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Tuberculosis of the Middle Ear: A Systematic Review

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Corresponding Author:	Kavya Pai, MD Geisinger Medical Center UNITED STATES
First Author:	Kavya K. Pai, MD
Order of Authors:	Kavya K. Pai, MD
	Ariel O. Omiunu
	Dhiraj K. Peddu
	Vivienne H. Au
	Christina H. Fang, MD
	Soly Baredes, MD, FACS
	Robert W. Jyung, MD, FACS
	Jean Anderson Eloy, MD, FACS, FARS

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Peter C. Weber, MD, MBA
Editor, The American Journal of Otolaryngology

Dear Dr. Weber,

We are pleased to submit our article, "**Tuberculosis of the Middle Ear: A Systematic Review"** to be considered for publication in *The American Journal of Otolaryngology*.

Tuberculous otitis media (TOM) is a rare extrapulmonary manifestation of tuberculosis (TB) and remains challenging to diagnose due to non-specific symptoms. Prompt recognition and management of TOM is critical, as disease progression can result in severe complications such as irreversible FP, hearing loss (HL), mastoiditis, labyrinthitis, osteomyelitis, abscess formation, and central nervous system involvement. This disease process is not well-characterized in adult patients. To date, most reports of TOM in adults have been either single case reports or case series. The primary objective of this study is to provide a comprehensive review of the recent literature to highlight the risk factors, clinical manifestations, and diagnostic findings associated with TOM in adult patients.

None of the authors have potential conflicts of interest with material presented herein. Each of the authors contributed substantially to the creation of this work. This report is not in consideration for publication elsewhere. We look forward to your decision on our paper.

Sincerely,

Christina H. Fang, MD
Assistant Professor
Department of Otorhinolaryngology – Head & Neck Surgery
Montefiore Medical Center
Albert Einstein College of Medicine
3400 Bainbridge Avenue
Bronx, NY 10467
Phone: (718) 920-2991
E-mail: christina.fang1@gmail.com

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Kavya K. Pai, MD[1]
Ariel O. Omiunu, MD[2]
Dhiraj K. Peddu, BS[3]
Vivienne H. Au, BA[4]
Soly Baredes, MD, FACS[5,6]
Robert W. Jyung, MD, FACS[5]
Jean Anderson Eloy, MD, FACS, FARS[5,6,7,8,9]
Christina H. Fang, MD[10]

[1]Department of Otolaryngology, Geisinger Health System, Danville, Pennsylvania, USA
[2]Department of Surgery, Division of Otolaryngology-Head and Neck Surgery, Yale School of Medicine, New Haven, Connecticut, USA
[3]Department of Otolaryngology, Rutgers Robert Wood Johnson Medical School, New Brunswick, NJ
[4]Department of Otolaryngology, SUNY Downstate College of Medicine, Brooklyn, NY
[5]Department of Otolaryngology – Head and Neck Surgery, Rutgers New Jersey Medical School, Newark, New Jersey, USA
[6]Center for Skull Base and Pituitary Surgery, Neurological Institute of New Jersey, Rutgers New Jersey Medical School, Newark, New Jersey, USA
[7]Department of Neurological Surgery, Rutgers New Jersey Medical School, Newark, New Jersey, USA
[8]Department of Ophthalmology and Visual Science, Rutgers New Jersey Medical School, Newark, New Jersey, USA
[9]Department of Otolaryngology and Facial Plastic Surgery, Saint Barnabas Medical Center – RWJBarnabas Health, Livingston, New Jersey, USA
[10]Department of Otorhinolaryngology – Head and Neck Surgery, Montefiore Medical Center, The University Hospital of Albert Einstein College of Medicine, Bronx, New York, USA

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Corresponding Author:
Christina H. Fang, MD
Assistant Professor
Department of Otorhinolaryngology – Head & Neck Surgery
Montefiore Medical Center
Albert Einstein College of Medicine
3400 Bainbridge Avenue
Bronx, NY 10467
Phone: (718) 920-2991
E-mail: christina.fang1@gmail.com

ABSTRACT

Objective: Tuberculous otitis media (TOM) is a rare extrapulmonary manifestation of tuberculosis (TB) and remains challenging to diagnose due to non-specific symptoms. This systematic review identifies clinical characteristics, diagnostic evaluation, and outcomes in cases of TOM.

Methods: A comprehensive literature search utilizing the PubMed, CINAHL, Scopus, and Cochrane Library databases was conducted for relevant articles published between 2000 to 2021. Cases involving adult patients with TOM were included. Non-English studies, animal studies, and reviews were excluded.

Results: 41 case reports and 7 case series were included, comprising data from 67 patients. The mean age was 40 years (range, 19-87 years) and the majority were female (n=46, 68.7%). The mean symptom duration was 12.8 months (range, 0.25-120 months). Common symptoms included otorrhea (n=60, 89.6%), HL (n=58, 86.6%), otalgia (n=19, 28.4%), and FP (n=18, 26.9%). Otoscopy revealed tympanic membrane (TM) perforation in 45 patients (67.2%). Most patients were diagnosed with tissue biopsy (n=53, 79.1%). Surgical interventions were performed in 48 patients (71.6%) and 63 patients (94.0%) were prescribed anti-TB chemotherapy. Long-term sequelae (e.g., HL, FP, and TM perforation) were noted in 39 patients (58.2%) at a mean follow-up of 18.8 months (range, 1-120 months).

Conclusion: TOM should be included in the differential diagnosis of chronic suppurative otitis media. Histopathological examination is a reliable diagnostic method. Early detection and management are recommended for optimizing outcomes.

1. INTRODUCTION

According to the World Health Organization (WHO), approximately 10 million new cases of TB were reported in 2019.[1] Despite the widespread success of anti-TB treatment, TB remains a global health concern due to its association with *human immunodeficiency virus* infections, poor socioeconomic conditions, and increasing resistance to antibiotics.[1] The most common site of primary infection is the lungs, comprising approximately 85% of reported cases. Extrapulmonary TB occurs in 15–20% of cases, most frequently affecting the lymph nodes, skeletal system, genitourinary tract, meninges, eyes, and ears.[2-4]

Tuberculous otitis media (TOM) is a rare form of extrapulmonary TB, accounting for 0.1% of all TB cases and 0.04-0.9% of chronic suppurative otitis media (CSOM) cases.[5-7] The pathogenesis of TOM typically involves contiguous spread through the eustachian tube, hematogenous spread from the lungs and other distant organs, or direct implantation through the external auditory canal and tympanic membrane (TM) perforation.[8] Clinical presentation of TOM is often described as a classic triad: painless otorrhea, multiple TM perforations, and facial paralysis (FP).[9,10] However, due to its non-specific presentation, TOM is often misdiagnosed, thus delaying initial treatment.[11-13]

Prompt recognition and management of TOM is critical, as disease progression can result in complications including irreversible FP, hearing loss (HL), mastoiditis, labyrinthitis, osteomyelitis, abscess formation, and central nervous system involvement.[9] This disease process is not well-characterized in adult patients. To date, most reports of TOM in adults have been either single case reports or case series. Therefore, this systematic review aims to provide a comprehensive review of the risk factors, clinical manifestations, and diagnostic findings associated with TOM in adult patients. Additionally, we aim to identify trends in TOM treatments and outcomes to potentially guide clinical management in this specific patient population.

2. METHODS

2.1 Search Strategy

A systematic review was performed in January 2021 according to the 2020 Preferred Reporting Items for Systematic Review and Meta-analyses (PRISMA) guidelines (**Supplemental Table 1**).[14] A literature search of the PubMed, CINAHL, Scopus, and Cochrane Library databases was completed using the following terms: "tuberculous otitis media", "middle ear tuberculosis", and "tuberculous otomastoiditis". The results of the search were limited to English language studies published between 2000-2021, including case reports and case series of adult patients (18 years and older) who were diagnosed with TOM. We excluded foreign language studies that could not be translated to English. Studies were also excluded if they were duplicates, non-human studies, review articles, or inaccessible.

2.2 Study Screening

Three independent reviewers (AOO, DKP, and VHH) screened publication titles and abstracts. The same authors screened full text articles to apply inclusion/exclusion criteria. Discrepancies were resolved through discussion between the three authors. References of all full text articles were reviewed to identify pertinent studies.

2.3 Data Extraction, Assessment of Bias, and Synthesis

The following data were extracted from each study: patient demographics, clinical signs/symptoms, pertinent lab findings, diagnostic and treatment modalities, management, follow-up duration, and outcomes. Eligible studies were critically appraised by three independent reviewers (AOO, DKP, and VHH) at the study level using two standardized critical appraisal instruments from the Joanna Briggs Institute (JBI) for case reports and case series respectively.[15] The general quality of studies was assessed using the Oxford Centre for Evidence-Based Medicine (CEBM) level of evidence. Disagreements that arose between the reviewers when applying the critical appraisal tools were resolved through discussion. Individual patient data was available for this study and allowed for descriptive statistical analysis using Microsoft Excel (Microsoft, Redmond, WA).

3. RESULTS

3.1 Search Results and Study Characteristics

Our search retrieved 488 potentially relevant articles. Subsequent screening of the full-text articles yielded 48 studies, including 4 obtained from reference review (**Figure 1**).[2,4,5,7-10,12,13,16-53] 41 retrospective case reports and 7 retrospective case series were included in this systematic review (**Table 1**).

Sixty-seven patients with a mean age of 40 years (range 19-87 years) were identified (**Table 2**). Cases were published from Asia (n=29, 43.2%), Europe (n=26, 38.8%), South America (n=5, 7.5%), North America (n=4, 6.0%), and Africa (n=3, 4.5%). The majority of patients with TOM were female (n=46, 68.7%).

3.2 Patient History

Twenty-five of the 67 patients in this review presented with significant medical and/or social histories. Of these cases, medical histories were positive for prior otologic disease (n=7, 28.0%), immunosuppression (n=4, 16.0%), respiratory disease (n=3, 12.0%), diabetes mellitus (DM) (n=2, 8.0%), congestive heart failure (n=2, 8.0%), hypertension (n=1, 4.0%), and Hepatitis C infection (n=1, 4.0%). Social histories were positive for social exposure to TB (n=4, 16.0%), direct exposure to patients with TB in the healthcare field (n=2, 8.0%), and possible environmental/occupational exposure to TB (n=2, 8.0%). Additionally, sixteen patients (23.9%) in this review presented with concomitant or prior history of pulmonary TB (PTB).

3.3 Clinical Findings

The mean duration of symptoms prior to presentation was 12.8 months (range 0.25-120 months). Unilateral infection was most common (n=51, 76.1%), however 11 patients (16.4%) presented with bilateral TOM. The most common presenting symptoms reported were otorrhea (n=60, 89.6%), HL (n=58, 86.6%), TM perforation (n=45, 67.2%), otalgia (n=19, 28.3%), and FP (n=18, 26.9%). Of the patients with reported hearing loss, types of hearing loss reported included conductive HL (n=38, 65.5%), mixed/unspecified HL (n = 18, 31.0%), and sensorineural HL (n=2, 3.4%). Less common symptoms included tinnitus (n=11, 16.4%) and vertigo (n=9, 13.4%). Constitutional symptoms (e.g., fever, weight loss, night sweats) were present in 5 patients (7.5%). These 5 patients had TB in another location [lung (n=2), abdomen (n=1), meninges (n=1), and cervical spine (n=1)] in addition to the middle ear.

3.4 Diagnosis

Most studies utilized more than one diagnostic method to confirm TOM (**Table 3**). Tests included tissue biopsy (n=53, 79.1%), acid-fast bacillus (AFB) testing (n=17, 25.4%), tissue/sputum culture (n=19, 28.3%) and purified protein derivative (PPD) exams (n=14, 20.9%). Notably, 26 patients (38.8%) presented with positive AFB and/or PPD tests. Of these, 20 patients (76.9%) had a positive tissue biopsy as well. A definitive diagnosis of TOM was obtained via an invasive method (e.g., tissue biopsy, tissue/sputum culture, AFB testing) in 56 cases (83.6%). Radiologic evaluation of the temporal bone/head and neck frequently included computed tomography (CT) scan (n=42, 62.7%), followed by x-ray (n=7, 10.4%) and magnetic resonance imaging (MRI) (n=7,10.4%).

3.5 Management and Outcome

Sixty-three patients (94.0%) were treated with anti-TB chemotherapy (ATC). Of these, 62 patients (98.4%) were prescribed ATC after the diagnosis of TOM was established. One patient (1.6%) had a prior diagnosis of PTB and did not complete the recommended course of ATC for his disease. He was prescribed ATC to treat his TOM and concurrent PTB after his ear discharge was positive for AFB staining and exhibited a positive AFB culture.[26] Of the 63 patients who underwent ATC treatment, treatment duration was reported for 35 patients (55.6%) with a mean duration of 8.5 months (range, 3-12 months). Surgical intervention was also common (n=48, 71.6%) in our patient cohort. Of the 48 patients treated with surgery, 24 patients (n=24, 50.0%) underwent mastoidectomy; 19 patients (39.6%) underwent tympanoplasty; and 5 patients underwent facial nerve exploration/decompression (n=5, 10.4%). Complications following initial surgery were reported in 11 cases (22.9%). Recurrent or persistent symptoms was the most common postoperative complication in these cases (n=8, 72.7%). Due to signs of active disease and persistent symptoms, nine patients included in this review required reoperation (13.4%). Disease eradication was reported in 56 patients (83.5%). Follow-up was reported for 43 patients (64.2%) with a mean follow-up time of 18.8 months (range, 1-120). At their most recent follow-up visit, 22 patients (32.8%) reported residual HL; 12 patients (17.9%) reported FP; and 5 patients (7.5%) had TM atrophy or perforation. There were no deaths reported.

4. DISCUSSION

TOM is an uncommon, yet well-recognized cause of suppurative middle ear disease in adult patients. While a history of PTB may increase the clinical suspicion for TOM, patients without a history of TB may present with TOM.[54] When patients solely or primarily present with otologic symptoms, early recognition of TOM becomes less likely due to its rarity and insidious symptomology.[54,55] Despite recent medical advances and efforts to combat TB globally, TOM has continued to post clinically-challenging cases of CSOM over the past two decades. [2,4,5,7-10,12,13,16-53] In this systematic review, we comprehensively characterize TOM as it presented in a group of adult patients described in studies written in the past 20 years.

4.1 Patient Demographics

In this systematic review comprised of data from adult patients over the past 2 decades, we found that patients, on average, presented with TOM at the age of 40 years with the disease showing a female predilection (2.5:1, F:M ratio). The mean age we report is consistent with reports in recent TOM case series; however, these series reported a slight male predilection of the condition.[56,57] We believe that this discrepancy in gender predisposition may be due to the differences in sample size between the case series and the larger patient cohort in this study.

According to the 2020 WHO Global Tuberculosis Report, the greatest burden of TB disease was in South-East Asia (44%), Africa (25%), and the Western Pacific (18%)[1] In our 65-

patient cohort, the greatest burden of disease was seen in patients of Asian descent (n=30, 46.2%), followed by those of European descent (n=23, 35.4%). Only 3 patients in our study were of African origin (4.6%). Our study shows a low burden of disease in African patients. According to a 2009 survey of otolaryngology services in 18 African countries, patients have poor access to basic otologic equipment and care.[58] It is possible that a lack of access to otolaryngologists and otologists can explain the low number of African patients that presented with TOM in this study.

4.2 Clinical Characteristics

We found that patients with TOM most frequently had a history of prior otologic disease, followed by immunosuppression and DM. While immunosuppression and DM are well-documented risk factors for TB, and even extra-pulmonary TB specifically, studies describing distinct risk factors for TOM are lacking. Details describing a patient’s medical history and the nature of prior otologic disease were often unclear in the included studies, but we suspect that a history of TM perforation or recurrent acute OM (known risk factors for CSOM) may have contributed to TOM in these specific patients.[59]

Studies reporting risk factors most frequently described TOM patients who were exposed to TB via social contact with infected individuals. Two patients in this review were healthcare workers who experienced direct exposures to patients with TB while another 2 patients likely experienced an environmental/workplace exposure. This finding is as expected since direct exposure to patients with TB and occupational exposures are well-known risk factors TB, in general. In our pooled patient cohort, only 24.6% of patients presented with PTB while 33.8% of patients presented with TB in another location (e.g., cervical spine, larynx, nasopharynx, brain, abdomen). Our results generally support previous findings that describe patients with otolaryngology-related TB with roughly 25-30% presenting with concurrent PTB. [56,60,61]

We found that the mean duration of symptoms prior to diagnosis was 12.9 months. This is possibly due to delays in diagnosis associated with the non-specific TOM disease presentation.[11,12,62] As commonly seen in cases of CSOM, we found that otorrhea and hearing loss were the most common presenting symptoms.[59,63] Interestingly, 26.2% patients in this study presented with otalgia. This is surprising since otalgia is not classically associated with TOM. The literature did not consistently elucidate the circumstances behind this unusual finding; however, we speculate that these patients might have developed an acute infection secondary to underlying TOM.[59] Only 24.6% patients presented with FP and only 3.1% of patients presented with symptoms following the “classic triad” of TOM (painless otorrhea, multiple TM perforations, and FP). A 1986 study by Skolnik et al. showed that the incidence of FP in TOM patients before 1953 was 30%, compared to 16% after 1953.[64] Similarly, our results suggest a low incidence of FP associated with TOM in the 21st century. Furthermore, according to studies conducted over the past 20 years, symptoms associated with the “classic triad” are uncommon and becoming decreasingly prevalent.[56,57,65] Another unique feature of TOM that we report in this study is that 11 patients (16.9%) presented with bilateral disease. TOM itself is a rare condition and there is sparse data on bilateral TOM.[46,66] A multi-center study of TOM patients may elucidate risk factors and prognostic indicators for patients with bilateral disese.

4.3 Diagnosis: Laboratory Testing, Imaging, and Histopathology

This systematic review revealed that tissue biopsy was the most frequently utilized diagnostic test in the evaluation of TOM. Histopathologic evaluation and culture of infected tissue are often utilized for definitive diagnosis of this elusive condition.[13,56,67] Common histopathologic findings of TOM include caseous necrosis, granulation with epithelioid cells, and giant Langerhans cells.[9] Of 50 biopsies reported in this review, 22 had caseous granulomas, epithelioid cells, and/or Langerhans cells. Several of the 28 remaining biopsy results describe nonspecific granulomatous lesions. Our findingssuggest that the absence of classic histopathologic findings should not rule out TOM. Apart from a positive tissue biopsy, patients in this review had positive PPD and AFB tests in 26% and 21% cases, respectively. While these tests may be suggestive of TB, or TOM specifically, they are not preferred methods of diagnosing TOM.[9,10] Unsurprisingly, over 70% of patients with positive PPD and/or AFB tests underwent tissue biopsy testing to support a diagnosis of TOM. Despite the presence of several laboratory tests commonly used to diagnose TB, some are not always feasible to obtain (e.g., histopathologic examination) or reliable (e.g., AFB). Though not employed in the studies included in this review, Matrix-assisted laser desorption ionization- time-of-flight (MALDI-TOF) is a modern diagnostic technique that can accurately identifies isolates of mycobacteria.[68,69] Further, two recent studies have described high-sensitivity cartridge-based nucleic acid amplification testing (CBNAAT) and its potential role in early diagnosis of head and neck TB, including TOM. It is possible that this new laboratory test can promote efficient and early diagnosis and treatment of TOM.[7,70]

The present study identified over 80% that involved an invasive method (e.g., biopsy, tissue/sputum culture, AFB testing) to arrive at a definitive diagnosis of TOM. It is important to note that such interventions pose safety concerns for surgeons obtaining these biopsies. We suggest that otolaryngologists undertake airborne safety precautions when evaluating patients with persistent CSOM.

Imaging studies were obtained in 73.8% of our patient cohort and 61.5% were evaluated with a CT scan of the head and neck/temporal bone region, specifically. CT scans may identify soft tissue disease and bony erosion commonly associated with TOM and have been shown to provide more clinical useful temporal bone radiologic information when compared to MRI studies.[71] It is important to note, however, that providers may obtain alternative imaging studies to perform a thorough work-up of patients presenting with non-specific signs and symptoms associated with TOM.

4.4 Treatment and Outcomes

Most of the patients in this review underwent surgical exploration and/or medical treatment for TOM. Within the surgical patient cohort, common procedures were tympanoplasty and mastoidectomy. Clear indications for surgical treatment are lacking and likely vary based on individual patient presentations; however, surgery is helpful for anatomic and auditory recovery.[72] Ultimately, as seen in 92.3% of the patients, ATC is the treatment of choice for eradicating the underlying disease in these patients. In general, patients with TOM receive a standardized ATC regimen consisting of isoniazid, rifampicin, ethambutol, and pyrazinamide for 6 months.[1,30,72] The mean ATC treatment duration reported in this study was closer to 9 months. This is likely because it is acceptable for physicians to deviate from the standardized anti-TB regimen to individualize care based on specific center-specific guidelines and patient scenarios (e.g., drug-resistance).[72]

Although 80% of patients in this study were cured of underlying TOM, residual long-term complications including HL, FP, and TM defects were often noted during follow-up encounters. Due to the wide range of follow-up times in this study (1-120 months), it is possible that a larger percentage of patients presented with residual symptoms several months after treatment – especially in patients who underwent surgery. Since medical treatment for TOM is prescribed for 6-9 months, long-term follow-up (e.g., 1-year) is likely required to monitor for persistent symptoms after treatment. A severe complication of TOM is intracranial extension[7], but only 2 patient (3.0%) in this review developed this specific complication.[33,44] Our findings support previous findings suggesting that intracranial extension is rare with appropriate antibiotic delivery and modern surgical techniques.[73] Even in recent decades, the pathogenesis and treatment considerations for TOM remain poorly understood.[73,74] A thorough evaluation by a multidisciplinary team is required to optimize outcomes in patients with TOM, as this rare subset of CSOM continues to pose significant challenges in otology.

4.5 Limitations

Limitations of this study stem from the poor level of evidence and heterogenous reporting trends in the literature. The JBI Critical Appraisal tools evaluate quality of evidence at the study level. At the study level, the case reports and case series included in this review were of high quality. However, according to the general Oxford CEBM level of evidence guidelines, these studies were levels 4 or 5 suggesting that the studies were of poor quality/limited clinical applicability. This finding was likely a result of limited TOM cases at individual institutions. Several studies did not report variables of interest such as patient history, key laboratory findings (e.g., AFB, PPD, TB PCR), imaging findings, treatment course, and clinical outcomes. When only a few studies report a specific variable, trends observed in a small subset of patients may not represent true trends in an entire population. Another limitation of this study was the necessity to exclude non-English articles that we could not translate. Importantly, there are no multi-institutional studies, randomized control trials, or prospective studies on this subject. Therefore, we were unable to perform a meta-analysis to produce a more robust pooled analysis. To our knowledge, this comprehensive systematic review includes the largest cohort of adult patients presenting with TOM and uniquely presents trends in disease progression in the modern era.

5. CONCLUSION

Clinical suspicion for TOM should arise when patients present with a history suggestive of TB and/or intractable CSOM. Patients commonly present with HL, otorrhea, and TM perforation. Histopathologic evaluation from tissue biopsy samples frequently provided a definitive diagnosis. Surgery and ATC were often employed to eradicate disease and alleviate symptoms.

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FIGURE LEGEND

Figure 1. Flow diagram outlining article inclusion/exclusion process.

Table 1. Overview of included studies.

Authors	Country	Study Design	Number of Cases	Strength of Evidence*	Oxford CEBM‡ Level of Evidence
Cavallin and Muren (2000)[16]	Sweden	Case Report	1	6/8	5
Varty et al. (2000)[13]	India	Case Series	4	7/9	4
Bhalla et al. (2001)[17]	UK	Case Report	1	8/8	5
Kiminyo et al. (2001)[18]	Nigeria	Case Report	1	8/8	5
Vital et al. (2002)[10]	Greece	Case Series	4	7/9	4
Aderibigbe and Ologe (2004)[19]	Nigeria	Case Report	1	8/8	5
Ergün et al. (2004)[20]	Turkey	Case Report	1	8/8	5
Chirch et al. (2005)[8]	USA, Russia	Case Report	2	8/8	5
Sens et al. (2008)[9]	Brazil	Case Report	3	6/8	5
Kahane et al. (2009)[21]	China	Case Report	1	8/8	5
Aremu and Alabi (2010)[22]	USA	Case Report	1	7/8	5
Dienye and Ndukwu (2010)[23]	Nigeria	Case Report	1	8/8	5
Iseri et al. (2010)[24]	Turkey	Case Report	1	8/8	5
Lalić et al. (2010)[25]	Croatia	Case Report	1	8/8	5
Parab et al. (2010)[26]	India	Case Report	1	8/8	5
Karcher et al. (2010)[27]	Germany	Case Series	2	8/9	4
Tang et al. (2010)[28]	Malaysia	Case Series	3	7/9	4
Dale et al. (2011)[12]	UK	Case Report	1	7/8	5
Kohli et al. (2011)[29]	India	Case Report	1	8/8	5
Quaranta et al. (2011)[30]	Italy	Case Report	1	8/8	5
Richardus et al. (2011)[4]	Netherlands	Case Report	1	8/8	5
Shu et al. (2011)[31]	Taiwan	Case Report	1	6/8	5
Hwang et al. (2012)[32]	Korea	Case Report	1	8/8	5
Suchanda et al. (2012)[33]	India	Case Report	1	7/8	5
Brar et al. (2013)[34]	India	Case Report	1	8/8	5
Djeric et al. (2013)[35]	Serbia	Case Report	3	8/8	5
Hwang et al. (2013)[36]	Korea	Case Report	1	8/8	5
Lmekki and Lecanu (2013)[37]	France	Case Report	1	8/8	5
Wang et al. (2013)[38]	Taiwan	Case Report	1	7/8	5
Kim et al. (2014)[39]	Korea	Case Report	1	8/8	5
Liktor et al. (2014)[40]	Hungary	Case Report	2	8/8	5
Hirata et al. (2014)[41]	Brazil	Case Report	1	8/8	5
Gupta et al. (2015)[2]	India	Case Report	1	8/8	5
Nanda et al. (2016)[42]	NR	Case Report	1	7/8	5

Tompkins et al. (2016)[43]	Mexico	Case Report	1	8/8	5
Lodoño et al. (2016)[44]	Colombia	Case Report	1	8/8	5
Bruschini et al. (2016)[45]	Italy	Case Report	1	8/8	5
Bhatkar et al. (2017)[46]	India	Case Report	1	8/8	5
Gilarranz et al. (2017)[47]	Spain	Case Series	3	8/9	4
de Barón et al. (2018)[48]	Spain	Case Report	1	7/8	5
Verma (2018)[49]	India	Case Series	3	8/9	4
Bakshi and Kaipuzha (2019)[50]	India	Case Report	1	8/8	5
Huu Ngoc Minh (2020)[51]	Vietnam	Case Report	1	7/8	5
Truong and Uyen (2020)[52]	Vietnam	Case Report	1	8/8	5
Velepic et al. (2020)[5]	Croatia	Case Report	1	8/8	5
Apostol et al. (2020)[75]	Romania	Case Report	1	7/8	5
Chen and Ye (2020)[53]	China	Case Report	1	8/8	5
Hajare et al. (2020)[7]	NR	Case Series	1[□]	7/9	4
					Aggregate: 3b

*According to The Joanna Briggs Institute (2017) critical appraisal checklist for case reports and case series.
[□]This case series included 5 patients, but only 1 patient met inclusion criteria for this study.

[ǂ]CEBM = Centre for Evidence-Based Medicine

Table 2. Summary of patient characteristics and clinical manifestations.

	N	%
Research type (N = 48)		
Retrospective case reports	41	85.4
Retrospective case series	7	14.6
Period of data sampling (overall 2020-2021)		
2000-2010	17	35.4
2011-2021	31	64.6
No. patients		
67 patients overall (range, 1-4 patients per article)		
Mean age, 40.0 yr (range, 19-87 yr)		
Gender		
Female	46	68.7
Male	21	31.3
Continent		
Asia	29	43.2
Europe	26	38.8
South America	5	7.5
North America	4	6.0
Africa	3	4.5
Patients with PTB	16	23.9
Mean duration of symptoms prior to evaluation, 12.8 mo (range, 0.25-120 mo)		
Site(s) Involved		
Unilateral ear	51	76.1
Bilateral ears	11	16.4
Clinical findings		
Otorrhea	60	89.6
Hearing Loss	58	86.8
CHL	38	66.7
Mixed/unspecified	18	31.0
SNHL	2	3.4
TM perforation	45	67.2
Otalgia	19	28.3
Facial paralysis	18	26.9
Tinnitus	11	16.4
Vertigo	9	13.4
Constitutional symptoms (e.g., fever, weight loss, night sweats)	5	7.5

Abbreviations: PTB, Pulmonary tuberculosis; CHL, conductive hearing loss; SNHL, sensorineural hearing loss; TM, tympanic membrane.

Table 3. Summary of the diagnostic findings, treatment modalities, and long-term outcomes in the included studies.

	N	%
Diagnosis		
Tissue biopsy	53	79.1
Positive tissue/sputum culture	19	28.3
Positive AFB smear/culture	17	25.4
Positive PPD exam	14	20.9
Imaging (of the temporal region)	51	76.1
CT Scan	42	62.7
XR	7	10.4
MRI	7	10.4
Surgical management	48	71.6
Mastoidectomy	24	50.0
Tympanoplasty	19	39.6
Facial nerve exploration/decompression	5	10.4
Medical management with ATC	63	94.0
Mean length of ATC treatment, 8.5 mo (range, 3-12 mo)		
Complications following initial surgery	11	22.9
Recurrent and/or persistent symptoms	8	72.7
Patients requiring reoperation	9	13.4
Mean follow-up time, 18.7 mo (range, 1-120 mo)		
Residual deficits/symptoms at last follow-up visit		
Hearing loss	22	32.8
Facial nerve paralysis	12	17.9
TM atrophy/perforation	5	7.5
Resolution of Tubercular Disease	56	83.5

Abbreviations: AFB, acid fast bacilli; PPD, purified protein derivative; CT, computed tomography; XR, x-ray; MRI, magnetic resonance imaging; TM, tympanic membrane.

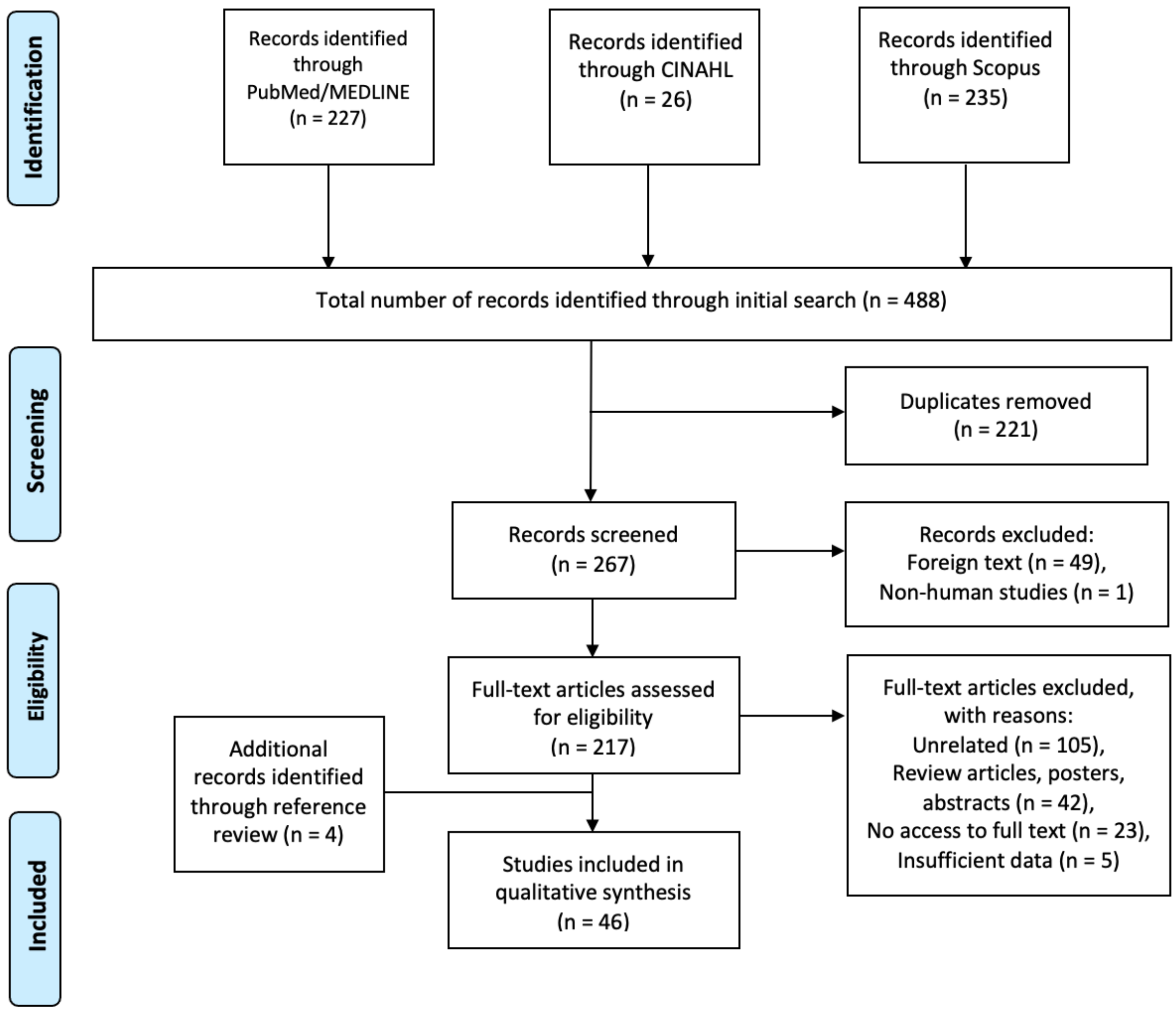

Figure 1. Flow diagram outlining article inclusion/exclusion process.