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# *Aspergillus* otitis externa: A retrospective study of predisposing factors, treatment, and complications

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## Abstract

**Objectives:** To study the predisposing factors, treatment, and complications of *Aspergillus* otitis externa.

**Methods:** A retrospective analysis of patients diagnosed with *Aspergillus* otitis externa at the Department of Otorhinolaryngology, Helsinki University Hospital, between January 2010 and December 2018 was performed.

**Results:** Of the 269 *Aspergillus* otitis externa (OE) patients, 96 developed otitis media (OM) and 7 developed mastoiditis. Antibiotic and steroid treatment and otological history were risk factors for *Aspergillus* OE. Systemic diseases and immunocompromising states were more common in mastoiditis patients. Repetitive ear cleaning and topical drugs are primary treatments, but systemic drugs and surgery were needed in resistant and invasive cases. Forty-five novel tympanic membrane (TM) perforations were reported. A strong association between *Aspergillus* species and final infection types was found; *A. niger* was the dominant species in OM and in novel TM perforations, whereas *A. flavus* and *A. fumigatus* caused mastoiditis. Some of the TM perforations persisted despite treatment. Permanent hearing impairment was associated with OM and mastoiditis.

**Conclusion:** As *Aspergillus* OE has the potential to cause acute and chronic complications, fungal OE should be suspected early on if the infection persists after conventional treatment. The identification of *Aspergillus* species could aid in spotting patients at risk for more severe disease and complications. Intensive local treatment is sufficient in most cases of OE and OM but effective topical antifungals are limited. Patients with *Aspergillus* OM and mastoiditis should be followed up for hearing impairment and permanent TM perforations after the infection resolves.

**Level of evidence:** Level 4 (The Oxford 2011 Levels of Evidence).

KEYWORDS

*Aspergillus*, mastoiditis, otitis externa, otitis media, tympanic membrane perforation

## 1 | INTRODUCTION

Along with *Candida* species, *Aspergillus* species are the most common fungi that cause otitis externa (OE). Predisposing factors for fungal OE are the use of topical antibiotics, steroids, and nonsterile oils, a warm environment, swimming, and mechanical trauma to the external auditory canal.[1,2]

Most fungal OE are superficial but they may result in severe complications, such as malignant OE, which is typically associated with diabetes, AIDS, and other immunocompromising conditions. Malignant OE is an invasive infection of tissues around the external auditory canal and may lead to further complications, such as cranial nerve palsies.[3–5] *Aspergillus* species are among the most common fungi in malignant OE.[4] Fungal OE may develop into otitis media (OM) and mastoiditis via tympanic membrane (TM) perforation or tympanostomy.[5,6] Few earlier studies have focused on TM perforations and acute OM caused by fungi.[7,8]

The most important *Aspergillus* species in OE are *A. niger*, *A. flavus*, and *A. fumigatus*.[2] Typically, *Aspergillus* forms a biofilm on the surface of skin and mucosa. This may enhance fungal growth and penetration and increase resistance to the host's immune system and antifungal drugs.[9] Adequate treatment includes mechanical cleaning of the biofilm and discharge with irrigation and suction, topical antifungals or other antimicrobial agents, and systemic antifungal drugs.[1,3,6] Surgery and hyperbaric oxygen therapy are additional treatment options for complicated cases and malignant OE.[4,5]

This study aimed to characterize the predisposing factors, treatment, and complications of *Aspergillus* OE with a special focus on TM perforations, acute OM, and mastoiditis.

## 2 | MATERIALS AND METHODS

This was a retrospective analysis of patients diagnosed with *Aspergillus* OE at the Department of Otorhinolaryngology, Helsinki University Hospital, a tertiary care center, between January 2010 and December 2018. The data were collected from the Helsinki University Hospital databases. We included all patients with clinically diagnosed and microbiologically verified *Aspergillus* OE. None of the patients were excluded due to limited follow-up data or for any other reason. The follow-up data were collected until the end of 2019.

The following patient data were collected: age, sex, comorbidities, body mass index (BMI), smoking history, alcohol and drug use status, immunocompetence status, and otological history. The following data were collected for the studied *Aspergillus* OE: infection characteristics, *Aspergillus* species, susceptibility results, other concomitant pathogens, treatment, number of outpatient visits, follow-up, outcomes, hearing test results, surgical procedures, and complications.

The onset of *Aspergillus* OE was defined as the date when *Aspergillus* was microbiologically verified. The duration of infection was calculated from the time of diagnosis until complete recovery, as determined by a physician, or until the end of follow-up, if earlier. The treatments targeted to *Aspergillus* after microbiological verification were included in the analysis of effective treatments.

Mycological and bacteriological samples were cultivated and morphologically analyzed at the laboratory of the Department of Microbiology, Helsinki University Hospital. Susceptibility testing was performed only if mastoiditis was diagnosed or suspected.

Hearing test results were available for a limited number of patients. Only patients with both pre- and postinfection hearing results were included in the hearing level analysis. Hearing results were reported as pure tone average (PTA) decibels from the frequencies of 500, 1000, 2000, and 4000 Hz.

The clinical and demographic data of the patients were analyzed using descriptive statistics and the IBM® SPSS® Statistics Chi-square test, ANOVA, and multinomial logistic regression. $p < .05$ was considered to indicate statistical significance.

The research protocol was approved by the Ethics Committee of Helsinki University Hospital. The analyses were anonymous and based on retrospective data. No patient was contacted or prospectively followed up.

## 3 | RESULTS

A total of 269 patients with *Aspergillus* OE were included in the study. Most patients had a noncomplicated OE with an intact TM and no signs of invasion but some developed OM and mastoiditis, through either an existing (chronic) or an infection-born (novel) TM perforation. In Tables 1–3, the cohort was divided into subgroups based on the final infection type: OE ($n = 166$, 61.7%), OM ($n = 96$, 35.7%), and mastoiditis ($n = 7$, 2.6%).

The average age was 51.7 years, and 135 (50.2%) patients were females. The majority ($n = 168$, 62.5%) had systemic comorbidities, most frequently cardiovascular diseases and diabetes. A history of repetitive OE (59.1%) was common. Psychiatric diseases, active malignancy, and ongoing immunosuppressive therapy were more common among patients with mastoiditis than others ($p < .05$). The demographic data and medical history are shown in Table 1.

The patients were diagnosed with OE in a primary or secondary care center or at our clinic, and most of them ($n = 216$, 80.3%) received local or systemic antibiotics, corticosteroids, or other drugs that were initiated empirically or targeted to other concomitant microbes (most frequently *Staphylococcus aureus*, *Pseudomonas*, and *Candida parapsilosis*). Usually, after treatment failure, the patients were referred to our clinic where microbiological samples were taken at the latest and afterward repeated in case of a weak response to treatment. Overall, a majority ($n = 172$, 63.9%) of the patients had monomicrobial *Aspergillus* OE. The mean and median durations of OE symptoms before *Aspergillus* diagnosis were 56 and 21 days, respectively. The management of *Aspergillus* OE required up to 542 days (mean 47 days, median 20 days) before recovery. Patients visited the outpatient clinic 1– 25 times. Repetitive visits were carried out to perform mechanical ear cleanings and to follow up recovery. Based on the TM status and signs of invasion, the final infection type was

**TABLE 1** Demographics.

| | OE ($N = 166$, 61.7%) | OM ($N = 96$, 35.7%) | Mastoiditis ($N = 7$, 2.6%) | *p*-value |
|---|---|---|---|---|
| Gender, *N* (%) | | | | .137 |
| Female | 76 (45.8) | 56 (58.3) | 3 (42.9) | |
| Male | 90 (54.2) | 40 (41.7) | 4 (57.1) | |
| Age, years | | | | |
| Range | 4.2–94.4 | 5.9–93.9 | 16.5–88.2 | |
| Mean | 51.7 | 51.7 | 52.7 | .826 |
| Median | 52.4 | 52.4 | 53.0 | |
| BMI, *N* (%) | | | | .813 |
| <30 | 120 (72.3) | 64 (66.7) | 5 (71.4) | |
| >30 | 36 (21.7) | 24 (25.0) | 2 (28.6) | |
| Not reported | 10 (6.0) | 8 (8.3) | 0 | |
| Intoxicants, *N* (%) | | | | |
| Current smoking | 35 (21.1) | 12 (12.5) | 2 (28.6) | .173 |
| Current alcohol abuse | 11 (6.6) | 5 (5.2) | 1 (14.3) | .616 |
| Comorbidities, *N* (%) | | | | |
| Cardiovascular | 61 (36.7) | 35 (36.5) | 3 (42.9) | .945 |
| Diabetes | 30 (18.1) | 11 (11.5) | 2 (28.6) | .245 |
| Chronic pulmonary disease | 18 (10.8) | 11 (11.5) | 2 (28.6) | .358 |
| Chronic auricular skin disease | 17 (10.2) | 5 (5.2) | 0 | .263 |
| Hypothyreosis | 11 (6.6) | 10 (10.4) | 1 (14.3) | .471 |
| Psychiatric disease | 8 (4.8) | 5 (7.2) | 2 (28.6) | .027 |
| Rheumatic or other autoimmune disease | 5 (3.0) | 6 (6.3) | 1 (14.3) | .211 |
| Chronic rhinosinusitis | 6 (3.6) | 3 (3.1) | 1 (14.3) | .322 |
| Neurological disease | 4 (2.4) | 6 (6.3) | 0 | .251 |
| Active malignancy | 1 (0.6) | 0 | 1 (14.3) | <.001 |
| None | 65 (39.2) | 34 (35.4) | 2 (28.6) | .688 |
| Ongoing immunosuppressive therapy | 3 (1.8) | 1 (1.0) | 1 (14.3) | .043 |
| Otological history, *N* (%) | | | | |
| Multiple OE | 96 (57.8) | 60 (62.5) | 3 (42.9) | .516 |
| Multiple *Aspergillus* OE | 36 (21.7) | 23 (24.0) | 1 (14.3) | .801 |
| Ear surgery on the infection side | 47 (28.3) | 30 (31.3) | 1 (14.3) | .606 |
| Hearing aid on the infection side | 16 (9.6) | 10 (10.4) | 1 (14.3) | .913 |

*Note*: The demographic data and medical history of the whole cohort and the subgroups are based on the final infection type.

categorized as OE, OM, or mastoiditis. 10 (3.7%) patients were hospitalized to enable intensive local treatment or to perform surgery and administer intravenous medication; 6 of them had mastoiditis. The duration of infection did not vary significantly between the final infection types but patients with *A. niger* infection had more outpatient visits (mean 4.60 vs. 3.89, $p < .05$) and more ear debridements (mean 4.19 vs. 3.54, $p < .05$) than did the other patients.

The primary treatment for *Aspergillus* OE was debridement, and topical drugs and antimicrobial agents, such as boric acid, methylene blue, clioquinol, miconazole, and off-label itraconazole. Additionally, oral itraconazole was used in 8.6% of the cases. Susceptibility testing that was performed only in 9 cases found no resistance to voriconazole. Mastoiditis was managed with long periods of intravenous voriconazole and/or oral itraconazole in 6 cases, with mastoidectomy in 6 cases, and with hyperbaric oxygen treatment in 1 case. (Table 2) No mortality or persistent *Aspergillus* infection was reported.

*A. niger* was the most common species and was isolated from 149 (55.4%) patients, followed by *A. flavus* from 62 (23.0%) patients and *A. fumigatus* from 29 (10.8%) patients. *A. niger* was the major species in the OM (72.9%, $p < .05$) and novel TM perforation (82.2%, $p < .05$) groups, whereas *A. flavus* (42.9%) and *A. fumigatus* (42.9%) were the dominant species in the mastoiditis group ($p < .05$) (Table 3). In a multinomial logistic regression analysis for severity of infection with *Aspergillus* species as factor, and age, gender, hearing aid use, smoking, and psychiatric diseases as covariates, we found *Aspergillus* species to be significant in the model ($p = .002$).

**TABLE 2** Treatment.

| Treatment, *N* (%) | Total (*N* = 269) | OE (*N* = 166, 61.7%) | OM (*N* = 96, 35.7%) | Mastoiditis (*N* = 7, 2.6%) |
|---|---|---|---|---|
| Mechanical ear cleaning | 264 (98.1) | 163 (98.2) | 94 (97.9) | 7 (100.0) |
| Local antiseptics | 238 (88.5) | 153 (92.2) | 80 (83.3) | 5 (71.4) |
| Boric acid | 179 (66.5) | 122 (73.5) | 55 (57.3) | 2 (28.6) |
| Methylene blue | 187 (69.5) | 121 (72.9) | 62 (64.6) | 4 (57.1) |
| Clioquinol | 73 (27.1) | 33 (19.9) | 38 (39.6) | 2 (28.6) |
| Local antifungals | 43 (16.0) | 20 (12.0) | 21 (21.9) | 2 (28.6) |
| Itraconazole | 16 (5.9) | 7 (4.2) | 8 (8.3) | 1 (14.3) |
| Miconazole | 31 (11.5) | 15 (9.0) | 14 (14.6) | 2 (28.6) |
| Systemic antifungals | 25 (9.3) | 6 (3.6) | 13 (13.5) | 6 (85.7) |
| Itraconazole p.o. | 23 (8.6) | 6 (3.6) | 13 (13.5) | 4 (57.1) |
| Voriconazole i.v. | 4 (1.5) | 0 | 0 | 4 (57.1) |
| Surgery | 6 (2.2) | 0 | 0 | 6 (85.7) |
| Hyperbaric oxygen | 1 (0.3) | 0 | 0 | 1 (14.3) |

*Note*: The treatments administered in the whole cohort and the subgroups based on the final infection type.

**TABLE 3** *Aspergillus* species.

| *Aspergillus* species, *N* (%) | Total (*N* = 269) | OE (*N* = 166, 61.7%) | OM (*N* = 96, 36.7%) | Mastoiditis (*N* = 7, 2.6%) | Novel TM perforation (*N* = 45, 16.7) |
|---|---|---|---|---|---|
| Niger | 149 (55.4) | 78 (47.0) | 70 (72.9) * | 1 (14.3) | 37 (82.2) * |
| Flavus | 62 (23.0) | 51 (30.7) | 8 (8.3) | 3 (42.9) * | 3 (6.7) |
| Fumigatus | 29 (10.8) | 20 (12.0) | 6 (6.3) | 3 (42.9) * | 2 (4.4) |
| Sydowi | 9 (3.3) | 5 (3.0) | 4 (4.2) | 0 | 0 |
| Terreus | 8 (3) | 6 (3.6) | 2 (2.1) | 0 | 1 (2.2) |
| Ochraceus | 1 (0.3) | 0 | 1 (1.0) | 0 | 0 |
| Glaucus | 1 (0.3) | 1 (0.6) | 0 | 0 | 0 |
| Hollandicus | 1 (0.3) | 0 | 1 (1.0) | 0 | 0 |
| Not specified | 9 (3.3) | 5 (3.0) | 4 (4.2) | 0 | 2 (4.4) |

*Note*: *Aspergillus* species in the cohort, in the subgroups based on the final infection type, and in the OM and mastoiditis cases with a novel TM perforation.
*$p < .05$.

Of the 7 patients, 3 with mastoiditis had further complications—1 with facial nerve palsy, 1 with facial and abducens nerve palsy and temporal bone osteomyelitis, and 1 with destruction of the ossicles. All of them had a monomicrobial *Aspergillus* infection. Both patients with cranial nerve palsies also had novel TM perforations due to *A. flavus* and *A. fumigatus*.

A novel, infection-born, TM perforation was diagnosed in 42 OM and 3 mastoiditis patients. In addition, 58 patients had a chronic or iatrogenic TM perforation. The total incidence of novel TM perforations was 16.7%. Nine perforations were closed surgically, 18 closed spontaneously during follow-up, 12 persisted, and 6 patients were lost to follow-up. The management of the novel TM perforations is shown in Figure 1.

Full hearing test results were available for 47 patients. The average decrease in the air conductivity PTA was 3.1 dB in the OE group, 13.8 dB in the OM group, and 19.0 dB in the mastoiditis group ($p = .178$). During follow-up, the number of hearing aid users increased from 44 to 58.

## 4 | DISCUSSION

We retrospectively studied a cohort of 269 patients treated for *Aspergillus* OE: 96 developed OM, and 7 developed mastoiditis. The risk factors for *Aspergillus* OE were previous antibiotic and steroid treatments and a history of otological disorders. These results are in line with the literature.[1,2,7,10] Mastoiditis patients more often had active malignancies and received immunosuppressive therapy ($p < .05$). Immunocompromised states, including diabetes, HIV/AIDS, malignancies, and organ transplants, have been identified as risk factors for invasive *Aspergillus* infections.[3,5,11] Except for diabetes, these etiologies were rare in our cohort. The small number of patients with mastoiditis was a limitation in the analysis of risk factors.

The symptoms of fungal OE are less fulminant with less pain than those of bacterial OE,[2] which may partly explain the prolonged symptoms. In our cohort, the diagnosis was delayed if *Aspergillus* was not suspected and microbiologically tested in the early stage. In some mixed infections, *Aspergillus* was not considered clinically relevant,

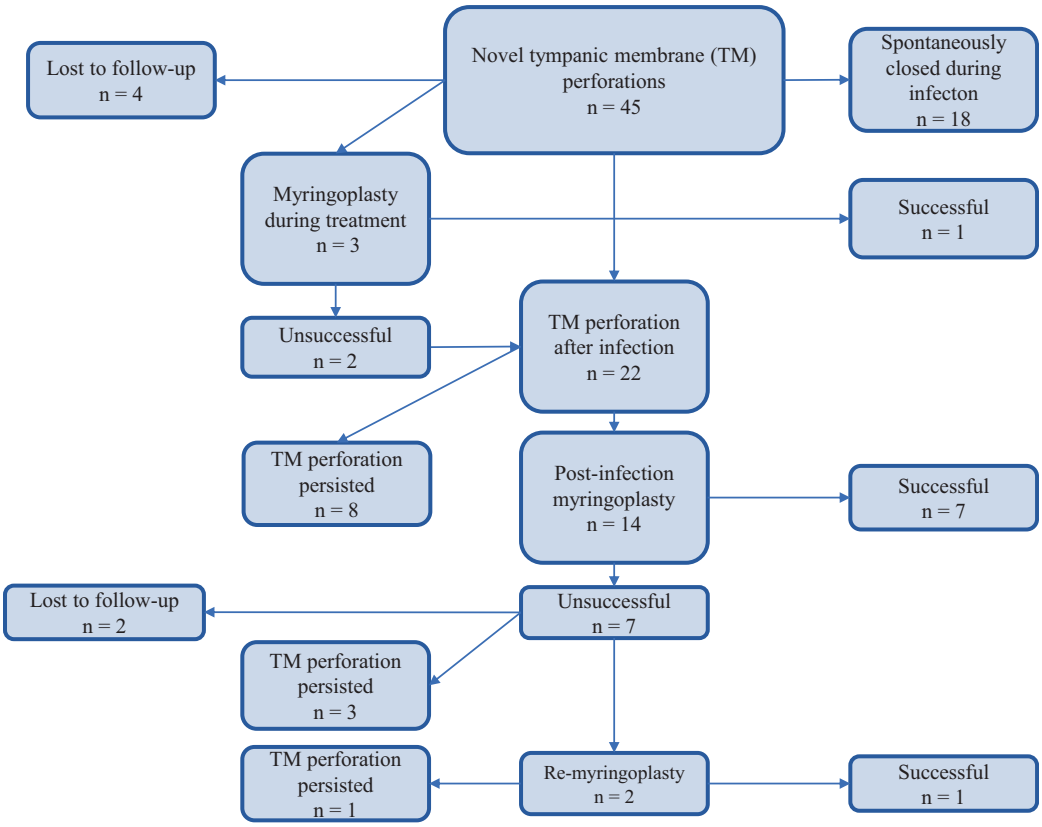


**FIGURE 1** Management of the novel TM perforations.

and the treatment was targeted at bacteria. In both noncomplicated and invasive fungal OE, the latency before diagnosis and onset of effective treatment was generally long, as has been observed in previous studies.[3,7,10,12,13] This may increase *Aspergillus* growth, prolong infection, and predispose patients to complications. In addition, delayed diagnosis increases patient burden and overall costs.

Treatment of noninvasive *Aspergillus* OE requires time and effort.[6,10] In our cohort, the response was often observed only after multiple debridements and treatment trials. Local treatment mainly consisted of nonselective antimicrobial agents, mostly because effective and nontoxic topical antifungal drugs are poorly available.[8] Adequate clotrimazole products were not available at all in our country, even though topical clotrimazole can be recommended for treating *Aspergillus* OE and OM.[1,2,14,15] Nevertheless, most noninvasive infections were successfully managed without systemic antifungals, indicating that careful local treatment is sufficient for eradicating *Aspergillus*. Instead, in invasive infections, long-term systemic antifungals are essential, and surgical treatment must often be combined.[3,4,12] In our study, severe complications such as mastoiditis were successfully managed according to these principles. In most cases with mastoiditis, voriconazole, which is a recommended drug,[3,16] was used.

A significant percentage of our *Aspergillus* OE patients developed OM, and a minority further developed mastoiditis. We found strong associations between *Aspergillus* species and final infection type. *A. niger* was the most common species in the OE.[1,2,17,18] *A. niger* also caused the most OM (72.9%) and infection-born TM perforations (82.2%) and was overrepresented in these groups ($p < .05$). After excluding patients with chronic TM perforation, the rate of novel TM perforations in *A. niger* OE patients was 32.2%. To our knowledge, such a strong potential to cause complications has not been reported before. However, mastoiditis was mainly caused by *A. flavus* and *A. fumigatus* ($p < .05$), which were much less common in the cohort. This was somewhat expected, as *A. flavus* and *A. fumigatus* are known to cause invasive infections.[3,5,11] Compared to other studies on fungal invasive OE, two patients developed cranial nerve palsy but we observed no persistent infections or mortality.[4,5,12] This could be explained by the low number of immunocompromising comorbidities in our cohort.

TM perforations have been previously reported in fungal OE.[1,7,8,10,18] In our cohort, an infection-born TM perforation was diagnosed in 16.7% of the patients. The rate of spontaneous recovery was 40% and the rate of surgical closure was only 20%. Thus, the rate of persistent novel TM perforations was relatively high compared to that in other studies on fungal OE.[8] This suggests that TM perforations caused by *A. niger* might have a lower healing potential than those caused by other fungal etiologies. This perspective warrants further study. Furthermore, this highlights that even noninvasive *Aspergillus*

OE may cause permanent TM perforations and subsequent disadvantages for the patient.

We found evidence of permanent hearing impairment caused by *Aspergillus* OE. Hearing loss in patients with noncomplicated OE was minor and not clinically significant. However, the difficulty of hearing loss in OM and mastoiditis correlated with infection severity. Fourteen new patients initiated hearing rehabilitation after *Aspergillus* OM or mastoiditis, indicating that these infections carry a risk of significant hearing loss. Similar results have been reported in fungal malignant OE.[3,4]

## 5 | CONCLUSION

*Aspergillus* etiology in OE should be suspected early on to prevent delays in the onset of intervention. Patients with a history of otological disorders are exposed to superficial *Aspergillus* OE and invasive infections may develop in immunocompromised patients with intact ears. Our results suggest that most noninvasive *Aspergillus* OE can be managed with intensive debridements and topical antifungals, provided that adequate drugs are available. The approach for treating mastoiditis, however, is different, warranting systemic antifungals and surgery. Complications such as OM and infection-borne TM perforations in superficial *Aspergillus* OE may be more common than previously thought. In particular, *A. niger* OE can be resilient and carry a risk for TM perforation. The management of TM perforations caused by *Aspergillus* is challenging, and repetitive surgical attempts may be needed. Hearing tests should be performed in the case of *Aspergillus* OM and mastoiditis to identify patients with impaired hearing. Our results indicate that even noninvasive *Aspergillus* OE may cause permanent disadvantages for patients, and these infections should be taken seriously.

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### CONFLICT OF INTEREST STATEMENT

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as potential conflicts of interest. Outside of this study, R. Saarinen is employed by Bayer Pharmaceuticals.

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### REFERENCES

1. Viswanatha B, Sumatha D, Vijayashree MS. Otomycosis in immunocompetent and immunocompromised patients: comparative study and literature review. *Ear Nose Throat J*. 2012;91(3):114-121. doi:10.1177/014556131209100308
2. Kiakojuri K, Armaki MT, Rajabnia R, et al. Outer ear infections in Iran: a review. *Open Access Maced J Med Sci*. 2019;7(7):1233-1240. doi:10.3889/OAMJMS.2019.176
3. Marchionni E, Parize P, Lefevre A, et al. *Aspergillus* spp. invasive external otitis: favourable outcome with a medical approach. *Clin Microbiol Infect*. 2016;22(5):434-437. doi:10.1016/J.CMI.2015.12.027
4. Mion M, Bovo R, Marchese-Ragona R, Martini A. Outcome predictors of treatment effectiveness for fungal malignant external otitis: a systematic review. *Acta Otorhinolaryngol Ital*. 2015;35(5):307-313. doi:10.14639/0392-100X-669
5. Parize P, Chandesris MO, Lanternier F, et al. Antifungal therapy of *Aspergillus* invasive otitis externa: efficacy of voriconazole and review. *Antimicrob Agents Chemother*. 2009;53(3):1048-1053. doi:10.1128/AAC.01220-08
6. Martin TJ, Kerschner JE, Flanary VA. Fungal causes of otitis externa and tympanostomy tube otorrhea. *Int J Pediatr Otorhinolaryngol*. 2005;69(11):1503-1508. doi:10.1016/J.IJPORL.2005.04.012
7. Ho T, Vrabec JT, Yoo D, Coker NJ. Otomycosis: clinical features and treatment implications. *Otolaryngol Head Neck Surg*. 2006;135(5):787-791. doi:10.1016/J.OTOHNS.2006.07.008
8. Koltsidopoulos P, Skoulakis C. Otomycosis with tympanic membrane perforation: a review of the literature. *Ear Nose Throat J*. 2020;99(8):518-521. doi:10.1177/0145561319851499
9. Beauvais A, Latgé JP. Aspergillus biofilm in vitro and in vivo. *Microbiol Spectr*. 2015;3(4). doi:10.1128/MICROBIOLSPEC.MB-0017-2015
10. Song JE, Haberkamp TJ, Patel R, Redleaf MI. Fungal otitis externa as a cause of tympanic membrane perforation: a case series. *Ear Nose Throat J*. 2014;93(8):332-336. doi:10.1177/014556131409300811
11. Gabrielli E, Fothergill AW, Brescini L, et al. Osteomyelitis caused by *Aspergillus* species: a review of 310 reported cases. *Clin Microbiol Infect*. 2014;20(6):559-565. doi:10.1111/1469-0691.12389
12. Hamzany Y, Soudry E, Preis M, et al. Fungal malignant external otitis. *J Infect*. 2011;62(3):226-231. doi:10.1016/J.JINF.2011.01.001
13. Punia RS, Singhal SK, Kundu R, Das A, Chander J. Fungal suppurative otitis media (histopathology) among patients in North India. *Head Neck Pathol*. 2019;13(2):149-153. doi:10.1007/S12105-018-0918-2
14. Vennewald I, Klemm E. Otomycosis: diagnosis and treatment. *Clin Dermatol*. 2010;28(2):202-211. doi:10.1016/J.CLINDERMATOL.2009.12.003
15. Jimenez-Garcia L, Celis-Aguilar E, Díaz-Pavón G, et al. Efficacy of topical clotrimazole vs. topical tolnaftate in the treatment of otomycosis. A randomized controlled clinical trial. *Braz J Otorhinolaryngol*. 2020;86(3):300-307. doi:10.1016/J.BJORL.2018.12.007
16. Kaya AD, Kiraz N. In vitro susceptibilities of *Aspergillus* spp. causing otomycosis to amphotericin B, voriconazole and itraconazole. *Mycoses*. 2007;50(6):447-450. doi:10.1111/J.1439-0507.2007.01409.X
17. Abdelazeem M, Gamea A, Mubarak H, Elzawawy N. Epidemiology, causative agents, and risk factors affecting human otomycosis infections. *Turk J Med Sci*. 2015;45(4):820-826. doi:10.3906/SAG-1407-17
18. Ozcan KM, Ozcan M, Karaarslan A, Karaarslan F. Otomycosis in Turkey: predisposing factors, aetiology and therapy. *J Laryngol Otol*. 2003;117(1):39-42. doi:10.1258/002221503321046621

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