

Exploring the Knowledge, Awareness and Practice Regarding Post COVID-19 Mucormycosis among Dental Professionals in Tamil Nadu, India: A Cross-sectional Survey

SAKTHISRI VIVEKANANDAN¹, GR KARTHIKEYAN², BALAGUHAN BALASUBRAMANIYAN³, MATHANMOHAN AYYATHURAI⁴, DEEPAK VELU⁵, M NIRMALA DEVAR⁶



ABSTRACT

Introduction: The incidence of mucormycosis in post Coronavirus Disease-2019 (COVID-19) cases increased in the second wave. Patients who had COVID-19 infection with pre-existing comorbidities underwent treatment and resultant immunosuppression made them vulnerable to secondary infections like mucormycosis.

Aim: To analyse the knowledge, level of awareness and practice among the dental professionals towards the mucormycosis infection in patients of post COVID-19 disease.

Materials and Methods: This cross-sectional survey was conducted from May 2021 to June 2021 among 428 dental professionals residing in Tamil Nadu, India. The 16-item questionnaire consisted of questions about knowledge, awareness and practice regarding post COVID-19 mucormycosis infection. The questionnaire was sent to the dental practitioners through online portals. The responses were tabulated and the results were analysed using Chi-square test. A p-value <0.05 was considered statistically significant.

Results: The study participants included 264 (61.68%) females and 164 (38.32%) males dental professionals. The dental professionals who participated were in the age range between 21 years to 45 years with a mean of 29.87±6.52 years. The subjects were categorised under general dental practitioners 254 (59.35%), postgraduate students 96 (22.43%), specialty dental practitioners 78 (18.22%). Total 406 (94.86%) respondents agreed that oral examination is necessary for post COVID-19 patient. Out of 428, 306 (71.5%) of the participants responded that tooth pain associated with headache is a watchful sign in diabetic post COVID-19 patients.

Conclusion: This study emphasises the role of dental professionals in diagnosis and management of mucormycosis infection in patients of post COVID-19 disease. Dental professionals demonstrated adequate knowledge about post COVID-19 mucormycosis. This may act as a source of information for the future pandemic crisis.

Keywords: Coronavirus disease-2019, Dental practitioners, Mucorales infection

INTRODUCTION

The Coronavirus Disease-2019 (COVID-19) is a contagious infection caused by the novel Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2), which may be associated with a wide range of disease patterns. The first known case was identified in Wuhan, China in December 2019 and it has since spread worldwide, leading to an ongoing pandemic [1].

The disease pattern of COVID-19 shown association with bacterial and fungal co-infections [2]. This leads to an emerging concern, especially because of their complex diagnosis, severity, and increased mortality [3]. Reports have suggested that patients who survive COVID-19 may experience impairment or prolonged symptoms in their overall health status after their acute phase recovery [3,4].

Various oral mycoses such as candidiasis, aspergillosis, mucormycosis, cryptococcosis, histoplasmosis, blastomycosis are reported with COVID-19. The steep rise in cases of mucormycosis in patients of COVID-19 remains one of the most devastating complications in uncontrolled diabetes with mortality rates of 40-80% [5]. Maharashtra, a state in India documented 1500 cases of post COVID-19 mucormycosis with 52 deaths in May 2021 [6].

Among various presentations of mucormycosis, Rhino-Orbital-Cerebral Mucormycosis (ROCM) is the most common variety seen worldwide. It is frequently associated with uncontrolled diabetes and diabetic ketoacidosis. The pulmonary mucormycosis is associated with neutropenia, bone marrow and organ transplant, and

haematological malignancies, while gastrointestinal mucormycosis seen in malnourished individuals [7].

Mucormycosis is a potentially lethal invasive fungal infection caused by saprophytic aerobic fungi *Rhizopus*, *Rhizomucor*, and *Cunninghamella* genera of the order mucorales, now called Rhidopodaceae, which colonises the oral and nasal mucosa and paranasal sinuses [8]. The disease usually evolves rapidly in patients with compromised immune system; that is, those with human immunodeficiency virus infection, uncontrolled diabetes, malignant diseases, and solid organ transplantation [9].

Dentists should have a high degree of clinical suspicion and keep COVID-19 Associated Mucormycosis (CAMCR) in the differential diagnosis of a severely ill patient with COVID-19 and diabetes mellitus, especially if rhino-orbital or rhino-cerebral presentations are noted [4]. To date, no study has investigated the knowledge, attitude and practice of dental professionals towards post COVID-19 mucormycosis in the Indian scenario. Hence, the present study was aimed to assess the knowledge, attitude, and practice regarding post COVID-19 mucormycosis among dental professionals.

MATERIALS AND METHODS

A descriptive cross-sectional survey was carried to assess the knowledge, attitude, and practice about post COVID-19 mucormycosis among the dental professionals. The study was conducted from May 2021 to June 2021 at Chengalpattu, Tamil Nadu, India. The planning of this study was based on the

guidelines of the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE guidelines). The study protocol was approved by the Institutional Review Board (IEC-KIDS no: KIDS/013/2021) before start of the study.

Sample size calculation: A pilot study was conducted among 25 dental practitioners to estimate the sample size and to check the feasibility of the study. The sample size was calculated with 80% statistical power, $\alpha=0.05$, 95% confidence interval, 10% margin of error (E) using G power software. The sample size was estimated to be about 420 participants. The sampling frame consisted of dental practitioners working in dental colleges and private practice.

Inclusion and Exclusion criteria: The eligibility criteria include dental professionals residing and practicing all over Tamil Nadu and those who gave consent by answering the questionnaire within the limited time frame of 1 month were included in the study. The dental auxiliaries, dental hygienists, and dental professionals of age above 50 years were excluded from the study.

Questionnaire

A self-structured questionnaire [10,11] comprising of 16-closed-ended questions were prepared using Google forms. The questionnaire assessed for content validity and internal consistency of the questionnaire was found to be good (Cronbach's $\alpha=0.84$) and further modifications were done in the questionnaire. The questionnaire was designed in the English language. It was categorised into 4 domains-

- **First domain-** involves demographic data.
- **Second domain-** to assess the knowledge among the participants regarding preoperative assessment, clinical signs and symptoms related to post COVID-19 mucormycosis (5 questions),
- **Third domain-** to assess the awareness among the participants regarding the aetiology, routes of transmission, the role of vaccination, and the need for antifungal treatment (5 questions),
- **Fourth domain-** includes the assessment of the overall outlook and dental practice towards post COVID-19 patients and the treatment and management of post COVID-19 mucormycosis (6 questions).

The confidentiality of information was preserved during the process by keeping it anonymous and the link of the questionnaire along with

a consent form was forwarded to the contacts of the researchers using e-mails and various social media platforms. The information regarding the dental practitioners was collected from State Dental Associations, before the administration of the questionnaire, the aim and the potential benefits of the study was clearly explained to all the study participants. Informed consent was obtained from all the participants after they thoroughly understood the contents of the information sheet. Demographic details of the participants were also collected. All the participants were asked to respond to each item in the questionnaire by choosing the most appropriate answer.

STATISTICAL ANALYSIS

Data collected was entered into Microsoft Excel sheet 2007 to prepare master chart and analyses were performed using a Statistical Package for Social Sciences (SPSS) software version 20.0, USA. Descriptive statistics were performed for demographic variables. For all the qualitative data, the Chi-square test was used and the p-value less than 0.05 which was considered to be significant.

RESULTS

Around 450 questionnaires were sent through mail and the response rate was 428 (95.11%). [Table/Fig-1] shows the demographic details of the study population.

Characteristics	n (%)
Age (in years)	
21 to 45	Mean age- 29.87±6.52 years
Gender	
Male	264 (61.68%)
Female	164 (38.32%)
Participants	
General dental practitioners	254 (59.35%)
Postgraduate students	96 (22.43%)
Specialty dental practitioners	78 (18.22%)

[Table/Fig-1]: Demographic details of the participants.

[Table/Fig-2] shows the distribution of responses to the knowledge items of post COVID-19 mucormycosis. Among the total participants,

Questions	Options	General dental practitioners n=254 (%)	Postgraduate students n=96 (%)	Specialty dental practitioners n=78 (%)	Total N=428	p-value
1. Is oral screening or dental examination necessary for post COVID-19 patients?	a. Yes	238 (93.70%)	90 (93.75%)	78 (100%)	406 (94.86%)	0.075
	b. No	16 (6.30%)	6 (6.25%)	0	22 (5.14%)	
2. Any of the below test needed for post COVID-19 patients requiring dental treatment?	a. Complete blood count	66 (25.98%)	14 (14.58%)	8 (10.26%)	88 (20.56%)	0.001*
	b. Antibody test	96 (37.80%)	48 (50%)	46 (58.97%)	190 (44.39%)	
	c. Serum biomarkers	28 (11.02%)	18 (18.76%)	14 (17.95%)	60 (14.02%)	
	d. Random blood glucose	64 (25.20%)	16 (16.66%)	10 (12.82%)	90 (21.03%)	
3. Common facial sign and symptom for post COVID-19 patient?	a. Facial swelling restricted to one side	36 (14.17%)	12 (12.5%)	0	48 (11.21%)	0.001*
	b. Orbital cellulitis restricted to one side	22 (8.66%)	14 (14.58%)	2 (2.57%)	38 (8.88%)	
	c. Paraesthesia and discoloration of skin	32 (12.60%)	4 (4.16%)	16 (20.51%)	52 (12.15%)	
	d. All the above	164 (64.57%)	66 (68.76%)	60 (76.92%)	290 (67.76%)	
4. Common oral cavity sign and symptom for post COVID-19 patient?	a. Multiple pustules and oral lesions	56 (22.04%)	18 (18.75%)	8 (10.26%)	82 (19.16%)	0.001*
	b. Loosening of teeth/dental segment	18 (7.09%)	12 (12.5%)	4 (5.13%)	34 (7.94%)	
	c. Discoloration of palate	48 (18.90%)	6 (6.25%)	6 (7.69%)	60 (14.02%)	
	d. All the above	132 (51.97%)	60 (62.5%)	60 (76.92%)	252 (58.88%)	
5. If you suspect fungal infection in post COVID-19 patient further investigation should be?	a. CT-PNS	56 (22.05%)	32 (33.33%)	26 (33.33%)	114 (26.64%)	0.001*
	b. MRI	28 (11.02%)	12 (12.51%)	4 (5.13%)	44 (10.28%)	
	c. Fungus culture	90 (35.43%)	20 (20.83%)	6 (7.69%)	116 (27.10%)	
	d. KOH staining and direct microscopy	80 (31.50%)	32 (33.33%)	42 (53.85%)	154 (35.98%)	

[Table/Fig-2]: Knowledge of the study participants about of post COVID-19 mucormycosis.

Chi-square test, *p<0.05 was considered significant; CT-PNS: Computed tomography-para nasal sinus; MRI: Magnetic resonance imaging; KOH staining: Potassium hydroxide staining; p-value <0.05 considered significant

406 (94.86%) respondents agreed that oral examination is necessary for post COVID-19 patient. About 190 (44.39%) of respondents suggested that antibody test is essential to rule out the status of the post COVID-19 patients. Over half of the participants in survey were aware of common facial signs and symptoms includes facial swelling restricted to one side, orbital cellulitis restricted to one side, paraesthesia, discoloration of skin and intraoral symptoms includes multiple pustules, loosening of teeth/dental segment, discoloration of palate. About 154 (35.98%) of total participants responded that Potassium Hydroxide (KOH) staining and direct microscopy as a first choice investigation for suspected fungal infection in post COVID-19 patients. Except for the first question regarding knowledge of post COVID-19 mucormycosis, the distribution of responses of all other questions found to be highly statistically significant (p -value=0.001).

[Table/Fig-3] shows the distribution of responses to the awareness about post COVID-19 mucormycosis. The vast majority of respondents 322 (75.23%) indicated that there is a need of antifungal drugs in post COVID-19 mucormycosis patients. Nearly equal responses were opted regarding the spread of fungal infection through aerosol

procedures and was highly statistically significant (p -value <0.05). Majority of the total respondents 312 (72.90%) replied that COVID-19 vaccination history should be mandatory for dental treatment and also about 370 (86.45%) indicated that steam inhalation is not useful in treating fungal infection and is found to be highly statistically significant (p -value=0.001).

[Table/Fig-4] shows the distribution of responses to practice towards post COVID-19 mucormycosis. More than half of the participants 238 (55.61%) had an idea of referring the patient to the Oral and Maxillofacial Surgeon if they suspect for post COVID-19 mucormycosis and was found to be statistically significant (p -value=0.002). Majority of the participants, 334 (78.04%) replied that the dental extraction will not be performed if tooth loosening or pus discharge is present and about 306 (71.5%) of the participants responded that tooth pain associated with headache is a watchful sign in diabetic post COVID-19 patients. Among all participants, 258 (60.28%) suggested that empirical antifungal treatment should be started if fungal infection was suspected and they were found to be highly statistically significant (p -value=0.001). Out of

Questions	Options	General dental practitioners n=254 (%)	Postgraduate students n=96 (%)	Specialty dental practitioners n=78 (%)	Total N=428 (%)	p-value
1. What is the need of antifungal drugs in post COVID-19 mucormycosis patients?	a. To target the fungal specimens	24 (9.45%)	6 (6.25%)	12 (15.38%)	42 (9.81%)	0.030*
	b. To slow down the rate of spreading	16 (6.30%)	10 (10.42%)	6 (7.70%)	32 (7.48%)	
	c. To decrease its destructive activity	12 (4.72%)	10 (10.42%)	10 (12.82%)	32 (7.48%)	
	d. All the above	202 (79.53%)	70 (72.91%)	50 (64.10%)	322 (75.23%)	
2. Is there a chance of fungal spread through aerosol procedure?	a. Yes	150 (59.06%)	52 (54.17%)	18 (23.08%)	220 (51.40%)	0.001*
	b. No	104 (40.94%)	44 (45.83%)	60 (76.92%)	208 (48.60%)	
3. Is COVID-19 vaccination mandatory for dental treatment?	a. Yes	202 (79.53%)	72 (75%)	38 (48.72%)	312 (72.90%)	0.001*
	b. No	52 (20.47%)	24 (25%)	40 (51.28%)	116 (27.10%)	
4. Is steam inhalation useful in treating fungal infection?	a. Yes	40 (15.75%)	18 (18.75%)	0	58 (13.55%)	0.001*
	b. No	214 (84.25%)	78 (81.25%)	78 (100%)	370 (86.45%)	
5. Probable cause for post COVID-19 fungal infection?	a. Uncontrolled Diabetes Mellitus	20 (7.87%)	4 (4.17%)	0	24 (5.61%)	0.005*
	b. Long-term use of steroids	38 (14.96%)	12 (12.5%)	4 (5.13%)	54 (12.62%)	
	c. Post COVID-19 complications- cytokines storm, lymphopenia	10 (3.94%)	4 (4.17%)	0	14 (3.27%)	
	d. All the above	186 (73.23%)	76 (79.16%)	74 (94.87%)	336 (78.50%)	

[Table/Fig-3]: Awareness of the study participants about of post COVID-19 mucormycosis.

Chi-square test, *p-value <0.05 was considered significant

Questions	Options	General dental practitioners n=254 (%)	Postgraduate students n=96 (%)	Specialty dental practitioners n=78 (%)	Total N=428 (%)	p-value
1. If you are suspecting/confirming mucormycosis then the following treatment would be?	a. Refer patient to ENT surgeon	62 (24.41%)	12 (12.5%)	10 (12.82%)	84 (19.63%)	0.002*
	b. Refer patient to Ophthalmologist	28 (11.02%)	10 (10.42%)	4 (5.13%)	42 (9.81%)	
	c. Refer patient to Oral and Maxillofacial Surgeon	124 (48.82%)	56 (58.33%)	58 (74.36%)	238 (55.61%)	
	d. Advice antifungals	40 (15.75%)	18 (18.75%)	6 (7.69%)	64 (14.95%)	
2. If tooth loosening or pus discharge is present, shall we proceed with dental extraction?	a. Yes	62 (24.40%)	27 (28.12%)	5 (6.41%)	94 (21.96%)	0.001*
	b. No	192 (75.60%)	69 (71.88%)	73 (93.59%)	334 (78.04%)	
3. Is toothpain associated with headache is a watchful sign of diabetic post COVID-19 patients?	a. Yes	184 (72.4%)	82 (85.4%)	40 (51.3%)	306 (71.5%)	0.001*
	b. No	70 (27.6%)	14 (14.6%)	38 (48.7%)	122 (28.5%)	
4. If fungal infection is suspicious whether we can start with empirical antifungal and wait?	a. Yes	184 (72.44%)	52 (54.17%)	22 (28.20%)	258 (60.28%)	0.001*
	b. No	70 (27.56%)	44 (45.83%)	56 (71.80%)	170 (39.72%)	
5. Is there any role of candid paint andazole derivatives in post COVID-19 fungal infection?	a. Yes	152 (59.84%)	56 (58.33%)	34 (43.59%)	242 (56.54%)	0.037*
	b. No	102 (40.16%)	40 (41.67%)	44 (56.41%)	186 (43.46%)	
6. If biopsy procedure planned in dental clinic for suspecting fungal infection the transporting medium should be?	a. Normal saline	56 (22.05%)	28 (29.17%)	10 (12.82%)	94 (21.96%)	0.004*
	b. Sabaraud's Dextrose Agar	88 (34.65%)	24 (25%)	26 (33.33%)	138 (32.25%)	
	c. KOH solution	76 (29.92%)	40 (41.67%)	36 (46.16%)	152 (35.51%)	
	d. Wet specimen without carrier medium	34 (13.38%)	4 (4.16%)	6 (7.69%)	44 (10.28%)	

[Table/Fig-4]: Practice of the study participants about of post COVID-19 mucormycosis.

Chi-square test, *p-value <0.05 was considered significant

all, 242 (56.54%) of the participants agreed to the statement that candid paint andazole derivatives play a role in post COVID-19 fungal infection. Regarding the sample collection of fungal biopsy specimen nearly equal responses were opted for KOH solution and Sabaraud's Dextrose Agar and it was found to be highly statistically significant (p-value=0.004).

DISCUSSION

COVID-19 is a highly infectious disease with fungal co-infections typically mucormycosis has been reported. It is attributed as a consequence of steroid therapy, uncontrolled diabetes, lung disease or as hospital acquired infection [12]. Though the fungus spread by various routes commonly the most common route is through paranasal sinus>orbit>meninges>brain [13]. This may result in cavernous sinus thrombosis, septicemia and multiple organ failure if prompt medical and surgical intervention had not done [14].

Healthcare professionals, especially dentists, should be well-prepared to manage these patients pragmatically and symptomatically, emphasising holistic support. The emergence of the COVID-19 pandemic led to the development of many dental practice guidelines as a standard precaution component [4]. Early identification of the disease with prompt medical and aggressive surgical intervention helps in successful management of this fatal infection [15].

A study conducted by Cicciu M et al., recommended that in COVID-19 recovered patients, it is necessary to perform an extensive intraoral examination to find any oral manifestation [16]. This is in accordance with our study where 94.9% participants agreed that oral screening/dental examination is necessary for COVID-19 patients. To proceed with the dental treatment in post COVID-19 patients, apart from routine preoperative assessment like complete blood count and random blood glucose, antibody test should be used to assess the status of the COVID-19 patients. This is in line with research done by Alfego D et al., who stated that antibody testing should be usually done after full recovery from COVID-19. Immunoglobulin G (IgG) antibody test is a quantitative test for the detection of SARS-CoV IgG antibodies, usually becomes positive after 6-13 days of infection and peaks around 21 days. It indicates how many people had COVID-19 and recovered, including those who did not have symptoms [17].

In our study, more than half of the participants had an idea to rule out the clinical signs and symptoms related to post COVID-19 mucormycosis. For a rapid diagnosis, direct microscopy of KOH wet mount can be used as a first choice investigation for suspected fungal infection in post COVID-19 patients. Literature evidence supports that for a presumptive diagnosis of mucormycosis by direct microscopy of KOH wet mounts can be used [18].

A steep rise in cases of mucormycosis in post second wave of COVID-19 was because of prescribing steroids early in the hope of avoiding the need for oxygen and hospital admission. Thus a combination of steroids, diabetes, lymphopenia and high ferritin might be the aetiological factors contributing to this sudden rise in cases [19]. As most of the dental treatment are aerosol generating procedures, thus even with mass-scale immunisation, the protective measures for routine clinical practice that were used pre-pandemic might not be sufficient for potentially infectious aerosol [20]. This is in accordance with our study where most of the general dental practitioners are more cautious in preventing transmission of virus and also to protect themselves in this pandemic situation by considering COVID-19 vaccination history as mandatory before proceeding dental treatment to the patients.

Though mucor (fungi) are ubiquitous in the environment, the major route of infection is via inhalation of spores, which then spread to the paranasal sinuses and lungs [21]. This is in line with our study where the dental professionals were aware that fungal spread is a non contagious and does not spread from diseased person to healthy person by close contact, coughing or through droplets. There is no evidence that steam inhalation is effective in treating fungal

infection, instead over steaming can contribute a warm and damp environment for the fungus and also that alone is unlikely to cause the disease. In our study, it was clear that the dental practitioners were aware that steam inhalation had no role in treating fungal infection. As per Indian Council of Medical Research (ICMR) guidelines, the management of mucormycosis is an interdisciplinary team work which includes members from almost all departments including Maxillofacial Surgeons [22]. In line with this recommendation, a high percentage of study participants showed a positive attitude to select maxillofacial speciality as referral for the management of post COVID-19 mucormycosis.

Coming to the practice, the dental professionals did not prefer tooth extraction if tooth loosening or pus discharge is present. This can be attributed that high propensity of association of mucormycosis with extraction of tooth, which often get involved when fungal spores are inhaled through nasal route. Tooth extraction itself can cause further spread and fatal complications [23]. In diabetic patients, craniofacial pain without swelling can be a neuropathic pain. It should not be confused with post COVID-19 mucormycosis if facial asymmetry or necrosis is not evident [24]. This is in contrast with our study findings where most of the practitioners consider tooth pain associated with headache as a watchful sign in diabetic post COVID-19 patients to rule out mucormycosis.

As mucormycosis is angioinvasive, Surgical debridement Functional Endoscopic Sinus Surgery (FESS)/Orbital exenteration will reduce the disease burden and allows better penetration of intravenous drugs, and limits further spread of the disease [25]. Though it is in contrary to current study results, few more evidence suggests that the treatment strategy includes aggressive surgical treatment in addition with systemic antifungals like amphotericin B (lipid complex or liposomal), posaconazole or isavuconazole has to be instituted [26]. If biopsy procedure is planned for mucormycosis, the specimen should be sent to the laboratory immediately for KOH mount and fungal culture [16]. When instituted about the transporting medium multiple responses were received from the dental professionals in our study. The Lexington Medical Centre protocol for mycology specimen collection reveals that if there is no evidence of abscess/pus the specimen should be placed in a sterile container containing normal saline without preservative or else if pus is present it should be sent for pus culture [27]. The results of the study showed adequate knowledge and awareness among dental professionals towards post COVID-19 mucormycosis.

Limitation(s)

This study was an online questionnaire study and it was limited to dental professionals who were able to be reached out through mail and social media.

CONCLUSION(S)

It can be concluded that the dental professionals who participated in this study demonstrated adequate knowledge about post COVID-19 mucormycosis and provided important insights regarding the practice towards post COVID-19 mucormycosis. This study has emphasised the role of dental professionals in the management of deadly infection mucormycosis. Dental professionals should also create awareness among the patients regarding the mucormycosis infection.

REFERENCES

- [1] Chintalapudi N, Battineni G, Amenta F. COVID-19 virus outbreak forecasting of registered and recovered cases after sixty day lockdown in Italy: A data driven model approach. *J Microbiol Immunol Infect.* 2020;53(3):396-403. Doi: 10.1016/j.jmii.2020.04.004.
- [2] Mehta S, Pandey A. Rhino-orbital mucormycosis associated with COVID-19. *Cureus.* 2020;12(9):e10726.
- [3] Cox MJ, Loman N, Bogaert D, O'Grady J. Co-infections: Potentially lethal and unexplored in COVID-19. *Lancet Microbe.* 2020;1(1):e11.

- [4] Chakraborty T, Jamal RF, Battineni G, Teja KV, Marto CM, Spagnuolo G. A review of prolonged post-COVID-19 symptoms and their implications on dental management. *Int J Environ Res Public Health*. 2021;18(10):5131.
- [5] Prakash H, Chakrabarti A. Global epidemiology of mucormycosis. *J Fungi (Basel)*. 2019;5(1):26.
- [6] Black fungus has claimed 52 lives in Maharashtra so far: Official [Internet]. Mumbai: The Hindu; 2021 May 14; [updated 2021 May 14; cited 2021 June 5].
- [7] Singh AK, Singh R, Joshi SR, Misra A. Mucormycosis in COVID-19: A systematic review of cases reported worldwide and in India. *Diabetes Metab Syndr*. 2021;15(4):102146.
- [8] Srivastava D, Mishra S, Chandra L, Passi D. Mucormycotic osteomyelitis of maxilla following maxillofacial trauma: The disease of the diseased. *J Family Med Prim Care*. 2019;8(2):748-750. Doi: 10.4103/jfmpc.jfmpc_410_18.
- [9] Pauli MA, Pereira LM, Monteiro ML, de Camargo AR, Rabelo GD. Painful palatal lesion in a patient with COVID-19. *Oral Surg Oral Med Oral Pathol Oral Radiol*. 2021;131(6):620-25.
- [10] Muth Lakshmi KS, Krithika CL, Kannan A, Aniyar Y. Knowledge, awareness and outlook on the COVID-19 disease among the dental professionals in Tamil Nadu. *J Indian Acad Oral Med Radiol*. 2021;33(1):40-46.
- [11] Arora S, Abullais Saquib S, Attar N, Pimpale S, Saifullah Zafar K, Saluja P, et al. Evaluation of knowledge and preparedness among Indian dentists during the current COVID-19 pandemic: A cross-sectional study. *J Multidiscip Healthc*. 2020;13:841-54.
- [12] John TM, Jacob CN, Kontoyiannis DP. When uncontrolled diabetes mellitus and severe COVID-19 converge: The perfect storm for mucormycosis. *J Fungi (Basel)*. 2021;7(4):298. Doi: 10.3390/jof7040298.
- [13] Mohindra S, Mohindra S, Gupta R, Bakshi J, Gupta SK. Rhinocerebral mucormycosis: The disease spectrum in 27 patients. *Mycoses*. 2007;50(4):290-96. Doi: 10.1111/j.1439-0507.2007.01364.x.
- [14] Deepa A, Nair BJ, Sivakumar T, Joseph AP. Uncommon opportunistic fungal infections of oral cavity: A review. *J Oral Maxillofac Pathol*. 2014;18(2):235-43. Doi: 10.4103/0973-029X.140765.
- [15] Bakathir AA. Mucormycosis of the jaw after dental extractions: Two case reports. *Sultan Qaboos Univ Med J*. 2006;6(2):77-82.
- [16] Ciciù M, Cervino G, Baldari S. The use of protective visors in the dentistry degree course of dental prosthetics technology at the University of Messina. *Prosthesis*. 2020;2:321-24.
- [17] Alfego D, Sullivan A, Poirier B, Williams J, Adcock D, Letovsky S. A population based analysis of the longevity of SARS-CoV-2 antibody seropositivity in the United States. *EClinicalMedicine*. 2021;36:100902.
- [18] Skiada A, Pavleas I, Drogari-Apiranthitou M. Epidemiology and diagnosis of mucormycosis: An update. *J Fungi (Basel)*. 2020;6(4):265.
- [19] Bhatt K, Agolli A, Patel MH, Garimella R, Devi M, Garcia E, et al. High mortality co-infections of COVID-19 patients: Mucormycosis and other fungal infections. *Discoveries (Craiova)*. 2021;9(1):e126.
- [20] Farshidfar N, Jafarpour D, Hamedani S, Dziedzic A, Tanasiewicz M. Proposal for tier-based resumption of dental practice determined by COVID 19 rate, testing, and COVID-19 vaccination: A narrative perspective. *J Clin Med*. 2021;10(10):2116. Doi: 10.3390/jcm10102116.
- [21] Pasero D, Sanna S, Liperi C, Piredda D, Branca GP, Casadio L, et al. A challenging complication following SARS-CoV-2 infection: A case of pulmonary mucormycosis. *Infection*. 2021;49(5):1055-1060. Doi: 10.1007/s15010-020-01561-x.
- [22] Advisory from ICMR in COVID 19. https://www.icmr.gov.in/pdf/covid/techdoc/Mucormycosis_ADVISORY_FROM_ICMR_in_COVID19_time.pdf.
- [23] Nilesh K, Vande AV. Mucormycosis of maxilla following tooth extraction in immune competent patients: Reports and review. *J Clin Exp Dent*. 2018;10(3):e300-5.
- [24] Badrah M, Riad A, Kassem I, Boccuzzi M, Klugar M. Craniofacial pain in COVID-19 patients with diabetes mellitus: Clinical and laboratory description of 21 cases. *J Med Virol*. 2021;93(5):2616-619.
- [25] Baldin C, Ibrahim AS. Molecular mechanisms of mucormycosis-The bitter and the sweet. *PLoS Pathog*. 2017;13(8):e1006408.
- [26] Verma DK, Bali RK. COVID-19 and Mucormycosis of the Craniofacial skeleton: Causal, contributory or coincidental? *J Maxillofac Oral Surg*. 2021;20(2):165-166.
- [27] Badiie P, Arastefar A, Jafarian H. Comparison of histopathological analysis, culture and polymerase chain reaction assays to detect mucormycosis in biopsy and blood specimens. *Iran J Microbiol*. 2013;5(4):406-10.

PARTICULARS OF CONTRIBUTORS:

1. Postgraduate, Department of Oral and Maxillofacial Surgery, Karpaga Vinayaga Institute of Dental Sciences, Chengalpet, Tamil Nadu, India.
2. Associate Professor, Department of Oral and Maxillofacial Surgery, Karpaga Vinayaga Institute of Dental Sciences, Chengalpet, Tamil Nadu, India.
3. Professor and Head, Department of Oral and Maxillofacial Surgery, Karpaga Vinayaga Institute of Dental Sciences, Chengalpet, Tamil Nadu, India.
4. Professor and Dean, Department of Oral and Maxillofacial Surgery, Karpaga Vinayaga Institute of Dental Sciences, Chengalpet, Tamil Nadu, India.
5. Associate Professor, Department of Oral and Maxillofacial Surgery, Karpaga Vinayaga Institute of Dental Sciences, Chengalpet, Tamil Nadu, India.
6. Senior Lecturer, Department of Oral and Maxillofacial Surgery, Karpaga Vinayaga Institute of Dental Sciences, Chengalpet, Tamil Nadu, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:

Sakthisri Vivekanandan,
GST Road, Chinnakolambakkam, Palayanoor Post, Madhurantagam,
Chengalpet, Tamil Nadu, India.
E-mail: sakthisriv21@gmail.com

PLAGIARISM CHECKING METHODS: [Jain H et al.]

- Plagiarism X-checker: Oct 08, 2021
- Manual Googling: Apr 16, 2022
- iThenticate Software: May 28, 2022 (13%)

ETYMOLOGY: Author Origin

AUTHOR DECLARATION:

- Financial or Other Competing Interests: None
- Was Ethics Committee Approval obtained for this study? Yes
- Was informed consent obtained from the subjects involved in the study? Yes
- For any images presented appropriate consent has been obtained from the subjects. NA

Date of Submission: **Oct 07, 2021**

Date of Peer Review: **Jan 06, 2022**

Date of Acceptance: **Apr 19, 2022**

Date of Publishing: **Jul 01, 2022**

QUESTIONNAIRE

1. Knowledge about post COVID-19 Mucormycosis

1. Is oral screening or dental examination necessary for post COVID-19 patients?
 - a. Yes
 - b. No
2. Any of the below test needed for post COVID-19 patients requiring dental treatment?
 - a. Complete Blood Count
 - b. Antibody test
 - c. Serum Biomarkers
 - d. Random Blood Glucose
3. Common facial signs and symptoms for post COVID-19 patient?
 - a. Facial swelling restricted to one side
 - b. Orbital cellulitis restricted to one side
 - c. Paraesthesia and discoloration of skin
 - d. All the above
4. Common oral cavity signs and symptoms for post COVID-19 patient?
 - a. Multiple pustules and oral lesions
 - b. Loosening of teeth/dental segment
 - c. Discoloration of palate
 - d. All the above

5. If you suspect fungal infection in post COVID-19 patient further investigation should be?

- a. CT-PNS
- b. MRI
- c. Fungus culture
- d. KOH staining and direct microscopy

2. Awareness about post COVID-19 Mucormycosis

1. Need of antifungal drugs in post COVID-19 Mucormycosis patients?

- a. To target the fungal specimens
- b. To slow down the rate of spreading
- c. To decrease its destructive activity
- d. All the above

2. Is there a chance of fungal spread through aerosol procedure?

- a. Yes
- b. No

3. Is COVID-19 vaccination mandatory for dental treatment?

- a. Yes
- b. No

4. Is steam inhalation useful in treating fungal infection?

- a. Yes
- b. No

5. Probable cause for post COVID-19 fungal infection?

- a. Uncontrolled Diabetes Mellitus
- b. Long term use of steroids
- c. Post COVID-19 complications- cytokine storm, lymphopenia
- d. All the above

3. Practice towards post COVID-19 Mucormycosis

1. If you are suspecting/confirming Mucormycosis then the following treatment would be?

- a. Refer patient to ENT surgeon
- b. Refer patient to Ophthalmologist
- c. Refer patient to Oral and Maxillofacial Surgeon
- d. Advice antifungals

2. If tooth loosening or pus discharge is present, shall we proceed with dental extraction?

- a. Yes
- b. No

3. Is toothpain associated with headache is a watchful sign of diabetic post COVID-19 patients?

- a. Yes
- b. No

4. If fungal infection is suspicious whether we can start with empirical antifungal and wait?

- a. Yes
- b. No

5. Is there any role of candid paint and azole derivatives in post COVID-19 fungal infection?

- a. Yes
- b. No

6. If biopsy procedure planned in dental clinic for suspecting fungal infection the transporting medium should be?

- a. Normal Saline
- b. Sabaraud's Dextrose Agar
- c. KOH solution
- d. Wet specimen without carrier medium