 (37.5)
Chronic mucosal disease	20 (62.5)
Evidence of ossicular erosion	18 (56.25)

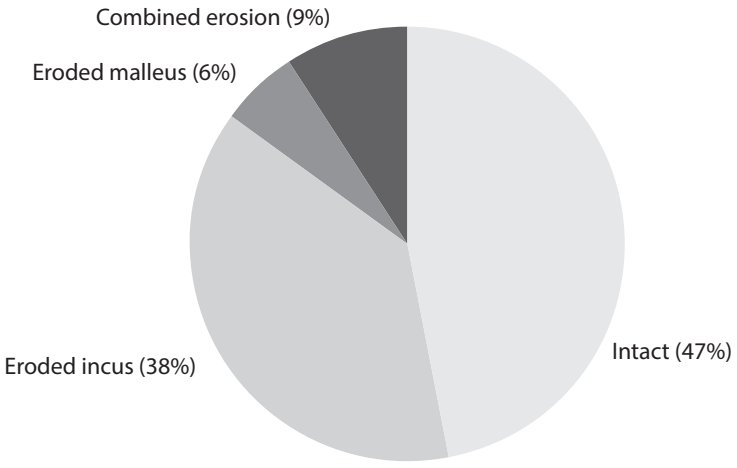
Table 5
Relationship of site and type of pathology during surgery

Type of pathology	Attic	Attic and antrum	Attic, antrum, mesotymp	Total
	No. (%)			
ASD	3 (23)	8 (61.5)	2 (15.5)	13 (40.6)
AMD	3 (15.8)	10 (52.6)	6 (31.6)	19 (59.4)
Total	6 (18.7)	18 (56.3)	8 (25)	32 (100)

Subtotal perforation was found in eight cases (25%), central perforation in six cases (18.75%), tic perforation in eight cases (25%), and marginal perforation in 10 cases (31.25%). ASD was observed in 13 patients (40.6%). The highest percentage involved the attic and antrum in eight (61.5%) of the cases. AMD was observed in 19 patients (59.4%). The highest percentage involved the attic, and the antrum was reported in 10 patients (52.6%) (Table 5).

In 15 (47%) cases, the ossicles were intact, the incus was eroded in 12 (38%) cases, the malleus was involved in 2 (6%) cases, and combined ossicular erosion was affected in 3 (9%) cases. In contrast, ossicles were absent in the study cases (Figure).

During the follow-up period, 4 cases (12.5%) were found to be dry by the end of the first month. Between the first and third months after surgery, 11 (34.4%) cases were dry. Sixteen (50%) cases were recognized as dry at the end of the 6th postoperative month. At the end of the study period (9 months), 21 (65.6%) cases were dry. Of the 13 ASD cases (40.6%) recognized at surgery, 6 (46.1%) had dry ears compromising (65.6%) of the total 21 dry ears 9 months after surgery, while the remaining 7 patients (53.9%) were reported to have discharging ears compromising (34.4%) of the total 11discharging ears 9 months after surgery. Out of the 19 cases (59.4%) with AMD, 15 (78.9%) developed dry ears, comprising as (65.6%) of the total 21 cases of dry ears, while 4 (21.1%) had discharging ears after 9 months follow-up period, comprising (34.4%) of the 11 discharging ears (Table 6).



Condition of the ossicles in the study cases

Table 6
Postoperative follow up period and type of disease related to the dryness of the ear status

		Dry	Discharge
		No. (%)	
Period of Postoperative follow up	1st month	4 (12.5)	28 (87.5)
	3rd month	11 (34.4)	21 (65.6)
	6th month	16 (50)	16 (50)
	9th month	21 (65.6)	11 (34.4)
Type of pathology	ASD	6 (46.1)	7 (53.9)
	Active mucosal disease	15 (78.9)	4 (21.1)
	Total	21 (65.6)	11 (34.4)

■ DISCUSSION

Currently, this technique is rarely used for the treatment of cholesteatomas. Recurrence and residual rates are notably high, particularly when performed by less experienced surgeons. As a result, it should be reserved for cases with significant pneumatization, where a large antrum provides a clear view of the posterior epitympanum and the facial recess can be sufficiently widened to allow thorough examination of the posterior middle ear [13].

In the present study, we observed that the extension of both forms of CSOM, ASD and AMD, was primarily localized to the attic and antrum in approximately 18 cases (56.3%). This included 8 cases (61.5%) of ASD and 10 cases (52.6%) of AMD. These findings are consistent with the results reported by Pareschi et al., who found that half of their cases involved both the attic and antrum [14]. However, our findings contrast with those of Sonkhya et al., who reported a higher rate of disease extension involving the antrum, attic, and mesotympanum in 41% of the patients [15].

At the end of the 9-month follow-up period, satisfactory infection control, defined as achieving a completely dry ear, was noted in 21 out of 32 cases (65.6%). Conversely, persistent ear discharge was observed in 11 (34.4%) patients. Compared to other published studies, our rate of persistent discharge was relatively high. For instance, Faramarzi et al. reported a postoperative discharge rate of approximately 20% [16]. Similarly, Zwierz et al., in a retrospective review of CSOM cases, reported an approximately 10% rate of persistent discharge, with 90% of patients achieving a dry ear over a one-year follow-up period [17]. Sonkhya et al. reported a lower rate of 10.2% in their study [15].

The higher rate of persistent discharge in our study may be attributed to two main factors: first, the extent of bony work during surgery may not have been sufficiently radical; and second, inadequate removal of infected tissue within the tympanic cavity may have contributed to the ongoing infection. It is important to note that the reported failure rates of primary mastoidectomy for CSOM in the literature range from 3% to over 26% [18].

Additionally, these findings indicate that surgical outcomes were significantly influenced by the COM diagnostic category. Patients with AMD had a much better outcome, with 71.4% achieving dryness compared to only 28.6% in cases of ASD. These findings are consistent with those of previous studies. Mishiro et al. reported a success rate of > 90% in AMD cases versus 10% in ASD cases [19]. Similarly, Akula et al. reported more than 80% favorable outcomes in patients with AMD [20].

One of the main limitations of canal wall up mastoidectomy is the variability in patient outcomes, which depend heavily on the severity and nature of the disease. Achieving a dry and stable ear may take several months, with some patients requiring up to nine months or longer of follow-up, which can be challenging due to poor compliance. The procedure tends to be more successful in cases of AMD than in cases of ASD, the latter showing significantly lower rates of control and higher chances of recurrence or residual disease. This often necessitates a second-look surgery, especially in pediatric patients. Furthermore, surgery requires a high level of anatomical knowledge and technical skill, and inexperience may increase the risk of complications involving critical structures, such as the facial nerve or semicircular canals. Patient education and motivation to adhere to long-term follow-up care are essential but not always achievable. Lastly, there is a lack of robust long-term clinical studies evaluating the outcomes of this procedure, particularly in children and cases involving ASD, highlighting the need for further research and postoperative monitoring.

Canal wall-up mastoidectomy offers significant clinical advantages in the management of COM, particularly by preserving the anatomy of the external auditory canal and providing better postoperative hearing outcomes. Its effectiveness in controlling infection is especially evident in cases of AMD, making it the preferred surgical option when anatomical preservation is desired. However, its use in ASD requires caution because of the higher risk of residual or recurrent cholesteatoma, often necessitating planned second-look surgery. The success of the procedure relies heavily on the surgeon's expertise and understanding of the complex temporal bone anatomy, underlining the importance of hands-on dissection training and continued surgical education. From a clinical standpoint, the need for long-term postoperative follow-up should be emphasized, as achieving a dry and stable ear may take several months. Appropriate patient selection, education, and compliance with follow-up protocols are crucial for improving patient outcomes. Additionally, the variable success rates highlight the need for individualized treatment planning and the consideration of alternative or adjunctive surgical approaches in more aggressive disease cases.

■ CONCLUSION

Owing to the nature, severity, and pathological progression of the disease, outcomes following canal wall-up mastoidectomy can vary. A key indicator of surgical success is achieving dry ear, which may be observed in approximately 12.5% of cases within one month, 34.4% within three months, 50% within six months, and 65.6% within nine months postoperatively. This procedure provides a better chance of infection control in patients with active COM. Outcomes were significantly better in patients with AMD than in those with ASD, with success rates of 78.8% and 46.1%, respectively. Canal wall-up mastoidectomy is a highly favorable surgical option for managing both the active mucosal and squamous forms of the disease. However, a thorough understanding of the temporal bone anatomy, gained through extensive dissection, is essential for successful outcomes. In pediatric patients with ASD, this surgery is considered the initial step to preserve hearing function, with the potential for a second-look procedure to identify and manage residual or recurrent disease. Continued basic research on the causes and pathology of ASD is encouraged. An extended postoperative follow-up is crucial to properly assess the long-term effectiveness of canal wall-up mastoidectomy. It is important to emphasize the

necessity of consistently attending follow-up appointments over time. Participation in temporal bone dissection laboratory courses is recommended to enhance the surgeon's familiarity with key anatomical structures in the middle ear and mastoid, such as the facial nerve, semicircular canals, facial recess, and sinus tympani, to improve surgical skills and reduce the risk of complications.

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