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Necrotizing Otitis Externa in Diabetic Patients: Clinical, Microbiological, and Therapeutic Findings from a Tunisian Cohort

Mtibaa L[1,2*], Ghorbel S[2,3], Ferchichi S[2,4], Boutheina J[1] and Halwani C[2,3]

[1]*Department of Parasitology-Mycology, Military hospital of Tunis, Tunis, Tunisia*
[2]*Faculty of Medicine of Tunis, University Tunis El Manar, Tunis, Tunisia*
[3]*Department of otorhinolaryngology, Military hospital of Tunis, Tunis, Tunisia*
[4]*Department of otorhinolaryngology, Mohamed Taher Maamouri Hospital Mrezga, Nabeul, Tunisia*

[*]**Corresponding author:** Mtibaa L, Laboratory of Parasitology-Mycology, Military Hospital of Tunis, 1008, Monfleury, Tunis, Tunisia, Faculty of Medicine of Tunis, Tunisia

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Abstract

Objectives: Necrotizing otitis externa (NOE) is a life-threatening infection of the external auditory canal that can extend to the skull base, predominantly affecting diabetic and immunocompromised patients. This study aimed to describe the clinical characteristics, microbiological profile, and management of NOE in order to improve patient outcomes.

Methods: We conducted a retrospective study over a 5-year period in the ENT and cervicofacial surgery department of the Military Hospital of Tunis. All patients diagnosed and treated for NOE were included. Demographic data, clinical presentation, microbiological findings, therapeutic management, and outcomes were analyzed.

Results: A total of 39 patients (40 affected ears) were included, with a mean age of 71 years and a male-to-female ratio of 1.29. All patients had diabetes mellitus. The mean delay before consultation was 50 days. Otalgia was the predominant symptom, and facial nerve palsy was observed in 8% of cases. Microbiological cultures were positive in 43% of cases. Among bacterial isolates, *Pseudomonas aeruginosa* accounted for 53%, with a resistance rate of 22%. Fungal pathogens were identified in 37% of cases, predominantly *Aspergillus flavus*. Empirical antipseudomonal antibiotic therapy was initiated in 59% of patients and administered to all cases, while antifungal treatment was prescribed in 51% based on microbiological results. Overall, infections were classified as bacterial (50%), fungal (33%), and mixed (18%).

Conclusion: Clinical outcomes were favorable, with no relapses or mortality reported. These findings emphasize the emerging role of fungal pathogens and antimicrobial resistance, highlighting the need for standardized therapeutic algorithms in the management of NOE.

Keywords: Necrotizing otitis externa; Diabetes mellitus; Microbiology

Introduction

Necrotizing otitis externa (NOE), formerly known as malignant otitis externa [1], is a severe infection of the external auditory canal that may extend to the skull base, leading to osteomyelitis [2,3]. It predominantly affects immunocompromised patients, particularly those with diabetes mellitus, and is most commonly caused by *Pseudomonas aeruginosa* [3]. Diagnosis remains challenging, as standardized diagnostic criteria have only recently been established [4,5]. This diagnostic uncertainty may delay treatment initiation and complicate management. Without prompt and appropriate therapy, NOE can result in cranial nerve involvement, intracranial extension, and even death [6]. Management relies on prolonged antipseudomonal antibiotic therapy combined with meticulous local care of the external auditory canal. Advances in antimicrobial therapy have significantly improved prognosis, reducing mortality from approximately 50% to less than 5%. However, the emergence of

resistant bacterial strains and the increasing recognition of fungal NOE represent growing challenges, complicating therapeutic decision-making. The aim of this study was to describe the clinical presentation, microbiological profile, and therapeutic management of NOE in our cohort.

Materials and Methods

We conducted a retrospective descriptive study of patients treated for necrotizing otitis externa in the Department of Otolaryngology and Cervicofacial Surgery at the Main Military Teaching Hospital of Tunis between January 2018 and December 2022. All included patients had a confirmed diagnosis of NOE based on clinical presentation and imaging findings and were hospitalized in our department for management. Patients with severe but non-necrotizing otitis externa without osteitic involvement, otitis media extending to the external auditory canal, neoplastic or inflammatory pathologies of the external auditory canal or middle ear, as well as patients with incomplete or unusable medical records, were excluded. Data were collected retrospectively from medical records and included demographic characteristics, comorbidities, clinical features, laboratory and microbiological findings, imaging results, therapeutic modalities, and follow-up outcomes. The study protocol was approved by the Institutional Review Board of the Military Hospital of Tunis. As this was a retrospective study using anonymized medical records, the requirement for written informed consent was waived.

Results

Patient Demographics and Comorbidities

A total of 39 patients (40 ears) were included. The mean age was 71 years (range 43–92), and 84% were over 60. There was a slight male predominance (M/F ratio 1.29). All patients had diabetes mellitus, predominantly type 2 (97%). Poor glycemic control was observed in 47%, and 27% had diabetes-related complications. Other comorbidities included: Hypertension (56%), coronary artery disease (38%), and dyslipidemia (21%).

Premedication with oral antibiotics was reported in 23 patients (59%), mostly amoxicillin–clavulanic acid alone or combined with ciprofloxacin, which may have contributed to diagnostic delay. The mean interval from symptom onset to hospital admission was 50 days (median 30).

Clinical Presentation

- Otalgia: 97%, severe, pulsatile, nocturnal, refractory to first-line analgesics;
- Otorrhea: 69%;
- Hearing loss: 31%;
- Facial asymmetry: 8%, without other cranial nerve deficits.

On otoscopy:

- External auditory canal (EAC) inflammation: 100%;
- EAC narrowing: 90%;
- Granulation tissue: 53%;
- Otorrhea appearance: thick whitish (49%), purulent (34%), yellow-green/malodorous (6%), cotton-like (11%).

Microbiological Findings

Based on combined microbiological and clinical data, infections were classified as bacterial in 20 cases (50%), fungal in 13 cases (33%), and mixed bacterial–fungal in 7 cases (18%).

Bacterial cultures

Initial bacterial cultures were positive in 16 patients (17 ears, 43%). The most frequently isolated bacteria were:

- *Pseudomonas aeruginosa* (n = 9, 53% of positive cultures)
- Coagulase-negative Staphylococc*us* (n = 5, 29%)
- *Morganella morganii* (n = 1, 6%)
- *Achromobacter spp.* (n = 2, 12%)

Antibiotic resistance was observed in 22% of bacterial isolates, without a clear association with prior antibiotic therapy.

Fungal cultures

Fungal cultures were positive in 13 patients (37%), yielding 16 isolates. The distribution of fungal pathogens was as follows:

- *Aspergillus flavus* (n = 6, 38%)
- *Candida albicans* (n = 5, 31%)
- *Candida parapsilosis* (n = 2, 13%)
- *Candida tropicalis* (n = 1, 6%)
- *Aspergillus niger* (n = 1, 6%)
- *Geotrichum capitatum* (n = 1, 6%)

Mixed fungal infections were identified in three patients, including:

- *Aspergillus flavus* + *Candida albicans* (n = 2)
- *Aspergillus flavus* + *Candida parapsilosis* (n = 1)

Imaging and Paraclinical Investigations

- Computed tomography (CT) was performed in all patients (Figure 1). Findings included:
- External auditory canal (EAC) thickening: 83%
- Tympanic bone erosion: 50%
- Facial nerve canal erosion: 15%
- Temporomandibular joint involvement: 33%

Magnetic resonance imaging (MRI) was performed in 8 patients. Abnormalities included:

- Venous thrombosis: 4 patients

- Leptomeningeal enhancement: 1 patient

Bone scintigraphy was performed in 25 patients and was positive in all, consistent with active osteitis.

Treatment and Outcomes

Local and systemic therapy

All patients received daily care of the external auditory canal (EAC), and canal calibration was performed in 38 cases, with granulation tissue debridement performed as indicated. Histological examination of tissue samples revealed inflammatory changes, and one biopsy was obtained under general anesthesia for microbiological analysis. Systemic antibiotic therapy was administered to all patients, with the most commonly used regimen being ciprofloxacin–ceftazidime (n=35). Among these, 14 patients received culture-guided therapy, while 21 were treated empirically (Table 1). The mean duration of antibiotic therapy was 62 days (range 16–>90 days). Alternative regimens were required in five patients due to resistance or poor clinical response (Table 1). Antifungal therapy was administered to 20 patients (51%) based on positive fungal cultures (Table 2). Voriconazole was used in 13 patients and fluconazole in 7. One patient was switched from amphotericin B to voriconazole due to renal toxicity. The duration of antifungal therapy ranged from three to four months. Analgesics were provided to all patients, with 12% requiring level II opioids for pain control. Corticosteroids were administered in two patients with facial palsy. Four patients with venous thrombosis received anticoagulation therapy, all with favorable outcomes.

Table 1: *First-line antibiotic regimens, doses, culture guidance, and treatment duration in patients with necrotizing otitis externa.*

Antibiotic Regimen	N	Pathogen	Duration
Ceftazidime (Fortum®) + Ciprofloxacine	35	*Pseudomonas Aeruginosa* (N=6) *Morganella morganii* (N= 1) *Staphylococcus* coagulase negative (N=5) *Achromobacter* (N=2) Negative (N= 21)	62 days (Mean duration)
Cefotaxime (Claforan®) + Vancomycin	1	-	26 days
Imipenem-Cilastatin (Tienam®) + Fosfomycin	1	*Pseudomonas aeruginosa*, resistant to cefotaxime & ciprofloxacin	15 days
Ciprofloxacin + Imipenem-Cilastatin + Gentamicin (2days)	1	*Pseudomonas aeruginosa*, resistant to cefotaxime	35 days
Ciprofloxacin + Imipenem-Cilastatin + Vancomycin	1	-	15 days
Amikacin (5 days) + Cefotaxime (Fortum®)	1	*Pseudomonas aeruginosa*, resistant to ciprofloxacin & levofloxacin	15 days

Table 2: *First-line antifungal regimens, doses, culture guidance, and treatment duration in patients with necrotizing otitis externa.*

Antifungal Agent	No. of Patients	Pathogen(s) Isolated
Fluconazole	7	*Candida albicans, Candida tropicalis, Candida parapsilosis*
Voriconazole	12	*Aspergillus flavus, Aspergillus niger, Aspergillus flavus + Candida albicans, Aspergillus flavus + Candida parapsilosis*
Amphotericin B → Voriconazole	1	*Geotrichum capitatum*

Adjunctive therapy

Hyperbaric oxygen therapy (HBOT) was administered in 10 patients (26%), with 9–28 sessions (mean 16). Indications included poor response to antibiotics and neurological involvement, particularly facial palsy. No patients required surgical intervention.

Discussion

Pseudomonas aeruginosa remains the predominant pathogen in necrotizing otitis externa (NOE), identified in 53% of our patients, followed by coagulase-negative Staphylococcus (29%), consistent with previous reports [3,6]. The observed 22% resistance rate of *Pseudomonas aeruginosa* to ciprofloxacin underscores the need for early culture-guided therapy and vigilance in antibiotic stewardship to prevent treatment failure

[7,8]. Fungal infections, particularly *Aspergillus flavus* and *Candida albicans*, were observed in 50% of cases, frequently coexisting with bacterial pathogens. The relatively high proportion of fungal isolates observed in our cohort highlights the need for systematic mycological investigation in patients with NOE, particularly in cases of poor response to antibacterial therapy. Superficial cultures may underestimate fungal involvement, and deep tissue biopsy remains the gold standard when systemic antifungal therapy is considered [8-10]. Management of NOE remains complex and requires a multidisciplinary approach. Early empiric antipseudomonal therapy, typically with dual intravenous antibiotics, should be initiated promptly, followed by adjustments according to culture results [6,8,11]. Ciprofloxacin is favored for its bone penetration, though monotherapy is generally discouraged due to the risk of resistance [9,12]. In our cohort, the mean treatment duration was eight weeks, consistent with literature recommending at least six weeks, with extension in cases of slow clinical response, cranial nerve involvement, or poor glycemic control [12-14].

Systemic antifungal therapy, mainly voriconazole, was administered in 51% of patients based on microbiological evidence. Empirical antifungal therapy was avoided to minimize toxicity, although delayed initiation may pose a risk in invasive aspergillosis [8-10]. Optimal glycemic control and regular endocrinology follow-up were essential adjuncts to therapy [7,8,13]. Surgical intervention played a limited role and was reserved for refractory cases or complications; none were required in our series. Hyperbaric oxygen therapy (HBOT) was administered in 26% of patients with poor response or cranial nerve involvement, reflecting the variable evidence for its benefit [15]. Our results support a multidisciplinary approach combining targeted antibiotics, antifungal therapy when indicated, and strict glycemic control, which contributed to the absence of relapses or mortality in this cohort. The study highlights several key findings: a high prevalence of *Pseudomonas aeruginosa*, frequent fungal involvement, and effective multidisciplinary management resulting in favorable outcomes. Strengths include comprehensive clinical, microbiological, and imaging data, as well as consistent follow-up enabling reliable assessment of treatment response. Limitations include the retrospective single-center design, small sample size, and partial use of advanced imaging such as 18F-FDG PET, which may have influenced the evaluation of healing. Assessment of healing relied on clinical and laboratory improvement, supported by nuclear imaging when indicated. No recurrences or deaths were observed, consistent with improved outcomes reported in recent literature [8]. Overall, these results support a standardized, multidisciplinary protocol combining early targeted antibiotics, antifungal therapy when indicated, glycemic control, and selective adjunctive interventions to optimize outcomes, reduce hospitalization, and minimize complications in NOE.

Conclusions

Necrotizing otitis externa remains a challenging infection that requires early diagnosis and a multidisciplinary approach. Our findings underscore the importance of systematic microbiological investigation, including fungal cultures, to guide targeted therapy. Based on our experience, we propose the structured management protocol presented in Figure 2. This strategy, emphasizing rapid adaptation and individualized treatment, provides a practical framework to improve patient outcomes, reduce relapse rates, and optimize antimicrobial stewardship in NOE.

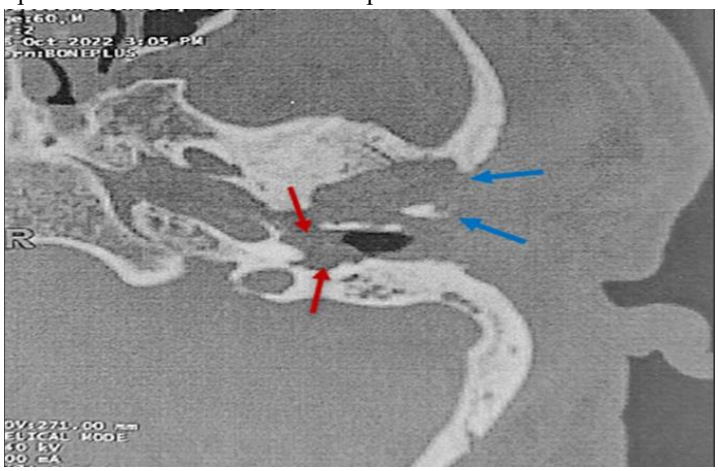

Figure 1: *CT scan centered on the left petrous bone, axial view with bone window, showing extensive bony lysis of the external auditory canal walls (red arrows), with extension to the mandibular fossa of the temporal bone and the ipsilateral mandibular condyle (blue arrows).*

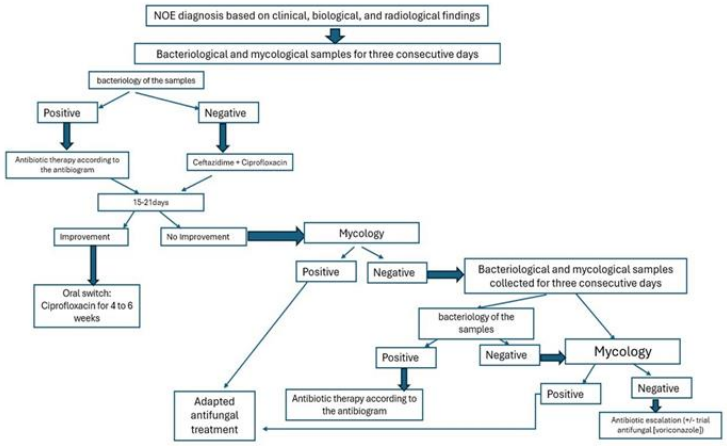

Figure 2: *Proposed management algorithm of NOE.*

Highlights

- Necrotizing otitis externa (NOE) is a severe infection predominantly affecting diabetic patients.

- In this Tunisian cohort (39 patients, 40 ears), *Pseudomonas aeruginosa* was the most frequent bacterial pathogen, while *Aspergillus flavus* was the predominant fungal isolate.
- Mixed bacterial-fungal infections were observed in 18% of cases, emphasizing the importance of comprehensive microbiological assessment.
- Empirical antipseudomonal therapy combined with targeted antifungal treatment led to favorable outcomes, with no relapses or mortality.

Standardized diagnostic and therapeutic protocols are crucial to optimize management and reduce complications in NOE.

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