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Original Article

A retrospective analysis of single dental implants in three different diameters

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Abstract

Aim: The aim of this study is to examine the distribution of intra-osseous dental implants in the mandible and maxilla applied to correct single missing tooth defects in terms of their size and length and retrospectively evaluate the implant loss rate.

Material and methods: Demographic data showing the age/sex and dental implant records of 180 patients who underwent dental implant treatment at our clinic between 2011 and 2016 were retrieved from archival records. Patients with a missing single tooth in the mandible and maxilla who had an implantation in three different diameters (4.1 mm, 4.5 mm, 4.8 mm) were included. The anatomical localizations, height characteristics and rate of losses concerning the implants were analyzed by descriptive statistical analysis.

Results: Of the 180 patients, 79 received dental implants with a diameter of 4.1 mm; 49 received dental implants with a diameter of 4.5 mm and 52 received dental implants with a diameter of 4.8 mm, making it 221 in total. The mean age of the patients included in the study was 43.1 years. Of the 180 patients, 105 (58.3%) were male and 75 (41.7%) were female. The length of the most commonly used implant was 14 mm (34%) with a diameter of 4.1 mm (45.2%). Of the 221 implants examined, 111 were placed on the maxilla (50.22%) and 110 on the mandible (49.78%). Of the implants examined, 18 were implanted in the anterior region (8.14%); 33 in the premolar region (15%) and 170 in the molar region (77%).

Conclusion: This retrospective study found that single-tooth implant treatment covers a wide range of ages, mainly applied to patients aged 30 to 40 years. Treatment with single-tooth implants was shown to be a successful treatment with a high survival rate when factors such as implant diameter/length and age/sex of the patient are considered.

Keywords: Dental implant; maxilla; mandible

INTRODUCTION

Dental implants have significantly evolved in recent years in keeping with advances in technology. With the increasing aesthetic expectations of patients and physicians, there have been innovations in dental implant design and clinical techniques (1).

The design of dental implant has a critical role in ensuring the primary stability and stress distribution (2). There are many types of dental implants with different exterior designs, surfaces, platforms, connections, diameters and lengths (3). The stress placed on the surrounding bone by the implant depends on the type of stress, the bone, the implant interface, the length and diameter of the implant, the shape and properties of the implant surface, the type of prosthesis and the quantity and quality of the surrounding bone (1). The clinician should biomechanically analyze the case and select the most appropriate dental implant according to the biological and anatomical conditions of the patient.

Dental implants are available on the market in various lengths and sizes. Length and diameter influence the load transferred from the dental implant to the bone. The clinical success of implant prostheses is related to mechanical loads not causing stresses that can compromise the survival time of implants and prostheses as they are transferred from the implant to the surrounding tissues (4, 5).

The prognosis and long-term success of dental implant treatment is highly influenced by the physical and geometric properties of the individual implant components

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and the biomechanical environment to which they are exposed (6). The clinician's inadequate knowledge of biomechanical concepts can lead to the failure of implant restorations

(7). Clinicians should be aware that the transfer process of stress to the surrounding bone and its consequences depend on the type of stress applied (amplitude, direction and frequency), the implant design, the biological and biomechanical properties of the bone-implant interface, and the response of bone tissue to the mechanical environment caused by the stress (8).

The aim of this study is to retrospectively assess demographic data concerning the three most commonly used dental implants applied in our clinic between 2011 and 2016, compare their performance and offer a thorough assessment using methods of descriptive statistics.

MATERIAL and METHODS

This study provides a retrospective assessment of demographic and clinical characteristics of 221 intra-osseous dental implants of 180 patients who had one or two dental implants in the mandible and/or maxilla and were admitted to the Gaziantep University, Faculty of Dentistry, Prosthodontics Clinic to get implant prosthesis between 2011-2016. The study was approved by the Clinical Research Ethics Committee of the Sanko University and conducted in compliance with the ethical principles according to the Declaration of Helsinki. Implants of 4.1 mm, 4.5 mm and 4.8 mm in diameter were compared. The study examined the age and sex of patients as well as the tooth surface where the implant was applied; implant diameter and length, distribution of the number of implants applied to the mandible or maxilla according to the tooth region and the rate of implant losses among patients. Almost all implants examined had either natural or prosthetically restored teeth on both sides of the cavity.

Dental implant data from 10 manufacturers i.e. Straumann (Straumann Institute, Waldenburg, Switzerland), Bredent (Bredent medical GmbH & Co.KG, Senden, Germany), Biotech (Biotech Dental, Salon de Provence, France), Zimmer Dental (Carlsbad, CA, USA), Biohorizons (Maestro Dental Implants, Birmingham, AL, USA), Mis® Seven (MIS®, Medical implants System, Israel), NucleOSS, (Şanlılar Tibbi Cihazlar Medikal Kimya San Tic Ltd. Sti, İzmir, Turkey), BIOMET 3i, Palm Beach Gardens, FL, USA), Implantium implants (Dentium Co., Seoul, Korea), DIO Implant, Busan, Republic of Korea, were examined.

Statistical analysis

Descriptive statistical analysis was performed for data analysis. Data are classified in the descriptive statistical analysis that can be defined as making frequency distributions, classification of data, defining these distributions as percentages, means, standart deviations etc., also results are provided to reader via graphs and tables.

RESULTS

A total of 221 implants with selected diameters were investigated in the study. Of the 180 patients observed, 105 (58.3%) were male and 75 (41.7%) were female is shown in graphic 1. The mean age of the patients included in the study is 43.1 years. The age range of the patients included in the study is 17-80 years. According to the data of the study, single-tooth implants were mostly used in patients aged 30-40 years. Relationship between age ranges and dental implants according to diameter is shown in Table 1.

Of the single tooth dental implants, the most commonly used diameter was 4.1 mm. Of the 100 (45.2%) implants included in the study, 52 implants with a diameter of 4.1 mm were applied to the maxilla (52%) and 48 to the mandible (48%). In this group of 79 patients there were 37 male (46.8%) and 42 female (53.2%) patients. Of the 61 (27.6%) implants with a diameter of 4.5 mm, 32 were applied to the maxilla (52.45%) and 29 to the mandible (47.55%). In this group of 49 patients were 23 male (46.9%) and 26 female (53.1%) patients. Of the 60 (27.1%) implants with a diameter of 4.8 mm, 27 were applied to the maxilla (45%) and 33 to the mandible (55%). In this group of 52 patients there were 30 male (57.69%) and 22 female (42.31%) patients. A balanced distribution across genders was observed in the study for all diameters.

Table 1. Relationship between age ranges and dental implants according to diameter

	4.1 MM	4.5 MM	4.8 MM	Total(%)
17-30 Age Range	21	6	8	35(15.8%)
30-40 Age Range	26	14	11	51(23%)
40-50 Age Range	17	13	16	46(20.8%)
50-60 Age Range	20	13	9	42(19%)
60-70 Age Range	16	12	11	39(17.6%)
70-80 Age Range	0	3	5	8(3.6%)
Total N(%)	100(45.2%)	61(27.6%)	60(27.1%)	221(100%)

Of the 221 implants examined, 111 were placed on the maxilla (50.22%) and 110 on the mandible (49.78%). When examining the distribution of implants applied to the maxilla with regards to those with a diameter of 4.8 mm, 0 (0%) were planted in the anterior region, 5 (16.6%) in the premolar region and 25 (83.3%) in the molar region. There were 4 (12.5%) in the anterior region, 8 (25%) in the premolar region and 20 (62.5%) in the molar region for implants with a 4.5 mm diameter. For implants with a diameter of 4.1 mm, there were 14 (26.9%) in the anterior region, 25 (48%) in the premolar region and 13 (25%) in the molar region. Based on these observations, implants with a larger diameter are preferred in posterior regions while implants with a smaller diameter are preferred in anterior regions for all areas of the upper jaw.

Examination of the distribution of implants with a diameter of 4.8 mm which were applied to the mandible revealed 7 (23.3%) in the anterior region, 3 (10%) in the premolar region and 20 (66.6%) in the molar region. Concerning implants with a 4.5 mm diameter, 1 (3.44%) was observed in the anterior region, 4 (13.79%) in the premolar region and 24 (82.75%) in the molar region. There were 8 (16.6%) in the anterior region, 4 (8.33%) in the premolar region and 36 (75%) in the molar region for implants with a diameter of 4.1 mm. Based on these observations, implants with a larger diameter are preferred in posterior regions while implants with a smaller diameter are preferred in anterior regions for all areas of the lower jaw. At the same time, it was observed that implants with a diameter of 4.1 mm were preferred to implants with a diameter of 4.5 mm and 4.8 mm in the premolar region. The demographic distribution of mandibular and maxillary implants by jaws is shown in Table 2.

The most preferred implant length was 14 mm (75 (33.9%). The second most preferred implant length was 12 mm (66 (29.8%)), followed by 10 mm (53 (23.9%)). Eight of the implants were 13 mm (3.6%), eight were 11.5 mm (3.6%), six were 11 mm (2.7%), three were 8 mm (1.3%) and two were 16 mm (0.9%) in length. The distribution of implant lengths by diameter is shown in Table 3. The demographic distribution of mandibular and maxillary implants by jaws according to lengths is shown in Table 4.

Of all the dental implants, one implant was lost. The lost implant was 8 mm in length and 4.5 mm in diameter. The loss rate of the implants was (0.45%). The lost implant was located in the premolar region of the maxilla of a 66-year-old patient.

Table 2. The demographic distribution of mandibular and maxillary implants by jaws according to the diameters.

	4.1 MM		4.5 MM		4.8 MM		Total
	Mandible	Maxilla	Mandible	Maxilla	Mandible	Maxilla	n(%)
Anterior Region	8	14	1	4	7	0	34 (15.38%)
Premolar Region	4	25	4	8	3	5	49 (22.17%)
Molar Region	36	13	24	20	20	25	138 (62.44%)
Total	48	52	29	32	30	30	221
	100		61		60		221
	(45.24%)		(27.60%)		(27.14%)		

Table 3. The distribution of implant lengths by diameter

	4.1 MM	4.5 MM	4.8 MM	Total (%)
8 MM	2	0	1	3 (1.3%)
10 MM	26	14	13	53 (23.9%)
11 MM	3	1	2	6 (2.7%)
11.5 MM	5	2	1	8 (3.6%)
12 MM	30	17	19	66 (29.8%)
13 MM	4	2	2	8 (3.6%)
14 MM	29	25	21	75 (33.9%)
16 MM	1	0	1	2 (0.9%)
Total	100 (45.2%)	61 (27.6%)	60(27.1%)	221

Table 4. The demographic distribution of mandibular and maxillary implants by jaws according to the lengths.

	ANTERIOR	REGION	PREMOLAR	REGION	MOLAR	REGION	TOTAL
	Mandible	Maxilla	Mandible	Maxilla	Mandible	Maxilla	N (%)
LENGTHS							
8 MM	0	2	0	0	0	1	3(1.3%)
10 MM	8	18	6	8	7	6	53(23.9%)
11 MM	2	1	1	0	0	2	6(2.7%)
11.5 MM	4	1	1	1	1	0	8(3.6%)
12 MM	10	12	7	10	13	14	66(29.8%)
13 MM	3	1	0	2	1	1	8(3.6%)
14 MM	10	11	13	12	16	13	75(33.9)
16 MM	0	0	0	1	1	0	2(0.9%)
Total	37	46	28	34	39	37	221
	(16.7%)	(20.8%)	(12.6%)	(15.3%)	(17.6%)	(16.7%)	(100%)

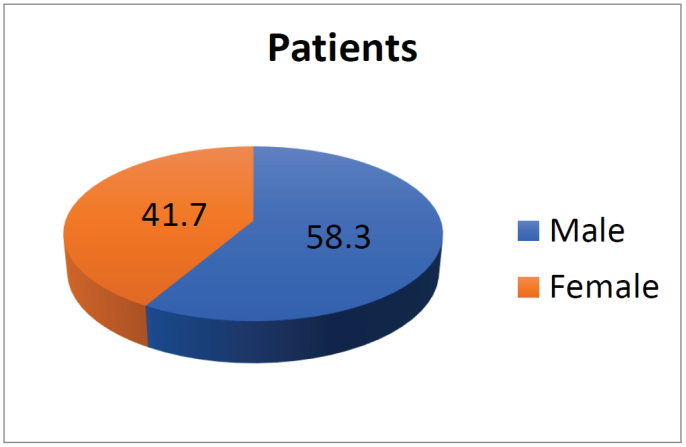

Figure 1. Patients distribution according to gender

DISCUSSION

Dental implants that replace missing teeth have become a popular treatment option. Conducted with patients who were admitted to the Gaziantep University, Faculty of Dentistry, Prosthodontics Clinic between 2011 and 2016, the aim of this study is to examine the distribution of intra-osseous dental implants in the mandible and maxilla applied to correct single-tooth defects in terms of their size and length and retrospectively evaluate the implant loss rate.

Factors causing premature loss of the implant include bone necrosis, bacterial contamination, poor bone quality, micro-movement of the implant, premature loading and inadequate primary stabilization (9). However, poor oral hygiene, excessive occlusal loading and improper prostheses can lead to late implant loss (10), while the patient's immune system and the implant's surface characteristics are other risk factors that must also be considered (11-13). The success rate of implants placed on the basis of these risk factors over a period of five years is more than 95% (14,15). Berglund et al. reported in a 2002 study that implant losses ranged between 2 to 3% for implant-supported fixed partial dentures and over 5% for removable implant overdentures (15). In this study, it was also reported that the rate of implants that failed before loading was between 2.16% and 2.53% (15). In their study, Çelebi et al. found an implant loss rate of 0.5% (16). We determined an implant loss rate of 0.45%, which is consistent with the results obtained by Çelebi et al.

Some studies have reported that the length of the implant affects how long an implant can endure in the mouth (17,18), while other studies report that the implant's diameter affects the same (19,20). Selecting the correct implant diameter normally depends on bone presence (21). If the cortical bone thickness is insufficient, the implant diameter can influence the success of the treatment. Biomechanically, the implant diameter seems to influence the stress concentration of the surrounding bone as it does in the implant with an inevitable impact on the success rate (7,22). An increase in implant diameter with the same load reduces stress on the implant and peri-implant bone (23-25).

Iplikcioglu and Akça (26) showed that the length of the implant, in contrast to the diameter of the implant, had no influence on the reduction of the stress placed on the bone. Petrie and Williams (27) concluded that the increase in implant diameter reduced the load on the alveolar crest 3.5 times, which was better for short and conical implants. In our study, it was found that implants with a length of 14 mm (30%) were preferred over short implants with different diameters.

Kong et al. (28) reported that larger diameters can reduce cortical bone stress, and implant displacement under lateral stress for cases of immediate implant. In the

same study, based on the results of the finite element analysis, they concluded that implants with a diameter of more than 4 mm and a length of more than 11 mm were the appropriate combination to achieve the best biomechanical characteristics in case of immediate loading (28). Therefore, implants with a diameter greater than 4 mm were included in our study and similar results were obtained. It was observed that increasing the diameter of the implant had a positive effect on success, especially in the posterior regions where bone length is insufficient. It was also reported in the literature that an increase in the diameter of the implant compensates for the length of the implant (29,30).

Requirement for implant treatment depends upon the patient's age in cases of tooth loss (31). Vehemente et al. (32) reported in their study that the average age was 53.5 years and the age range was between 16 and 92 years. Eltas et al. (9) reported in their study that the average age was 45.2 years and the age range was between 20 and 78 years. Urvasızoglu et al. (31) reported in terms of the age group of the subjects included, that the age when people get implants the most was between 46 and 55 years and that the average age was 41.1 years. In our study, the age of the patients was between 17 and 80 years. While the age where patients got implants the most was in the third decade, i.e., between 30 and 40 years of age, the age average was 43.1 years, similar to previous studies.

Our study also examined the distribution of implants according to different regions of the jaw. It was observed that 15.3% were performed in the anterior region and 84.7% in the posterior region. This may be due to the fact that diameters of the implants exceed 4 mm, i.e. they are not classified as implants with a narrow angle. However, Urvasızoğlu et al. (31) reported that 40% of the implants were applied for aesthetic purposes while 60% were applied in the posterior area. Vehemente et al.(32) also showed a higher rate of implantation in the posterior region, similar to our study. Urvasızoğlu et al. (31) reported in their study that longer and narrower implants were preferred for implants done for aesthetic purposes (mean implant diameter 3.6 mm, average implant length 12.0 mm), while shorter and wider implants were preferred for applications in the posterior region (mean implant diameter 3.9 mm, average implant length10.7 mm). According to our study, the most preferred implant diameter was 4.1 mm for all jaws and the most preferred length was 14 mm.

CONCLUSION

Within the framework of our study;

- Implant treatment has proven to be a very successful and reliable treatment option for single-tooth defects with a high survival rate.
- It has been established that single-tooth deficiencies cover a wide age range (17-80 years) and the age range in which single-tooth implants are applied the most is 30-40 years.
- There was no significant difference in the success of single-tooth implant treatment in terms of gender, but implants were mostly performed on male patients.
- It has been observed that most single-tooth implants are placed in the posterior area.
- The most preferred implant diameter is 4.1 mm. The most preferred implant lengths were 14 mm, 12 mm and 10 mm respectively.

In view of this information, more detailed, multi-center and multidisciplinary studies are needed on dental implants and clinicians should be provided proper guidance on implant treatment.

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