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ORIGINAL RESEARCH

PREFERENCE OF TITANIUM VERSUS ZIRCONIA AS A MATERIAL IN DENTAL PRACTITIONERS: AN ORIGINAL RESEARCH

Dr. Amandeep Singh[1], Dr. Lakshmi Senkumar[2], Dr. Anmol Singh Boparai[3], Anoop Kaur Boparai[4], Dr. Damarasingu Rajesh[5], Dr. Dandu Manohar Varma[6],

1. BDS. Adesh institute of dental sciences and research, Adesh university, Bathinda, Punjab. amanyvr@gmail.com
2. BDS, Clinical Assistant Professor, ECU School of Dental Medicine, Greenville, NC, USA. lakshmisenkumar1981@gmail.com
3. BDS, Dr. Harvansh Singh Judge Institute of Dental Sciences and Hospital, Panjab University, Chandigarh, India. anmolboparai@yahoo.com
4. BDS, Dr. Harvansh Singh Judge Institute of Dental Sciences and Hospital, Panjab University, Chandigarh, India. anoopboparai00@gmail.com
5. OMFS, PhD Scholar, Dept of OMFS, Narsinhbhai Patel Dental College and Hospital, Sankalchand Patel University, Visnagar, Gujarat. rajeshoralsurgeon@gmail.com
6. BDS, Consultant & Chief Dental Surgeon, Smile Care Dental Hospital, Sethammadhara, Visakhapatnam, AP, India. dmanoharvarma2012@gmail.com

Corresponding Author: Dr. Amandeep Singh, BDS. Adesh institute of dental sciences and research, Adesh university, Bathinda, Punjab. amanyvr@gmail.com

ABSTRACT

Aim

The purpose of the present research was to assess the knowledge as well as preference related to material of choice amongst various dental practitioners between titanium and zirconia.

Methodology

The cross-sectional study was conducted where a set of questions was designed by the research group to form a questionnaire that covers the knowledge of the participants and their preferred material in various scenarios. The questionnaires were distributed online, electronically using Google forms to the dental practitioners and dental students. Dental students, interns, general practitioners, post-graduate students, specialists and consultants were included in the sample of this study. Statistical analysis was conducted where comparisons between the various groups were done utilizing the Chi-square test.

Results

308 (80.2%) participants chose Titanium implants while only 26 (6.8%) participants chose Zirconia, and 40 (10.4%) participants didn't know, while the remaining 2.6% chose other materials. Comparing the biocompatibility of the Titanium and the Zirconia implants, 174 (45.3%) participants chose that both materials have the same biocompatibility, 77 (20.1%) chose Titanium as being more biocompatible, and only 45 (11.7%) chose Zirconia as being more biocompatible.

Conclusion

Titanium was the top choice for every given scenario except if the implant was to be placed in the anterior esthetic zone; which indicates the awareness of the participants of the esthetic benefits that Zirconia implants.

Keywords dental implants, titanium, zirconium, dental materials.

INTRODUCTION

Metal-free treatment is now popular in dentistry due to the esthetic problem of metal restoratives. Metals have long been used for dental restoratives. In dentistry, esthetics is among the predominant goals. Therefore, even if the mechanical properties of a material are insufficient, its esthetics is sometimes preferred. Metals or metallic materials are defined as "materials consisting of metallic bonds." One of the characteristics of metals is metallic luster due to these metallic bonds. This disadvantage of metals has led to their substitution by ceramics and polymers in dentistry. There are always discussions and debates on material selection among dentists, manufacturers, and dental materials researchers. However, these discussions, debates may not always be based on scientific viewpoints such as materials science and engineering. Among the causes for debates is the propaganda from manufacturers which only highlight the merits of products that is believed by most of dentists and some of researchers. An interesting theme of recent debates is the selection of zirconia or titanium as dental implants. Comparing zirconia to titanium is almost equivalent to comparing ceramics with metals. The advantages of ceramics are high-temperature resistance, wear resistance, chemical stability, and importantly, white color for dentistry, while the disadvantages include low fracture toughness or brittleness. On the other hand, the advantages of metals are high fracture toughness based on high strength and elongation and good balance between rigidity and stiffness, while the disadvantages include corrosion and fatigue. As is well known, all materials have advantages and disadvantages; there is no material that shows only advantages.

At present, titanium and titanium alloys are widely used as dental implants because of the high biocompatibility, the good mechanical properties they have and the long-term clinical success of their follow-up. Although Titanium is a commonly used material; for an anterior region in particular where the gingival tissue is significantly thin, it has several disadvantages, like the grayish color appearance.[1] The implementation of ceramic materials for the production of implant abutments as well as dental implants is a focus of interest in implant dentistry. In the 1990s, Zirconia was introduced in dentistry, Alumina and Zirconia are the ceramic materials of choice nowadays. The use of dental implants in the esthetic area is challenging in which restorations are subjected to direct visual comparison with the neighboring natural teeth, particularly in patients with a gummy smile or elevated lip line. Zirconia is being used in dentistry as a material for posts build-up, as a framework of abutments and pontics of FDPs.[2] Zirconia dental implants have been developed in recent years as a titanium alternative. It has an osseointegration potential and other positive properties such as translucency and its white color in which limits the mismatching potential with natural teeth, It's also radiopaque comparable to titanium and readily visible on radiographs. Moreover, bacterial colonization around Zirconia is found to be less when compared to that with titanium.[2]

AIM OF THE PRESENT STUDY

The purpose of the present research was to assess the knowledge as well as preference related to material of choice amongst various dental practitioners between titanium and zirconia.

METHODOLOGY

The cross-sectional study was conducted where a set of questions was designed by the research group to form a questionnaire that covers the knowledge of the participants and their preferred material in various scenarios. The reliability of the questionnaire was tested on 5 participants who are fluent in the English language and any comments or unclarities were adjusted, then the validity of the questionnaire was tested on 15 participants who answered the survey twice with 7 days separating each attempt. Cohen's Kappa test was used to

measure the agreement between the readings, and the values ranged between 0.84 to 0.90, which is interpreted as a "very good" strength of agreement according to the classification by Altman et al. The questionnaires were distributed online, electronically using Google forms to the dental practitioners and dental students. Dental students, interns, general practitioners, post-graduate students, specialists and consultants were included in the sample of this study. The study employed convenient sampling to select the participants after obtaining the necessary ethical approval and the consent was given by the participants before starting the survey. The encoding and statistical analysis were done using Microsoft Excel and SPSS version 22. The comparisons between the various groups were done utilizing the Chi-square test.

RESULTS

The number of the practitioners that answered the survey was 384, with 232 (60.4%) males and 152 (39.6%) females, the highest participating age group was (21 to 30) years old practitioners representing 56.5% of the sample. The three top participating groups were the General Practitioners (23.2%), the Specialists (21.4%), and Dental Students (21.1%). The majority of the participants had (1 to 5) years of experience representing 71.6%. And only 177 (46.1%) of the participants had an official implant training in the form of workshops, postgraduate courses, or implantology diplomas. When asked which dental implant is used most frequently, 308 (80.2%) participants chose Titanium implants while only 26 (6.8%) participants chose Zirconia, and 40 (10.4%) participants didn't know, while the remaining 2.6% chose other materials. Comparing the biocompatibility of the Titanium and the Zirconia implants, 174 (45.3%) participants chose that both materials have the same biocompatibility, 77 (20.1%) chose Titanium as being more biocompatible, and only 45 (11.7%) chose Zirconia as being more biocompatible, while the remaining 22.9% chose "I don't know". When comparing the osseointegration, 115 (29.9%) participants chose Titanium as having the better osseointegration, 107 (27.9%) chose that both have the same osseointegration, and only 24 (6.3%) chose Zirconia as having the better osseointegration. Lastly, comparing the stress distribution around the implant, 86 (22.4%) participants chose Zirconia as having more stress, 85 (22.1%) chose Titanium as having more stress, and 48 (12.5%) chose that both materials share the same stress distribution. When the focus was placed on the Zirconia implants, the main advantages listed by the participants were esthetics, mechanical properties, and reduced bacterial adhesion. With 190 (49.5%) participants had chosen esthetics as the major advantage of the Zirconia implants. And the highest uses of Zirconia in implant dentistry listed by the participants were as implant abutments (30.2%), as implant supported fixed partial prosthesis (27.2%), and as implant fixtures (23.9%). As for the main limitations of using the Zirconia implants, the participants chose the lack of long-term clinical study (29.4%), and the cost (26.2%). Zirconia was the top choice for the material that reduces bacterial colonization and the risk of peri-implantitis by 121 (31.5%) participants, and also 104 (27.1%) participants chose it as the material that is most sensitive to shear and tensile strengths with the highest risk of failure. Finally, Titanium was the top choice for the material that has the potential to enhance bone formation by 205 (53.4%) participants. When the choice was given to the participants on which implant materials to use in specific scenarios; Titanium was the top choice if the implant was to be placed to replace a tooth in the posterior areas by 288 (75%) participants, it was also chosen if the implant was to be placed for a patient with high occlusal loads 258 (67.2%), if the implant was to be placed for an immunocompromised patient 211(54.9%), if the implant was to be placed for a case with multiple implants placements 278 (72.4%), if the implant was to be placed for an overdenture supported by implants case 283 (73.7%), if the implant was to be placed with simultaneous bone grafting 265 (69%), and finally Titanium was still the top choice if the implant was to

be placed with simultaneous sinus lifting 246 (64.1%). Zirconia was the top choice only if the implant was to be placed to replace a tooth in the anterior areas by 249 (64.8%) participants. The differences between the groups were statistically significant ($p < 0.05$). (Table 1)

DISCUSSION

The dental implants field is constantly changing and improving with the introduction of new materials and surface modifications, and the introduction of Zirconia dental implants had a positive impact on the implant therapy as now the practitioners have multiple options to choose from in order to achieve optimum results. Relating the knowledge of the participants based on their answers to the literature revealed that the participants chose Titanium as the most frequently used implants material which matches what is stated in the literature.[3] While when they were asked about the biocompatibility of the materials the top answer was that both have the same biocompatibility, and the second highest answer was Titanium having the better biocompatibility, which doesn't follow the literature as it was stated that Zirconia implants have better biocompatibility and gingival tissue reaction when compared to Titanium implants.[4] Also when they were asked about the osseointegration of the materials the top answer was Titanium having the better osteointegration, and the second highest answer by was that both have the same osseointegration, but in the literature it was stated that both material have the same osseointegration with Zirconia being an equal to Titanium.[5] And when asked about the stress distribution the top answer was "I Don't Know"43%, with the second top answer being Zirconia having more stress around the implant compared to the Titanium, which doesn't follow the literature as it is stated that both materials have the same stress distribution properties, but the wrong answer could be due to the confusion between stress distribution and resistance to shear forces, as the top answer for the material that has the lower resistance to shear forces was Zirconia implants which coincides with the literature.[6] Coinciding with the findings in the literature; when asked about the enhanced bone formation and density the top answer was Titanium implants, and when asked about the reduced bacterial colonization that top answer was Zirconia implants.[7] As for the osteoblast adhesion and allergic reactions; the literature states that Zirconia has better adhesion compared to other materials[8] and that Titanium, albeit very rare, can cause an allergic reaction.[6]When the participants were asked to choose between the various implant materials; Titanium was the top choice for every given scenario except if the implant was to be placed in the anterior esthetic zone; which indicates the awareness of the participants of the esthetic benefits that Zirconia implants have over other materials.[9]

CONCLUSION

The dental practitioners are well aware of the overall properties of the Titanium implants while being only conversant on the esthetic benefits of the Zirconia implants but lack the knowledge of their mechanical and biochemical properties.

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TABLES

Table 1- Comparing perceived properties of implant materials

	Titanium	**Zirconia**	**Other**	**Chi-Square**	**df**	**Sig.** ***P value***
Biocompatibility	77	45	88	94.896	3	.000
Osseointegration	115	24	138	77.396	3	.000
Stress Distribution	85	86	165	75.896	3	.000
Frequently Used	308	26	40	881.521	4	.000
Reduces Bacterial Colonization	92	121	154	227.589	4	.000
Adhesion of Osteoblasts	39	49	199	278.656	4	.000
Enhance Bone Formation	205	38	125	387.120	4	.000
Allergic Reaction	87	29	138	138.604	4	.000
Sensitivity to Shear & Tensile Strengths	51	104	144	140.557	4	.000