

Commonly Used Implant Dimensions in the Posterior Maxilla - A Retrospective Study

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ABSTRACT: Implant therapy is a treatment option to ensure prosthesis survival rate and it is also done as a fixed dental prosthesis for replacing single and multiunit gaps. Posterior maxilla often has insufficient bone quality and quantity; for this reason it makes implant placement challenging in the site. Posterior edentulous maxilla presents special challenges to implant surgeons that are unique to this region compared to other regions of the maxilla. Thus, the aim of this study is to determine the common implant dimensions used in posterior maxilla. Completed case sheets were collected from a private dental hospital software system. Case sheets were taken from June 2019 to March 2020. Data was retrieved and evaluated by two reviewers. The parameters taken were patients, age groups, gender, teeth indicated for implants (maxillary premolars and molars), implant height, and implant width. Two-hundred fifty-four implants have been placed on the posterior maxilla of which 139 were premolars and 115 were molars. There was no statistical significance between the implants placed in both males and females (p value: 0.274). Between the age groups, the highest number of implants was seen in 41–60 years ($n = 146$) followed by 17–40 years ($n = 78$) and finally > 61 years ($n = 30$). The p value was 0.000, which was statistically significant. Various implant sizes for posterior maxilla have been introduced due to its challenging site. Thus in our study, we can see there is a difference in sizes for premolars and molars. Implant dimensions with increased height are used in the premolars compared to the molars. Implant dimensions with increased width are used in the molars compared to the premolars. In general, implant width and implant height can range from 3.6 to 4.5 mm and implant height ranging from 9.50 to 12.00 mm.

KEY WORDS: edentulous space, implant, implant dimension, posterior maxilla

I. INTRODUCTION

Dental implants are a surgical component that interfaces with the bone of the skull or jaw for the purpose of supporting a dental prosthesis.¹ Dental implants have also been overriding other prosthetic treatment options² and their increasing popularity means they are often chosen as a first treatment option.³ Implants today are a better treatment option as they provide good retention, stability, and support for the prosthesis.⁴ Dental implants are a treatment option in oral rehabilitation of partially or fully edentulous patients.⁵ However, unlike in partially edentulous patients, implant placement and restoration in completely edentulous patients is a challenge, mainly due to the advanced age in these patients.⁶ Posterior edentulous maxilla presents with special challenges to the implant surgeon. The most unique region compared to other areas of the mouth is the posterior maxilla region. An important anatomical

structure located near the posterior maxilla region is the maxillary sinus, which is an air cavity located only in the maxilla. The Schneiderian membrane lines the maxillary sinus and is adherent to the underlying bone. Pseudostratified ciliated epithelium lines the membrane of the maxillary sinus. It allows the passage of fluid toward the nasal meatus. Alveolar ridge and maxillary posterior teeth region are the structures located beneath the maxillary sinus.⁷

Maxilla is made primarily of spongy bone and it is composed of the least dense bone in the oral environment. Limited amount of bone is present beneath the sinus, thus the treatment option for replacement of maxillary posterior teeth varies depending on the amount of bone present in the subsinus region.⁷ Fixed partial denture is often advised when there is a lack of good quality and quantity of bone for implant placement.⁸ Insufficient bone volume is often the problem encountered in the replacement of edentulous posterior maxilla. It is said that this

anatomical region endures lower mechanical forces due to its thinner cortical layer and low density of the spongiosa as compared to the mandible.^{9–11} The upper jaw is mainly composed of type IV bone. Alveolar bone height is compromised in the posterior maxilla, which can lead to atrophic ridges.^{9,11} Atrophy of the alveolar process makes it difficult to place dental implants as there is poor bone quality and maxillary sinus pneumatization, thus vertical alveolar ridge augmentation is done.¹²

There have been various studies that demonstrate the survival rates of dental implants of various dimensions placed in the posterior maxilla. Dental implants placed in native bone have been found to have favorable long-term treatment outcomes. There has been a decrease in the length and diameter of dental implants over the past years. Patients often demand for minimally invasive surgical procedures with fewer or no complications, lower cost of treatment, and reduced treatment time. This resulted in various publications regarding the diameter and length of dental implants.^{13–16} Selection of the diameter of the implant is often based on the patient, and should also be based on the type of edentulism, the amount of residual bone, the volume of space available for prosthetic rehabilitation, the emergence profile, and the type of occlusion.^{16,17} There are certain conditions that prevent the placement of a standard or wide implant, which are a severely resorbed narrow ridge, narrow mesiodistal span, and the replacement of teeth with small cervical, diameters, such as the incisors.^{16,18,19}

Previously our team had conducted numerous studies including *in vitro* studies,^{20–25} reviews,^{26–29} surveys,^{30,31} and clinical trials.^{32–34} Now, we are focusing on retrospective studies; the aim of this study is to determine the implant dimensions of maxillary posterior teeth used as well as correlation with different age groups, gender, as well as teeth (maxillary premolars and molars).

II. MATERIALS AND METHOD

A retrospective institution based study was conducted at the Department of Implantology, Saveetha Dental College and Hospital, Chennai, India. The advantage of choosing to conduct the study in an

institutional setup provides for a population with similar ethnicity. Institutional ethical committee approval was obtained for the study (SDC/SI-HEC/2020/DIASDATA/0619-0320). All patients who underwent implant placement in the posterior maxillary region were included in the study. Exclusion criteria were patient records that were incomplete or repetitive. Data was obtained by the Dental Information Archiving Software (DIAS) developed and maintained by the institution. This is a database of 86,000 patients. The sample size of this study was 160 patients with a mean age of 45 years and standard deviation was 11.61. Of the 160 patients, 46.25% were males and 53.13% were females. Two-hundred fifty-four implants were placed from June 2019 to March April 2020. The variables retrieved were age groups (17–40 years, 41–60 years, and > 61 years), gender, teeth indicated for implants (maxillary premolars and molars), and implant dimension (implant height and width). Three reviewers analyzed the data obtained in this study. Previously our department has published extensive research on various aspects of prosthetic dentistry^{24,35–43}; this vast research experience has inspired us to research about this topic.

Once the case details have been obtained, the data is then extracted and tabulated based on the parameters.

A. Statistical Analysis

Once the results have been tabulated based on the parameters, the data was then exported to SPSS. Frequency, percentage, and mean values were employed in the analysis. Correlation of the parameters (age group, gender implant height, implant width, and teeth) was done in SPSS. ANOVA and independent *t*-test were done to compare means. Charts and tables are added to represent the level of significance between the parameters. *P* value < 0.05 was considered to be significant.

III. RESULTS

A total of 160 patients underwent implant placement in 254 sites. The mean age and standard deviation was 11.61. Of the 160 patients, 46.25% were males and 53.13% were females. Figure 1 represents the

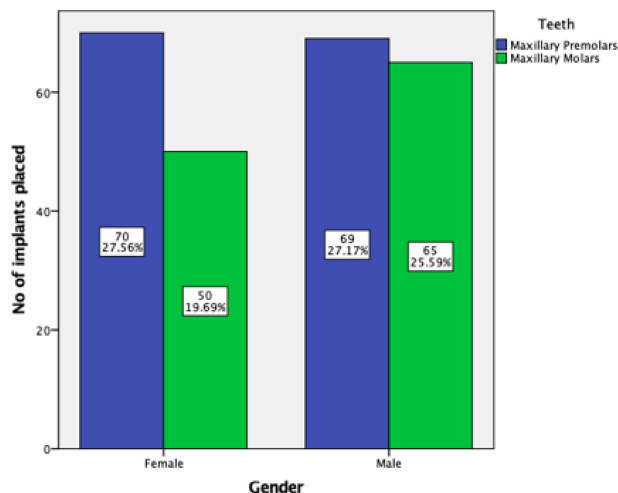


FIG. 1: Graphical representation of the association between number of implants placed and gender. It was found that in both males and females, the greatest number of implants placed were in maxillary premolars (27.17% and 27.56%, respectively). Implants in maxillary molars were placed more in males (25.59%) than in females (19.69%). Chi-square test shows no statistically significant association between the gender and implants placed (Chi-square test: 1.196; p value: 0.274).

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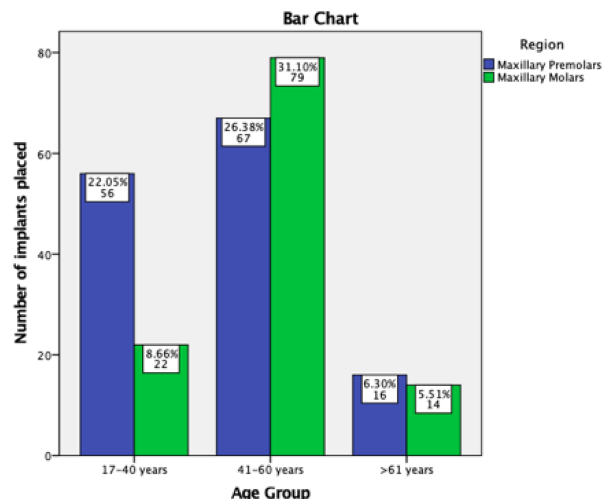


FIG. 2: Graphical representation of the association between number of implants placed and age groups. Those aged 41–60 years had the greatest number of implants placed in both maxillary premolars (26.38%) and maxillary molars (31.10%). The least number of implants placed for maxillary premolars and molars was seen in > 61 years age group with 6.3% and 5.51%, respectively. Chi-square test shows statistically significant association between the age groups and implants placed (Chi-square test: 1.196; p value: 0.001).

in > 61 years age group with 6.3% and 5.51%, respectively. This association was found to be statistically significant (p value: 0.001). Table 1 shows distribution of participants based on age groups and gender. Between the age groups, the highest number of implants was seen in 41–60 years ($n = 146$) followed by 17–40 years ($n = 78$) and finally > 61 years ($n = 30$).

Table 2 shows the association of the implant dimensions (implant height and width) for maxillary premolars and molars. The mean values for both

TABLE 1: Table shows the distribution of participants based on age groups and gender

Gender	Age groups			Total	P value
	17–40 years	41–60 years	> 61 years		
Male	31	78	25	134	0.000
Female	47	68	5	120	
Total	78	146	30	254	

Between the age groups, the highest number of implants was seen in 41–60 years ($n = 146$) followed by 17–40 years ($n = 78$) and finally > 61 years ($n = 30$). P value was 0.000 (< 0.05), which is statistically significant.

TABLE 2: Table shows the association of the implant dimensions (height and width) for maxillary premolars and molars

Implant dimensions	Implant site	N	Mean	Std. deviation	P value
Height	Premolar	139	11.3417	1.12938	0.000
	Molar	115	10.4304	0.98428	
Width	Premolar	139	3.8849	0.49386	0.000
	Molar	115	4.3261	0.31122	

The mean values for both height and width of premolars and molars were determined. It was found that the mean implant height for premolars ($n = 11.34$) was greater than molars ($n = 10.43$); however, the mean implant width of molars ($n = 4.32$) was found to be greater than premolars ($n = 3.88$). P value for both implant height and width was found to be 0.000 (< 0.05), which is statistically significant.

implant height and implant width of premolars and molars were determined. It was found that the mean implant height for premolars ($n = 11.34$) was greater than molars ($n = 10.43$) (p value = 0.000), however, the mean implant width of molars ($n = 4.32$) was found to be greater than premolars ($n = 3.88$) (p value = 0.000). Table 3 shows the descriptive statistics on the implant dimensions (height and width) based on gender. The mean values for both implant height and width for males and females were determined. It was found that the mean implant height for females ($n = 11.10$) was greater than for males ($n = 10.78$), however, the mean implant width for males ($n = 4.13$) was found to be greater than for females ($n = 4.04$).

Table 4 shows the descriptive statistics on the implant dimensions (implant height and width) based on age groups. The mean values for both implant height and width for the age groups were determined. It was found that the mean implant height for 17–40 years ($n = 11.04$) was the highest and the least was > 61 years ($n = 10.55$). The highest mean

implant width was seen in 41–60 years ($n = 4.17$) and the lowest was seen in 17–40 years ($n = 3.93$) ($p = 0.000$, within groups). Thus the mean implant dimensions for the premolar region would be 3.9 mm \times 11.3 mm and for molars would be 4.3 mm \times 10.4 mm.

IV. DISCUSSION

In one systematic review, the authors found that 2132 implants were placed on an atrophic posterior maxilla in a year.⁹ Another study found that 484 implants were placed in 130 patients who were followed-up for 6 to 60 months.⁴⁴ A total of 660 implants were placed on the posterior maxilla in the past 12 years.⁴⁵ Over 100,000 to 300,000 dental implants are placed per year.²¹ Dental implant therapy is the most popular method of replacing missing dentition⁴⁶ as it does not require prepping the adjacent teeth and compromising the adjacent teeth. A study done among patients to determine their knowledge and awareness regarding dental implants found that 58% of the

TABLE 3: Table shows the association of the implant dimensions (height and width) based on gender

Implant dimensions	Gender	N	Mean	Std. deviation	P value
Height	Male	134	10.7799	1.13970	0.030
	Female	120	11.0958	1.15827	
Width	Male	134	4.1276	0.44306	0.127
	Female	120	4.0367	0.50476	

The mean values for both implant height and width for males and females were determined. It was found that the mean implant height for females ($n = 11.10$) was greater than males ($n = 10.78$); however, the mean implant width for males ($n = 4.13$) was found to be greater than females ($n = 4.04$). P value for implant height was 0.03 (< 0.05), which is statistically significant; however, the P value for implant width was 0.127 (> 0.05), which is not statistically significant.

TABLE 4: Table shows the association of the implant dimensions (implant height and width) based on age groups

Implant dimensions	Age groups	N	Mean	Std. deviation	P value
Height	17–40 years	78	11.0449	1.17104	0.133
	41–60 years	146	10.9452	1.18194	
	> 61 years	30	10.5500	0.93172	
	Total	254	10.9291	1.15708	
Width	17–40 years	78	3.9333	0.49113	0.002
	41–60 years	146	4.1699	0.46407	
	> 61 years	30	4.0633	0.38460	
	Total	254	4.0846	0.47445	

The mean values for both implant height and width for the age groups were determined. It was found that the mean implant height for 17–40 years ($n = 11.04$) was the highest and the lowest was > 61 years ($n = 10.55$) (ANOVA test, $p = 0.133$, not significant). The mean implant width was seen highest in 41–60 years ($n = 4.17$) and the least was seen in 17–40 years ($n = 3.93$) (ANOVA test, $p = 0.002$, significant).

patients were not aware of dental implants and 50% of the patients were not considering implants for replacement options of missing teeth due to cost.⁴⁷ Various reasons, such as cost, compromised health status, and interfering anatomical landmarks, can prevent patients from having implants done.

Males were found to be the majority of participants. Another study, which correlates to our study, showed that the majority of participants from a sample size of 731 participants were males.⁹ Similarly, in another study of 14 patients, 9 were males.⁴⁸ The age range in our study was found mostly between 17 and > 61 years of age, with the highest number of patients in the 41–60 years group (Table 2). Implants are often advised in all ages; however, implants are often seen in the younger generation. There are patients above 60 years that have implants, most of which are implant supported dentures. In our study, the patient age range is 17 to older than 61 years; another study found participants between the ages of 37 and 60 years.⁹ Whereas in another study, it was found that the mean age was 63 years with an age range of 34 to 80 years.⁴⁸ Another study showed that their patients were ages from 20 to 85 years old with a mean age of 52.5 years.¹⁶ Thus, based on these findings we can say that patients of various ages are eligible for implants. Knowledge among patients regarding dental implants is increasing across various age groups.⁴⁹

Classification of implants is done based on diameter. Narrow-diameter implants (NDI) are those

with less than or equal to 3.75 mm. Those with diameters > 3.75 mm but less than 4.5 mm were classified as conventional diameters, and finally implants with diameters > 5 mm were considered to be wide-diameter implants (WDI).^{9,50} Based on our study, the mean values of implants placed are classified as conventional diameter. Similarly, in the study done by Rodriguez et al.,⁵¹ implants with 3.75 mm, 4.0 mm and 4.2 mm were used. In a study by Ormianer et al.,⁵² implant diameters ranged between 3.7 mm and 4.7 mm. Additionally, there has been a study that uses an implant diameter of 5.5 mm.⁹ Other studies such as Mangano et al.,⁵³ Oliveira et al.,⁵⁴ Manso and Wassal,⁵⁵ and Krennmair and Waldenberger,⁵⁶ used implants with consistent diameters of 4.1, 4.1, 3, and 5.5 mm. Peleg et al.⁵⁷ used implants with different diameters ranging between 3.25 and 4.7 mm.

Based on our study the height/length of implant, in our study the height of implants used is greater than 10 mm, as shown in Table 4. It was found in our study that the mean implant dimensions for the premolar region would be 3.9 mm × 11.3 mm and for molars would be 4.3 mm × 10.4 mm. There have been many studies in which the endosseous component is less than or equal to 8 mm.⁵⁸ Short implants prove to have a number of clinical advantages such as less skill necessary to perform the surgical procedure, less morbidity by avoiding intensive bone augmentation procedures, easy to remove in case

of failure, and increased number of sites for implant therapy.¹³ Long-term studies have shown that short implants exhibit a higher implant survival rate and better biological outcomes, which is similar to those of longer implants. Long dental implants have a survival rate of 99.5%.¹³ Thirty-three percent of the complications are due to short dental implants whereas long dental implants with sinus elevation procedure increased risk of complication by 100%. This proves that there is a higher risk of having an intraoperative complication when using long dental implants compared to using short dental implants. There are other reasons for failure as well besides selecting the proper implant dimension which is peri-implantitis. A study has showed that, out of 46 patients with peri-implantitis, 29 implants were placed in the posterior maxilla.⁵⁹

A. Study Limitation

The data obtained cannot be generalized to a larger population. This study was done in a small sample size at a private dental hospital.

B. Future Scope

Studies with larger sample size are needed taking into account additional surgical procedures to augment the posterior maxilla region.

V. CONCLUSION

Implant dimensions for posterior maxilla were found to be different based on gender and age groups. Implant dimensions with increased height are used in the premolars compared to the molars. Implant dimensions with increased width are used in the molars compared to the premolars. In general implant width and implant height can be ranging from 3.6 to 4.5 mm and implant height ranging from 9.50 to 12.00 mm in the posterior region of the mandible.

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