

Original Research Article

Symptoms and Complications of Nervous System in Patients with Mucormycosis: A Systematic Review

Saeid Charsouei¹, Ali Reza Lotfi^{2*}

¹Assistant Professor of Neurology, Tuberculosis, and Lung Disease Research Center, Tabriz University of Medical Sciences, Tabriz, Iran

²Associate Professor of Otorhinolaryngology, Head and Neck Surgery, Tuberculosis, and Lung Disease Research Center, Tabriz University of Medical Sciences, Tabriz, Iran

ARTICLE INFO

Article history

Submitted: 2022-10-31

Revised: 2022-11-10

Accepted: 2022-11-30

Available online: 2022-12-15

Manuscript ID: AJCB-2210-1132

DOI:10.22034/ajcb.2022.367982.1132

KEYWORDS

Mucormycosis

Covid-19

Complications

Nervous System

Symptoms

ABSTRACT

Introduction: Mucormycosis is a disease that is common in patients with a history of diabetes mellitus who have recently been infected with Covid-19, and it affects the nervous system more than other systems. This study was designed with the aim of examining the symptoms and complications of the nervous system in patients with mucormycosis.

Method: Searches were conducted in PubMed, Scopus, Science Direct, and Google Scholar databases between December 2019 and the first five months of 2020. The search terms were: Covid-19, SARS-CoV-2, olfactory disorder, loss of taste, mucormycosis, neurological manifestations, diabetes mellitus, neurological disorder, eye disease, thyroid disease, and diabetes complication.

Results: In the initial search, 1259 articles were extracted, after removing the duplicates and evaluating the title and abstract, the articles with the necessary conditions to participate in the present study were selected, and general conclusions were made based on information in the various selected articles.

Conclusion: Whether the findings of this study are sufficient to increase health literacy about mucormycosis and how much this information increases health literacy concerning mucormycosis should be determined in future studies. Given that the Internet is one of the most important sources of health knowledge in our society. Providing the correct information about the contents that are discussed in virtual spaces, especially about topics of interest to people such as traditional medicine and nutrition in the control of mucormycosis disease, can improve people's ability to evaluate the correctness or incorrectness of the information in these spaces.

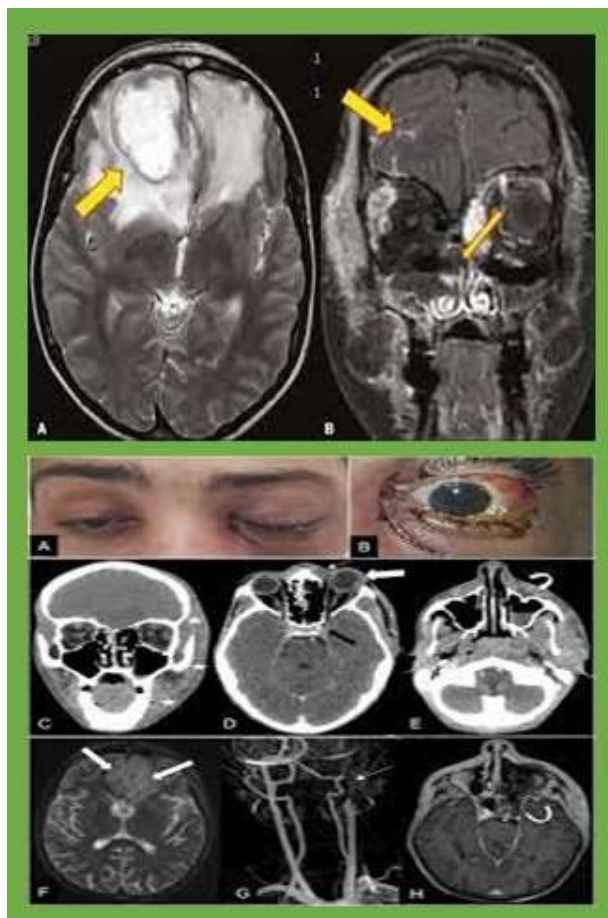
* Corresponding author: Ali Reza Lotfi

✉ E-mail: Alireza.Lotfi@yahoo.com

© 2022 by SPC (Sami Publishing Company)



GRAPHICAL ABSTRACT



1. Introduction

Coronaviruses are a large family of viruses that are mainly known in humans as the causative agents of respiratory tract infections, ranging from colds to more serious respiratory diseases such as pneumonia, bronchitis, and acute respiratory distress syndrome [1,2]. Of the seven different types of coronavirus that affect humans [3], four of them are very common and most people will experience at least one of them in their lifetime. Three other types of human-infecting coronaviruses under the names of SARS-CoV, MERS-CoV, and SARS-CoV-2 are associated with severe respiratory infections and death. SARS-CoV-2 is a new type of this family that was introduced in the world at the end of

2019 and the disease related to it is named as Covid-19 [4]. This virus is one of the enveloped viruses with a single-stranded ribonucleic acid (RNA) genome and uses the cell receptor "angiotensin-converting enzyme-2" to enter the target cells. This coronavirus, which multiplies efficiently in the upper respiratory tract, tends to the cells located in the lower respiratory tract, and by multiplying in these areas, it leads to lesions in the lower respiratory tract [5]. Approximately, 81% of patients who contract Covid-19 show mild symptoms, and in 14% of cases, the infected person shows severe symptoms, which include pneumonia and shortness of breath. In 5% of cases, the patient's condition has worsened, which is associated with

respiratory failure, infectious shock, and failure in the other body organs [6].

Due to the newness of this virus in the human population, new reports are published daily regarding various aspects of its pathogenesis [7]. Symptoms such as fever, cough, fatigue, muscle pain, joint pain, and shortness of breath have been reported as common and clinically confirmed symptoms caused by the pathogenesis of this virus [8]. However, in addition to these symptoms, SARS-CoV-2 affects different organs of the body, such as the digestive system, nervous system, skin, olfactory system, cardiovascular system, liver, kidney, and eye, and one of these complications in diabetic patients is mucormycosis. Mucormycosis is a disease that is common in patients with a history of diabetes mellitus who have recently been infected with Covid-19, and it affects the nervous system more than other systems [9,10]. This study was designed with the aim of examining the symptoms and complications of the nervous system in patients with mucormycosis.

2. Method

This narrative review study was conducted using relevant articles available in reputable English scientific databases such as PubMed, Scopus, Science Direct, and Google Scholar between December 2019 and the first five months of 2020. The searched words were Covid-19, SARS-CoV-2, olfactory disorder, loss of taste, mucormycosis, neurological manifestations, diabetes mellitus, neurological disorder, eye disease, thyroid disease, and diabetes complication which are equivalent to the Latin databases. The search was conducted by both the main authors of this study and after confirming the titles and abstracts of the articles, the main text of the article was read and included in the present study.

3. Results

In the initial search, 1259 articles were extracted, after removing duplicates and evaluating the title

and abstract. 25 articles with the necessary conditions to participate in the present study were selected and general conclusions were made based on the information available in the various selected articles.

The main risk factor

There is a bidirectional relationship between mucormycosis and diabetes. On the one hand, diabetes is associated with an increased risk of severe Covid-19, and on the other hand, sudden diabetes and severe metabolic complications of diabetes, such as diabetic ketoacidosis, for which very high doses of insulin are allowed, have been observed in patients with mucormycosis [11]. Based on observations of people who spontaneously developed diabetes after being infected with SARS-CoV-2 or people who presented to the hospital with very high blood sugar and ketones, the researchers suggest that diabetes may only make people more vulnerable to SARS-CoV. 2- It does not make it vulnerable, but this virus may also trigger the occurrence of diabetes in some people [12,13]. This virus can create a severe inflammatory state that disrupts the ability of the pancreas to release insulin and reduces the ability of the liver and muscles to recognize the hormone. However, it is still unclear whether the changes in glucose metabolism remain stable in these patients or disappear during resolution of the infection [14]. In addition, it is not clear whether this is type 1 diabetes, type 2, or a new type of diabetes. Answering these questions is a priority to quickly inform about clinical care, follow-up, and monitoring of affected patients [15].

A possible mechanism of neurological manifestations of mucormycosis

The causative agent of mucormycosis may cause neurological manifestations by releasing cytokines, viral circulation in the body, or direct virus invasion through multiple ACE2 receptors in the olfactory epithelium [16]. Olfactory

disorder may be caused by damage to the olfactory epithelium. Fever is believed to be caused by cytokines or hypothalamic dysfunction. Seizures may also be due to an excessive increase in cytokines, the severity of the disease, or the involvement of the brain parenchyma; especially the middle temporal lobe [17].

Nonspecific neurological manifestations

The most common symptoms include: consciousness disorder, cognitive disorder, cerebral hemorrhage, stroke, encephalopathy, seizures, ataxia (imbalance), smell disorder, and taste disorder [18]. The initial manifestations of mucormycosis are usually respiratory symptoms. However, doctors have identified neurological symptoms as one of the primary symptoms at the time of diagnosis. Non-specific symptoms when presented alone may make diagnosis difficult. After muscle pain, headache is one of the most common neurological symptoms in patients with mucormycosis [19]. Twenty-one studies have reported headache with a prevalence of 3.5% to 34% among patients with mucormycosis. In general, the prevalence of headache was 10.9% in the population of 6486 people from 21 studies. A review of the previous studies shows that headache is the most common symptom during disease exacerbation in patients with mucormycosis. In another study, dizziness was the most common central nervous system manifestation with 16.8%, followed by headache with 13.1%. Dizziness and headache are often seen in early disease as typical symptoms of mucormycosis. Dizziness has been reported in 6 studies with an overall prevalence of 8-77% among 1088 people [20].

Nausea with or without vomiting was reported in 13 studies with prevalence ranging from 1.25 to 8.7%. In general, the overall prevalence of nausea with or without vomiting is 4.6%. Several studies have been conducted during the mucormycosis outbreak. However, the advanced imaging and

diagnostic methods such as magnetic resonance imaging (MRI) and electroencephalography (EEG) have been avoided or their use has been dependent on having specific symptoms of a disease such as bleeding or seizures [20]. Therefore, it is difficult to diagnose the origin of neurological symptoms, either directly through the virus or indirectly through damage to other organs, such as gastrointestinal manifestations [21].

A new study of the neurological symptoms of patients with mucormycosis shows that this disease is a threat to the nervous system [22]. Many hospitalized patients have neurological manifestations that include headache, dizziness, loss of consciousness, difficulty concentrating, smell and taste disorders, seizures, strokes, weakness, and muscle pain [23]. Although the proportion of patients with neurological symptoms is small compared with the respiratory patients, with the epidemic continuation and the fact that a larger part of the world's population may be infected before an effective vaccine is available, the total number of patients with neurological symptoms can increase [24]. Neurological complications, especially encephalitis and stroke, can cause lifelong disability with long-term care needs and increased health, social and economic costs. Now the question is that what are the most common permanent neurological symptoms after contracting mucormycosis and what are the recommendations? [25]

Headache: Headache is one of the first neurological symptoms of mucormycosis. Especially if there are other symptoms such as pain, fever, and loss of taste, or smell [26].

Light sensitivity and other eye symptoms: Although not nearly as common as headaches, light sensitivity (or so-called photophobia) and the other eye symptoms can occur during an acute mucormycosis infection as well as in the weeks after recovery. Estimates suggest that

about 10 to 15 percent of patients develop photophobia, and some researchers have even found that it is the most common ocular symptom of mucormycosis [27] (Figure 1).

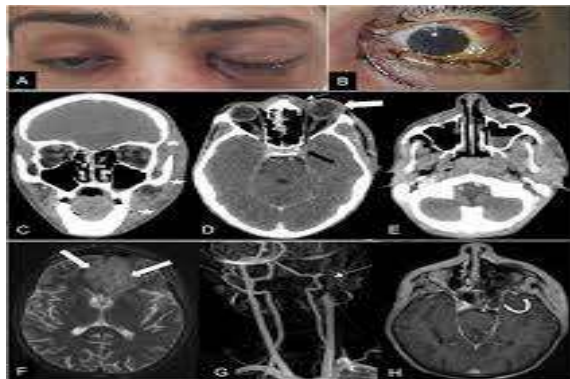


Figure 1. Eye symptoms and mucormycosis

Olfactory disorder

The loss of the sense of smell in adults following an infection with viruses infecting the upper respiratory tract is called "post-viral anosmia", which accounts for about 40% of anosmia cases. The common coronaviruses are thought to account for 10-15% of cases [28]. Therefore, it is not surprising that SARS-CoV-2 also causes anosmia in patients with Covid-19, but its exact pathogenesis is not known. It is possible that the damage caused by SARS-CoV-2 occurs on the surface of the olfactory neuroepithelium in the roof of the nasal cavity or in the central olfactory pathways [29]. There are several possible scenarios in this regard: In one scenario, SARS-CoV-2 could infect the lining of the nasal cavity and cause local inflammation, and then the inflammation in the nose would prevent odors from reaching the olfactory receptors, as in chronic rhinosinusitis, chronic inflammation of the sinuses and nasal cavity, is one of the main causes of loss of sense of smell. Alternatively, the virus can directly target the olfactory receptor cells inside the nose. If these cells become infected, they are unable to produce signals and the person temporarily loses their sense of smell

[30] because the body replaces the olfactory receptor cells every thirty to sixty days. Likewise, theoretically, viruses can pass through the sieve plate of the ethmoid bone, which is located in the roof of the nose, and infiltrate the olfactory bulb, which is one of the lower structures of the brain and the place where olfactory information is processed, and cause damage to that nerve area and ultimately olfactory disorder [31] (Figure 2).

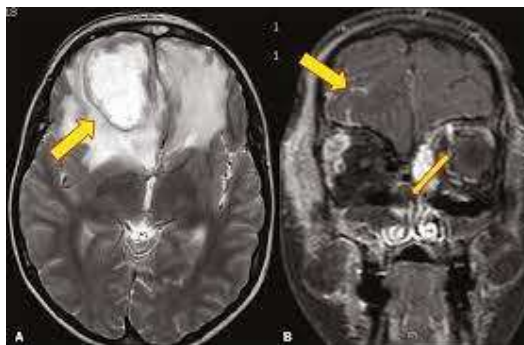


Figure 2. Brain and mucormycosis

The time of onset of olfactory symptoms in mucormycosis patients is different so that in some patients with mucormycosis, it has been reported as one of the initial symptoms in them, and in others, these symptoms develop later in the patients [32]. However, there is insufficient evidence to confirm these hypotheses and more comprehensive research is needed [33].

Loss of sense of taste

The loss of the smell sense can also be accompanied by the loss of the taste sense. Since the smell sense has a great influence on the ability to detect taste, the loss of the sense of smell can also affect the sense of taste, and people with mucormycosis may experience loss of the sense of taste [34]. Concerning that the chemical receptors for the sense of saltiness, sweetness, sourness, and bitterness of food are located on the tongue, so it seems that people's lack of taste in food is mainly secondary to the loss of their smell sense [35].

Discussion

According to this study, mucormycosis has a wide range of clinical symptoms, which can be classified into two groups of respiratory and non-respiratory symptoms, and respiratory symptoms are more common [36]. Fever and cough are the most common symptoms. There is also an asymptomatic form, which is an important factor in the spread of the disease in society, especially among children. The chance of infection is not the same for all people in the society. Severe disease usually occurs in susceptible people with underlying disease or in cases where the amount of virus introduced into the body is high. Diagnostic methods are not 100% [37].

Virus antigen measurement in pharynx or nose sample is the most important laboratory criterion and the other laboratory tests are helpful in diagnosing or predicting the disease severity [38]. The risk factors mentioned by most studies for severe disease are male gender, diabetes, high blood pressure, and heart disease. Regarding the other factors, there are contradictions in various studies. There is no age limit for infection. It is debated whether children have equal, less or more susceptibility than adults. In explaining why children are less sensitive to mucormycosis, there are hypotheses related to the immune system and ACE2 receptors [39].

However, they should be included in the transfer cycle. The disease severity is higher in men than in women. Effective treatment, especially for critically ill patients, has not yet been found. In the field of traditional medicine, despite the fact that sometimes strange claims are seen in virtual spaces, no registered study proving the effectiveness of a method, especially in critically ill patients, has been found so far [40]. In Iran, 67 clinical research projects investigating the effectiveness of traditional medicine treatments in mucormycosis have received the executive permission and are being carried out. The recommendations of the Iranian medicine in the

pandemic of respiratory diseases and respiratory drugs that are traditionally used in regions have been collected based on sources. According to the studies in the south of Iran, 99% of people have heard rumors promoted in the name of traditional medicine, and only 6.88% of people disagree with them. Traditional medicine recommendations were only 2.9% [41].

In addition, sometimes recommendations as traditional medicine are published in society, which not only do not exist in the sources of traditional medicine, but also are even theoretically questionable in modern medicine [42]. Traditional fumigation of baking soda to treat Covid-19 is a clear example of these cases [43]. The high level of health literacy, especially in crises, prevents the risk of spreading rumors. Since, according to the current information, close contact with infected people and transmission through the air are the most common methods of transmission of the virus, using a mask and washing hands along with observing physical distance are the most important ways to prevent people from contracting the disease and preventing the spread of the virus in the community [44].

Conclusion

Whether the findings of this study are sufficient to increase health literacy about mucormycosis and to what extent this information increases health literacy regarding mucormycosis should be determined in future studies. Given that the Internet is one of the most important sources of health knowledge in our society. Providing correct information about the contents that are discussed in virtual spaces, especially about topics of interest to people such as traditional medicine and nutrition in controlling mucormycosis disease, can improve people's ability to evaluate the correctness or incorrectness of the information in these spaces.

References:

- [1] D. Mathieu, A. Marroni, J. Kot, Tenth European Consensus Conference on Hyperbaric Medicine: Recommendations for accepted and non-accepted clinical indications and practice of hyperbaric oxygen treatment. *Diving Hyperb Med.*, 47 (2017) 24–32.
- [2] O.A. Cornely, S. Arikan-Akdoglu, E. Dannaoui, A.H. Groll, K. Lagrou, A. Chakrabarti, et al. ESCMID and ECMM joint clinical guidelines for the diagnosis and management of mucormycosis 2013. *Clin Microbiol Infect.*, 3 (2014) 5–26.
- [3] R. Ahmed, M.A. Severson, V.C. Traynelis. Role of hyperbaric oxygen therapy in the treatment of bacterial spinal osteomyelitis. *J Neurosurg Spine.*, 10 (2009) 16–20.
- [4] Jr. J. Bartek, S. Skyrman, M. Nekludov, T. Mathiesen, F. Lind, G. Schechtmann. Hyperbaric oxygen therapy as adjuvant treatment for hardware-related infections in neuromodulation. *Stereotact Funct Neurosurg.*, 96 (2018) 100–7.
- [5] Jr. J. Bartek, A.S. Jakola, S. Skyrman, P. Förander, P. Alpkvist, G. Schechtmann, et al. Hyperbaric oxygen therapy in spontaneous brain abscess patients: A population-based comparative cohort study. *Acta Neurochir (Wein).*, 158 (2016) 1259–67.
- [6] A. Larsson, M. Engström, J. Uusijärvi, L. Kihlström, F. Lind, T. Mathiesen, Hyperbaric oxygen treatment of postoperative neurosurgical infections. *Neurosurgery.*, 50 (2002) 287–95.
- [7] S.M. Haghdoost, M.K. Gol, The necessity of paying more attention to the neurological and psychological problems caused by the COVID-19 pandemic during pregnancy. *International Journal of Women's Health and Reproduction Sciences.*, 3 (2020) 243-44.
- [8] B.J. Ferguson, T.G. Mitchell, R. Moon, E.M. Camporesi, J. Farmer, Adjunctive hyperbaric oxygen for treatment of rhinocerebral mucormycosis. *Rev Infect Dis.*, 10 (1988) 551–9.
- [9] SM Haghdoost, S Mousavi, MK Gol, M. Montazer. Frequency of Chlamydia trachomatis Infection in Spontaneous Abortion of Infertile Women During First Pregnancy Referred to Tabriz University of Medical Sciences by Nested PCR Method in 2015. *International Journal of Women's Health and Reproduction Sciences.*, 7 (2019) 526-30.
- [10] P.M. Tibbels, J.S. Edelsberg, Hyperbaric-oxygen therapy. *N Engl J Med.*, 334 (1996) 1642–8.
- [11] M.Y. Memar, M. Yekani, N. Alizadeh, H.B. Baghi. Hyperbaric oxygen therapy: Antimicrobial mechanisms and clinical application for infections. *Biomed Pharmacother.*, 109 (2019) 440–7.
- [12] R. Benkő, Z. Miklós, V.A. Ágoston, K. Ihonvien, C. Répás, R. Csépanyi-Kömi, et al. Hyperbaric oxygen therapy dampens inflammatory cytokine production and does not worsen the cardiac function and oxidative state of diabetic rats. *Antioxidants (Basel).*, 8 (2019) 607.
- [13] MK Gol, F Jabarzade, V Zamanzadeh. Cultural competence among senior nursing students of medical universities in North-West Iran. *J Urmia Nurs Midwifery Fac.*, 18 (2017) 612-19.
- [14] S.M. Ronagh, A. Panahali, A. Lotfi, P.F. Ahmadpour. Comparison of body image and life satisfaction among patients undergoing cosmetic surgery and candidates for the surgery in maxillofacial department at Imam Reza Hospital in Tabriz. *Razi Journal Of Medical Sciences.* 2018.
- [15] K.C. Lin, K.C. Niu, K.J. Tsai, J.R. Kuo, L.C. Wang, C.C. Chio, et al. Attenuating

- inflammation but stimulating both angiogenesis and neurogenesis using hyperbaric oxygen in rats with traumatic brain injury. *J Trauma Acute Care Surg.*, 72 (2012) 650–659.
- [16] B.R. Fischer, E.J. Speckmann, C. Greiner, A. Gorji, J. Wölfer, H. Wassmann, Hyperbaric oxygen in neurosurgery. *Acta Neurochir (Wien)*, 151 (2009) 415–8.
- [17] L. Couch, F. Theilen, J.T. Mader, Rhinocerebral mucormycosis with cerebral extension successfully treated with adjunctive hyperbaric oxygen therapy. *Arch Otolaryngol Head Neck Surg.*, 114 (1988) 791–4.
- [18] H. Motaleb, M. Mohamed, F. Mobarak, A Fatal Outcome of Rhino-orbito-cerebral Mucormycosis Following Tooth Extraction: A Case Report. *Journal of International Oral Health.*, 7 (2015) 68–71.
- [19] M. Bonyadi, M. Esmaeili, M. Abhari, A. Lotfi. Mutation analysis of familial GJB2-related deafness in Iranian Azeri Turkish patients. *Genetic testing and molecular biomarkers.*, 13 (2009) 689–92.
- [20] M. Heyboer, D. Sharma, D. Santiago, N. McCulloch. Hyperbaric oxygen: Side effects defined and quantified. *Adv Wound Care (New Rochelle)*, 6 (2017) 210–24.
- [21] N.V. Sipsas, M.N. Gamaletsou, A. Anastasopoulou, D.P. Kontoyiannis. Therapy of mucormycosis. *J Fungi (Basel)*, 4 (2018) 90.
- [22] B. Spellberg, A.S. Ibrahim. Recent advances in the treatment of mucormycosis. *Curr Infect Dis Rep.*, 12 (2010) 423–9.
- [23] C.J. Lerche, L.J. Christophersen, M. Kolpen, P.R. Nielsen, H. Trøstrup, K. Thomsen, et al. Hyperbaric oxygen therapy augments tobramycin efficacy in experimental *Staphylococcus aureus* endocarditis. *Int J Antimicrob Agents.*, 50 (2017) 406–12.
- [24] N. Shahidi, A. Lotfi. Epidemiology and Clinical Findings of Oral Squamous Cell Carcinoma. *Majallah-i Pizishki-i Danishgah-i ulum-i Pizishki-i Tabriz.*, 44 (2022) 67–71.
- [25] A. Tragiannidis, A.H. Groll. Hyperbaric oxygen therapy and other adjunctive treatments for zygomycosis. *Clin Microbiol Infect.*, 15 (2019) 82–6.
- [26] S. Charsouei, F. Mahdavi, A.R. Nasser. Evaluation of Three-and Five-Year Disease-Free Survival in Patients With Cervical Cancer With Spinal Cord Metastasis Under Treatment With External Radiotherapy Brachytherapy. *International Journal of Women's Health and Reproduction Sciences.*, 10 (2022) 97–102.
- [27] M. Almannai, H. Imran, B. Estrada, A.H. Siddiqui. Successful treatment of rhino-orbital mucormycosis with posaconazole and hyperbaric oxygen therapy. *Pediatr Hematol Oncol.*, 30 (2013) 184–6.
- [28] M.D. Mignogna, G. Fortuna, S. Leuci, D. Adamo, E. Ruoppo, M. Siano. Mucormycosis in immunocompetent patients: a case-series of patients with maxillary sinus involvement and a critical review of the literature. *International Journal of Infectious Diseases.*, 15 (2011) e533–40.
- [29] L. García-Covarrubias, DM Barratt, R Bartlett, K Van Meter. Treatment of mucormycosis with adjunctive hyperbaric oxygen: five cases treated at the same institution and review of the literature. *Rev Invest Clin.*, 56 (2004) 51–5.
- [30] B.V. John, G. Chamilos, D.P. Kontoyiannis. Hyperbaric oxygen as an adjunctive treatment for zygomycosis. *Clin Microbiol. Infect.*, 11 (2015) 515–7.

- [31] A.G. Deepa, B.J. Nair, T.T. Sivakumar, A.P. Joseph. Uncommon opportunistic fungal infections of oral. *J Oral Maxillofac Pathol.*, 18 (2014) 235–43.
- [32] S. Charsouei, M.Z. Esfahlani, A. Dorosti, R.E. Zamiri. Effects of COVID-19 pandemic on perceived stress, quality of life, and coping strategies of women with breast cancer with spinal metastasis under chemotherapy. *International Journal of Women's Health and Reproduction Sciences.*, 9 (2021) 55–60.
- [33] J. kim, J. Fortson, H. Cook, A Fatal Outcome From Rhinocerebral Mucormycosis After Dental Extractions: A Case Report. *J Oral Maxillofac Surg.*, 59 (2001) 693–697.
- [34] C. Fogarty, F. Regennitter, C. Viozzi. Invasive Fungal Infection of the Maxilla Following Dental Extractions in a Patient with Chronic Obstructive Pulmonary Disease. *J Can Dent Assoc.*, 72 (2006) 149–52.
- [35] A. Bakathir, Mucormycosis of the Jaw after Dental Extractions: Two Case Reports. *Sultan Qaboos Univ Med J.*, 6 (2006) 77–82.
- [36] A. Auluck, Maxillary necrosis by mucormycosis. A case report and literature review. *Med Oral Patol Oral Cir Bucal.*, 12 (2007) E360–4.
- [37] N. Papadogeorgakis, E. Parara, V. Petsinis, C. Vourlakou, A case of successfully treated rhinocerebral mucormycosis: dental implications. *Int J Dent.*, 2010 (2010) 273127.
- [38] J.A. Kumar, P. Babu, K. Prabu, P. Kumar, Mucormycosis in maxilla: Rehabilitation of facial defects using interim removable prostheses: A clinical case report. *J Pharm Bioall Sci.*, 5 (2013) S163–5.
- [39] P. Choudhary, D. Bhargava, V. Chandavarkar, R. Sharma. Mucormycosis of maxilla. *Indian J Dent Adv.*, 6 (2014) 1503–6.
- [40] K. Nilesh, N.A. Malik, U. Belgaumi. Mucormycosis in a healthy elderly patient presenting as oro-antral fistula: Report of a rare incidence. *J Clin Exp Dent.*, 7 (2015) e333–6.
- [41] N. Kumar, A.K. Singh, S. Pandey, S. Singh. Rhino-maxillary osteomyelitis due to mucormycosis in an immunocompromised geriatric patient: A case report with review of treatment options. *Int J Health Allied Sci.*, 4 (2015) 160–4.
- [42] S Arya, B Sharanamma, N Patil, B Anitha, S Bhateja, Basavaraj Rhino-maxillary form of mucormycosis causing sinusitis: a rare case report with review of literature. *Journal of Oral Medicine Oral Surgery Oral Pathology and Oral Radiology.*, 1 (2015) 39–44.
- [43] F. M. Laihad, I. Ketut Sudiana, M. Guritno Suryokusumo, Case Report: The Diagnosis, Treatment and Outcome of a Rare Case Suspected as Mucormycosis. *Pinnacle Medicine & Medical Sciences.*, 2 (2015) 502–5.
- [44] S. Charsouei, L. Ghaderi, H.M. Anvari, R.E. Zamiri. Investigating the factors affecting the severity of neuropathic pain before and after the coronavirus infection in patients having breast cancer surgery. *International Journal of Women's Health and Reproduction Sciences.*, 9 (2021) 190–94.
- [45] S. Musaei, The Effect of Pregnancy on the Skin, *Eurasian Journal of Chemical, Medicinal and Petroleum Research*, 2 (2023) 17-23. [\[Publisher\]](#)
- [46] F. Atashzadeh-Shoorideh, S. Parvizy, M. Hosseini, Y. Raziani, F. Mohammadipour, Developing and validating the nursing presence scale for hospitalized patients, *BMC nursing*, 21 (2022) 1-6

- [47] Y. Raziani, L. Hasheminasab, R. Ghanei Gheshlagh, P. Dalvand, V. Baghi, M. Aslani, The prevalence of intimate partner violence among Iranian pregnant women: a systematic review and meta-analysis, *Scandinavian Journal of Public Health*, 2022.
- [48] Y. Raziani, S.H. Qadir, A.H. Hermis, A. Nazari, B. Salah Othman, S. Raziani, Pistacia atlantica as an effective remedy for diabetes: a randomised, double-blind, placebo-controlled trial, *Australian Journal of Herbal and Naturopathic Medicine*, 34 (2022) 118-124
- [49] A. Amin, M.R. Gavanrudi, K. Karami, Y. Raziani, P. Baharvand, The role of aromatherapy with lavender in reducing the anxiety of patients with cardiovascular diseases: A systematic review of clinical trials, *Journal of Herbmed Pharmacology*, 11 (2022) 182-187
- [50] Y. Raziani, S. Hossein Qadir, B. Salah Othman, A. Mohammed Ahmed, The Student Voice To Improve Osce, *Mosul Journal of Nursing*, 10 (2022) 89-97
- [51] Y. Raziani, B. Salah Othman, S. Raziani, A common but unknown disease; A case series study, *Annals of Medicine and Surgery*, 69 (2021) 102739
- [52] S. Alnomasy, G. Raheem Lateef Al-Awsi, Y. Raziani, A.E. Albalawi, A.D. Alanazi, M. Niazi, H. Mahmoudvand, Systematic review on medicinal plants used for the treatment of Giardia infection, *Saudi Journal of Biological Sciences*, 28 (2021) 5391-5402
- [53] S. Ghorbanizadeh, Y. Raziani, M. Amraei, M. Heydarian, Care and precautions in performing CT Scans in children, *Journal of Pharmaceutical Negative Results*, 12 (2021) 54
- [54] Y. Raziani, S. Raziani, Evaluation of Mental Health of Chemotherapy-Treated Cancer Nurses, *Journal of Medicinal and Chemical Sciences*, 4 (2021) 351-363
- [55] Y. Raziani, B. Salah Othman, Ointment therapy and prevention of cannulation-induced superficial phlebitis, *Veins and Lymphatics*, 10 (2021).
- [56] Y. Raziani, S. Raziani, The effect of air pollution on myocardial infarction, *Journal of Chemical Reviews*, 3 (2021) 83-96
- [57] N. Shahkarami, M. Nazari, M. Milanifard, R. Tavakolimoghadam, A. Bahmani, *Eurasian Chem. Commun.*, 4 (2022) 463-472. [[Crossref](#)], [[Google Scholar](#)], [[Publisher](#)]
- [58] S.Z. Nazardani, S.H. Nourizadeh Dehkordi A. Ghorbani, A comprehensive evaluation of the Sports Physiotherapy curriculum, *Eurasian Journal of Chemical, Medicinal and Petroleum Research*, 2 (2023) 10-16. [[Google Scholar](#)], [[Publisher](#)]
- [59] E. Ghaibi, M.R. Soltani Manesh, H. Jafari Dezfooli, F. Zarif, Z. Jafari, Z. Gilani, Comparison of Marital Satisfaction, Emotional Divorce and Religious Commitment among Nurses and Staff of Ahvaz Government Hospitals, *Eurasian Journal of Chemical, Medicinal and Petroleum Research*, 1 (2022) 33-39. [[Google Scholar](#)], [[Publisher](#)].

HOW TO CITE THIS ARTICLE

Saeid Charsouei, Ali Reza Lotfi. Symptoms and Complications of Nervous System in Patients with Mucormycosis: A Systematic Review, Ad. J. Chem. B, 4 (2022) 261-270.

DOI: 10.22034/ajcb.2022.367982.1132

URL: http://www.ajchem-b.com/article_162967.html

