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Dr. Rupal J Shah
Department of Prosthodontics and Crown & Bridge, Gujarat University, Ahmedabad, Gujarat, India

Dr. Hemal Agrawal
Department of Prosthodontics and Crown & Bridge, Gujarat University, Ahmedabad, Gujarat, India

Dr. Monika Varma
Department of Prosthodontics and Crown & Bridge, Gujarat University, Ahmedabad, Gujarat, India

Dr. Ekta Chheda
Department of Prosthodontics and Crown & Bridge, Gujarat University, Ahmedabad, Gujarat, India

Dr. Ritika Patel
Department of Prosthodontics and Crown & Bridge, Gujarat University, Ahmedabad, Gujarat, India

Corresponding Author:
Dr. Rupal J Shah
Department of Prosthodontics and Crown & Bridge, Gujarat University, Ahmedabad, Gujarat, India

Questionnaire study to assess the level of knowledge and awareness of patient-specific implants (PSI) in rehabilitation of mucormycosis among prosthodontists and oral surgeons in Gujarat

Dr. Rupal J Shah, Dr. Hemal Agrawal, Dr. Monika Varma, Dr. Ekta Chheda and Dr. Ritika Patel

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Abstract
The present survey aims to assess knowledge and awareness of patient-specific implants (PSI) in the rehabilitation of Mucormycosis among Prosthodontists and oral surgeons working in dental hospitals/ teaching institutions and post-graduate students in Gujarat state, India.
Methods: A descriptive survey was done through an online questionnaire using Google Forms software distributed to 350 participants of Dental hospitals/ teaching institutions in Gujarat state through their Email and other social media platforms. The data was analyzed using the Statistical Package for Social Sciences (SPSS) statistical software, version 19.0.
Results: 299 participants responded, though only 23 people have rehabilitated the mucormycosis population (7% of people have rehabilitated patients with PSI) and less than half the study subjects knew about the advancements and management of complications occurring from PSI**.** Statistically significant differences in knowledge about the use of patient-specific implants in mucormycosis among the various highly experienced and designated doctors and residents were found as the level of knowledge increased with experience. The study also shows that more than half of about 7% of the participants have rehabilitated the case of mucormycosis using PSI and among them, 3% of people observed some difficulties in the management of PSI prosthesis, and post-operative complications.
Conclusion: Though our study showed an average number of participants have adequate knowledge about patient-specific implants for rehabilitation of mucormycosis patients, and their recent advances, only the subjects particularly from the age group 40 and above had less knowledge compared to people under 40. Hence, our study concludes that there is a need for increased awareness among young and elderly prosthodontists and oral surgeons regarding the same.

Keywords: Patient-specific implants, mucormycosis, COVID-19, prosthetic rehabilitation, questionnaire study

Introduction
The incidence of mucormycosis, a life-threatening fungal infection, has increased significantly, particularly during the COVID-19 pandemic, creating substantial challenges in medical and dental healthcare. Mucormycosis, known for its rapid progression and high morbidity, often requires extensive surgical debridement to remove necrotic tissues, frequently resulting in significant facial defects and functional impairments. The aftermath of these invasive treatments necessitates comprehensive rehabilitation efforts to restore both the aesthetic and functional aspects of the patient's maxillofacial region [1, 2].
Prosthodontists and oral surgeons are crucial in rehabilitating patients affected by mucormycosis. One groundbreaking advancement in this field is the development and application of patient- specific implants (PSIs). PSIs are meticulously designed to match the unique anatomical contours of each patient, ensuring more precise and effective reconstruction. These implants, created using advanced imaging and manufacturing technologies, offer several advantages over conventional treatment methods, including improved fit, reduced surgical time, and enhanced patient outcomes [1].

Despite the potential benefits of PSIs, their implementation in clinical practice is not yet widespread. Factors such as awareness, knowledge, training, and accessibility to advanced technologies can influence the adoption of PSIs among dental professionals. Understanding these factors is crucial to fostering broader acceptance and utilization of PSIs, ultimately leading to better rehabilitation outcomes for patients suffering from the debilitating effects of mucormycosis.

This questionnaire-based study aims to evaluate the level of knowledge and awareness regarding PSIs among prosthodontists and oral surgeons in Gujarat. By systematically assessing their familiarity with the concept, their perceptions of its benefits and limitations, and the extent of their clinical experience with PSIs, this study seeks to identify existing gaps in knowledge and potential barriers to the adoption of these advanced implants.

No study has been done yet to determine the knowledge and awareness regarding mucormycosis and patient-specific implants among dental professionals in Gujarat, India. Therefore, this questionnaire study was undertaken with the primary objective of assessing the knowledge, awareness, and management of mucormycosis using patient-specific implants among prosthodontists and oral surgeons working in dental hospitals or private practicing specialists.

Materials and Methods

A quantitative descriptive survey was conducted through an online Questionnaire using Google Forms and analyzed using percentages. The questionnaire required prior consent, and only those who agreed to participate were included in the study. The inclusion criteria were prosthodontists and oral surgeons working in dental hospitals or teaching institutions, those with private clinics, and prosthodontic and oral surgery residents in Gujarat who were available during the study and willing to participate. The exclusion criteria included general dentists and specialists from other fields who were unavailable during the survey period. Based on these criteria, convenience sampling was employed, and a sample size of 350 (N=350) was selected. The Google Form was distributed to all 350 participants via online portals such as WhatsApp and Email. Of these, 299 participants have filled out the survey questionnaire forms. Participants were informed about the study's aims and objectives through email, and their consent was obtained through the same method.

The self-structured questionnaire was formulated in English. The study protocol, questionnaire, validation, and consent form were approved by the institutional ethical committee. The knowledge, awareness, and practice questionnaire was designed based on the Indian Council of Medical Research (ICMR) guidelines for the screening, diagnosis, and management of mucormycosis, as this provided an evidence-based advisory for India [6]. The questionnaire consisted of two sections: Section A included 8 items covering demographic variables such as name, age, gender, contact details, years of experience, and designation as a prosthodontist, maxillofacial oral surgeon, or resident doctor. Section B comprised 20 questions, focused on knowledge, awareness, and management of patient-specific implants (PSI).

Results

The study included 350 dental professionals who were invited to participate, all of whom responded, giving us a response rate of 85%. Table 1 presents the study subjects' personal characteristics and demographic details based on their age group, gender, designation, years of experience, and willingness to provide contact details. Most of the study subjects were from the age group of 20-30 (36.5%) and 31-40 (34.4%). There were no study subjects above the age of 50. The study subjects were almost equally represented by both genders, with 136 males (45.4%) and 163 females (54.5%). Most study subjects were postgraduate students (36.5%) or specialists practicing in Government institutes (37.8%). All study subjects were willing to provide their contact details for future correspondence. A large proportion of study subjects had 5 years or less of years of experience in the dental profession (36.5%). The smallest group in this division was professionals with 20 or more years of experience, representing only 8.69% of the sample.

The document presents a table summarizing the responses to questions related to knowledge and management of mucormycosis among a sample group. It reveals that a vast majority (98.7%) correctly identified mucormycosis as a fungal infection, while only 1% and 0.3% mistakenly thought it was a bacterial or viral infection, respectively. The most common type of mucormycosis identified was Rhinocerebral (61.2%), followed by pulmonary (23.7%), gastrointestinal (11.7%), and cutaneous (3.3%). Individuals with uncontrolled diabetes were recognized as the highest risk group (97%).

Regarding surgical interventions, 68.2% indicated that either partial or total maxilla, orbital floor, orbital + maxilla, or mandible could be resected. For rehabilitation, 93.6% noted the use of removable prostheses, fixed prostheses, and recent advances like rapid prototyping/CAD CAM. Among implant types, 47.2% selected all types, including conventional, zygomatic/pterygoid, and patient-specific implants.

For patient-specific implants (PSI), 95.3% acknowledged their use in congenital facial defects, post-traumatic cases, and surgically acquired defects post-tumor. The materials used for PSI predominantly included metals, ceramics, and polymers like PEEK, with titanium alloy being the most common (87.6%). The primary advantage of titanium is its corrosion resistance and lightweight properties (95.7%).

Additive manufacturing/rapid prototyping (57.9%) and 3D scanning and printing (28.8%) were the leading technologies for producing PSIs. The benefits of PSIs over conventional implants included greater accuracy, better site adaptation, and shorter operating times (92.3%).

Table 1: Demographic variables and responses given

Demographic details and their responses	N=299, N%
Name	299(100)
Age	109 (36.5)
20-30	
31-40	103 (34.4)
41-50	87 (29)
Above 50	0
Gender	136 (45.4)

Male	
Female	163 (54.5)
Designation	109 (36.5)
Postgraduate student	
Specialists having a private practice	64 (21.4)
Specialists practicing in Government hospitals / Institute	113 (37.8)
Other	13(4.3)
Contact details	299 (100)
Years of experience	109 (36.5)
0-5	
6-10	49 (16.3)
11-15	64 (21.4)
16-20	51 (17)
>20	26 (8.69)

Table 2: Knowledge, awareness, and management Questions and number of responses with percentages

List of questions	**N (%)**
What is Mucormycosis? A bacterial infection	3 (1)
A fungal infection	295 (98.7)
A viral infection	1 (0.3)
An autoimmune disorder	0
What is the most common type of mucormycosis?	10 (3.3)
Cutaneous	
Gastrointestinal	35 (11.7)
Pulmonary	71 (23.7)
Rhinocerebral	183 (61.2)
Who is at higher risk of developing mucormycosis?	1 (0.3)
Individuals with a history of dental cavities	
Individuals with allergies	5 (1.7)
Individuals with high blood pressure	3 (1)
Individuals with uncontrolled diabetes	290 (97)
Surgeries of mucormycosis will involve resection of?	42 (14)
Partial maxilla	
Total maxilla	4 (1.3)
Orbital floor	4 (1.3)
Orbital + maxilla	44 (14.7)
Mandible	1 (0.3)
Either of the above	204 (68.2)
What treatment plan do you know about rehabilitation of mucormycosis?	9 (3)
Removable prosthesis	
Fixed prosthesis	4 (1.3)
Recent advances like rapid prototyping/ CAD CAM	6 (2)
All of the above	280 (93.6)
What types of implants can be done to rehabilitate	3 (1)
Mucormycosis?	
Conventional implants	
Zygomatic implants/pterygoid implants’	5 (1.7)
Patient-specific implants	31 (10.4)
Any of the above	117 (39.1)
All of the above	141 (47.2)
Where can PSI be used?	6 (2)
Congenital facial defects	
Post-traumatic cases	4 (1.3)
Surgically acquired defects-post tumor	4 (1.3)
All of the above	285 (95.3)
Which materials are used for PSI?	12 (4)
Metallic	
Ceramic	5 (1.7)
Polymers-PEEK	20 (6.7)
All of the above	262 (87.6)
Most commonly used material for PSI?	30 (10)
Stainless steel	
Silicone rubber	6 (2)
Titanium alloy Wood composite	262 (87.6) 1 (0.3)
Advantages of titanium framework?	3 (1)
Biodegradability and natural appearance	
Corrosion resistance and lightweight	286 (95.7)

Excellent aesthetic properties and flexibility	5 (1.7)
High thermal conductivity and affordability	5 (1.7)
Which technology is typically employed to produce patient- specific implants?	
Subtractive manufacturing	39 (13)
Additive manufacturing/ rapid prototyping	173 (57.9)
3D scanning and printing	86 (28.8)
Manual	1 (0.3)
Why is PSI better than conventional implants in the reconstruction of maxillofacial defects?	
Greater accuracy	9 (3)
Better site adaptation	13 (4.3)
Shorter operating time	1 (0.3)
All of the above	276 (92.3)
Future aspects of PSI? Do you know how adipose-derived stem cells (ASCs) can be used to fabricate PSI?	
Yes	27 (9)
No	272 (91)
Disadvantages of PSI?	7 (2.3)
Enhanced precision and fit	
Improved patient comfort and satisfaction	1 (0.3)
Increased cost	288 (96.3)
Lower risk of complications	3 (1)
After how many days does prosthetic rehabilitation start in patient-specific implants?	
After 15 days of implant placement	56 (18.7)
0-5 days of implant placement	129 (43.1)
15-30 days of implant placement	114 (38.1)
Which type of occlusion is given in PSI Prosthesis?	
Bilateral balanced occlusion	212 (70.9)
Ligualized occlusion	32 (10.7)
Neutral zone	52 (17.4)
Have you ever rehabilitated any patient with patient-specific implants?	
Yes	23 (7.7)
No	276 (92.3)
If yes, Have you come across any complications?	7 (2.34)

Discussion

Mucormycosis is an opportunistic fungal infection mostly affecting the immunocompromised patients. There are several types of mucormycosis such as gastrointestinal, cutaneous, encephalic, and rhinocerebral among these, rhinocerebral is most commonly seen [7]. Prosthodontists and oral surgeons play a critical role in its management which primarily occurs around rhinomaxillary or rhinocerebral areas which was answered by 61.2% of the study participants, involving facial tissues, palate, alveolar bone, mandibular bone, and orbital areas. Prosthetic rehabilitation of mucormycosis patients can be achieved through removable and fixed prostheses, each offering distinct benefits.

The extent of surgical defects depends on the amount of tissue loss, ranging from simple to complex. Using traditional maxillofacial implants, attachments, adhesives, and spectacles as retentive aids, simple defects can be repaired with removable prostheses. Rehabilitating untailored defects with prosthetics is challenging due to the significant loss of soft and hard tissues in an uneven manner. In such cases, customized implants that anchor the remaining zygomatic, pterygoid, nasal, and orbital floors produce better outcomes than traditional implants [8].

Patient-specific implant prostheses for mucormycosis patients can face several complications. Common issues include infection, implant rejection, and mechanical failures such as fractures or loosening. Infection remains a significant risk due to the compromised immune state of mucormycosis.

Computer-designed PSI enables more accurate reconstruction of maxillofacial defects eliminates the usual complications seen in preformed implants and results in higher patient satisfaction. Its main drawback is its high cost. To manage infections, rigorous aseptic surgical techniques and prophylactic antibiotics are employed. The use of computer-designed PSI enables a more accurate reconstruction of cost. Out of 299 study participants, 288 people (96.3%) have considered the major disadvantage of high price which is supported by the study done by Alasseri N *et al*. [9].

In our study, 2.3% of people have faced complications related to the implant prosthesis and their management such as post-operative infections, edema and subconjunctival hemorrhage, gingival overgrowth, and difficulty in providing proper occlusal contacts in case of opposite natural teeth.

From the responses of the survey participants, It was found that there are statistically significant differences in knowledge among the various specialists and residents as the level of knowledge increased with seniority and experience.

The survey indicated that the responses were debatable regarding the timing of prosthetic delivery after implant placement, with some suggesting 0-5 days and others advocating for delivery after 30 days of implant placement. A systematic review performed by Polido *et al* (2023) [3] - concluded that immediate loading will improve the health of the implants as well as the patient's well-being. More than half a percentage of the population was aware of the treatment of mucormycosis using fixed implants such as patient-specific implants.

Literature Limitations of the study were the essentially small number of participants. A future study can be done on a pan-India basis to assess the awareness of mucormycosis and its treatment. In addition, some other factors that are associated with self-reporting studies such as accuracy of recall, and personal bias could also have affected the results of this study in some.

Conclusion

Our study concludes that age, years of experience, and designation of prosthodontists, oral surgeons, or postgraduate residents are significantly associated with knowledge and

awareness about mucormycosis and its management but gender plays no significant role. The mean age group of 20-30 years showed substantial awareness regarding the treatment protocol. Practicing clinicians were actively involved in the treatment of mucormycosis patients. Despite the growing recognition of PSIs, 92.3% of respondents had not rehabilitated a patient with PSIs, and among those who had, only a few (2.34%) reported encountering complications. This data underscores the growing acceptance and recognition of PSIs in managing complex conditions like mucormycosis. It highlights areas needing further education and cost management to enhance their adoption in clinical practice.

Conflict of Interest
Not available

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Not available

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