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The Role of Radiographic Images of Dental Implants in Forensic Identification

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ABSTRACT: Due to many different reasons, forensic events, individual and mass deaths occur in different parts of the world. The first step in solving forensic cases is case identification studies. In this study, the radiographic images of the patients who received dental implant treatment in case identification studies were evaluated. For this purpose, the orthopantomographic images of single dental implant applications of 150 patients with 1st molar deficiency, who were treated in our clinic by the same physician, were examined. Distinctive findings have been demonstrated in radiographic images of different implant brands of the same diameter and length. It has been determined that the implants Q4.0 mm X H10.0 mm in the upper jaw and the Q3.5 mm X H12.0 mm in the lower jaw were more preferred and there was negative correlation between the implant diameter and the implant length. It was determined that the distance between the implant and the adjacent second premolar 3.32 ± 1.34 mm (1.1-7.7 mm) in the lower jaw and 2.60±1.07 mm (0.6-7.5 mm) in the upper jaw. The average angle of the implants with the y-axis was found to be 8.01° ± 5.94 (0-22.2 °) in the lower jaw and 5.22° ± 3.74 (0.30-16.10°) in the upper jaw. An implant by itself would not establish a dental ID but would be a piece of the bigger picture and totality of the comparative evidence.

KEYWORDS:case identification, dental implant, diagnostic x-ray radiology, forensic dentistry, forensic medicine, periodontology

I. INTRODUCTION

Forensic dentistry is one of the important branches of forensic medicine that deals with the examination and evaluation of dental remains in order to ensure justice. It has a field of study where odontological information and legal system are interpreted together. The most important step in the evaluation of forensic cases is the identification studies to be carried out on each living or dead individual. Forensic identification information, appearance, fingerprint, DNA analysis and dental remains are used in identification[1]. It has long been used to evaluate and describe a case using dental remains[2].

The first known use of dental remains in case identification was when Dr. Warren, who died in the Battle of Bunker Hill in 1775, was diagnosed by his dentist friend Dr. Revere[3]. 'L'art dentaire en medicine legale', the first book in the field of forensic dentistry, was published by Dr. Oscar Armoedo in 1898, making this field heard worldwide[4]. In our country, the inclusion of forensic dentists in forensic case identification has been observed since 1992[5].

Today, examination of dental remains by forensic dentists is used in the identification of many forensic cases. For this purpose, teeth, dental records, radiographic images, lip and palate marks, applied restorative, endodontic, prosthetic and surgical procedures are used[2].

In the literature sources examined, it was seen that dental implants, which are frequently preferred in the treatment of tooth deficiencies, are also used in identification studies. Although different methods have been tried, no study has been found to distinguish between implant applications performed at the same location by measuring on radiographic images. In this study, it was aimed to determine the differences between the cases by examining and making measurements on the radiographic images of dental implants applied to the same area.

II. MATERIAL & METHOD

This study is a longitudinal cohort study that evaluates the data obtained by retrospectively examining digital dental records. The study was conducted in full accordance with the World Medical Association Declaration of Helsinki, approved by the Ethics Committee of XXX University, Dentistry Faculty in YYY (06/10/2020). This study was carried out by examining the radiographic images of patients who received dental implant treatment between 2017 and 2020 at Atatürk University Faculty of Dentistry, Department of Periodontology. In this study, radiographic images

of 150 patients with a single tooth implant, which are considered to be recessive under ideal conditions, were included. Also, informative consent form was read and signed by the all patients.

Two hypotheses were evaluated in this study; 1) different brands of implants with the same diameter and length have different features in the radiographic images, and 2) there are distinctive signs between the radiographic images of implants applied to the same parts of different people (See the diameter, length, brand and location features of the implant).

In the evaluation of the first hypothesis; the 'Q3.5mm X H10.0mm' implant type, which has the same diameter and length of 3 different implant brands (Bredent Narrow (GmbH & Co. KG, Senden, Germany), NucleOSS T-6 (NucleOSS, Izmir, Turkey), Osstem TSII SA Fixture (Implant Co., Ltd. Seoul, Korea), has been used. At this stage, 18 cases with implant treatment in the tooth area numbered 36 or 46 according to Palmer classification, and have an ideal radiographic image were included in the study. The macro design of the implants was examined on the radiographic images. Implant body designs (screw, cylindrical, combination of these designs), thread design (thread shape, thread pitch, thread depth, thread width and thread pitch), crestal module design (implant neck design), prosthetic interface and spacer type were evaluated.

In the evaluation of the second hypothesis, radiographic images of 150 patients with first molar tooth deficiency treated with the same brand of implant were examined. 75 of these implants are made in the upper jaw and 75 in the lower jaw. It was paid attention that the radiographs included in the case were taken under ideal conditions and the presence of second premolar and second molar teeth adjacent to the first molar tooth deficiency. Millimetric measurements were made on the radiographic images using Adobe Photoshop CS6 program[6]. The distance in the horizontal plane from the adjacent second premolar tooth of the implants for which diameter and length information are available was measured. The distance in the horizontal plane from the adjacent second premolar tooth of the implants for which diameter and length information are available was measured. In addition, the lower wall of the maxillary sinus cavity of the upper jaw implants and the distance between the upper wall of the mandibular canal in the verchal plane and the angles of the implants with the y-axis were evaluated (Figures I-II).

While determining the angle made by the implant with the y-axis, first of all, the axis angle of the implant was determined with the Adobe Photoshop CS6 program and its equivalent in the y-axis was noted. In order to emphasize the implant axis, (-) value is given to the implants that are sloping to the right in the radiography, while (+) value is given to the implants that are sloping to the left (Figure III).

The data obtained from implants applied to the same toothless areas were evaluated statistically.

III. RESULT

Radiographic images of a total of 150 people, 91 males and 59 females, who received dental implant treatment in the Department of Periodontology, Faculty of Dentistry, XXX University, were included in the study. The age distribution of the people included in the study ranged from 16 to 74, while the mean age was 46.6 ± 11.2. The distribution of the implants evaluated within the scope of the study according to their localization and brands is given in Table I.

Because of the macro design examinations performed on orthopantomography radiographs, differences that enable different implant brands to be distinguished from each other have been observed with the same diameter and length implants (Figure IV).

It is seen that the body design of the Osstem brand implants has a single piece, 0.8mm spacing x 0.25mm deep, wrapped with double spiral threads and has a 1.5 ° conical angle. The double helix thread pitch is 1.6 mm[7].

In the body design of the Nucleoss brand implants; The cylindrical surface consisting of micro threads on the upper part and the double structure formed by the implant surface with double helix (double thread) and reverse butterss screw pitch draw attention. There is a 20 ° contact area in the area where the abutment and implant surface meet[8].

It is noteworthy that the Bredent brand implant body design has a double structure as in the Nucleoss brand and the lower part is double helix. The implant macro design is conical and cylindrical[9]. In addition, it was determined in the radiographic image that the implant healing head is different in 3 brand types.

Implants of different diameters, lengths and brands applied for the treatment of first molar tooth deficiencies were evaluated by measuring on their radiographic images. It was observed that the distribution of the diameter and length values of the implants applied to the upper and lower jaws was wide (Tables II and III). It has been determined that implants of 4.0 mm diameter and 10.0 mm length in the upper jaw, 3.5 mm diameter and 12.0 mm length in the lower jaw are more preferred.

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While examining the sources in which the patient information and the diameter, length and localization of the implants were noted by the implant officials, it was determined that the information of 122 patients (81.3%) was recorded correctly, and that there was a lack or inaccuracy in the information of 28 patients (18.7%). It has been observed that these errors are mostly recorded in the records of the implants placed in the form of irregular and incorrect tooth and / or jaw.

The evaluation of the distance of the implants from neighboring teeth (distance1- distance in the horizontal plane with the second premolar) and anatomical structures (distance2- the distance in the vertical plane with the closest maxillary sinus lower wall for the upper jaw and the closest upper wall of the mandibular canal for the lower jaw) and the angle made with the y-axis were evaluated.

Because of the measurements of the implants applied to the lower jaw, it was determined that it was approximately 3.32 ± 1.34 mm (1.1-7.7 mm) from the neighboring second premolar tooth. When the distance between the mandibular canal walls was examined, it was seen that the implants were placed with an average distance of 3.69 ± 1.59 mm (0-6.2 mm). The average angle of the implants with the y-axis was measured as 8.01° ± 5.94 (0-22.2°). A negative correlation was found between the diameter and length of the implants applied to the lower jaw ($p < 0.05$) (Table IV).

Because of the measurements of the implants applied to the upper jaw, it was determined that it was approximately 2.60 ± 1.07 mm (0.6-7.5 mm) from the neighboring first premolar tooth. When the distance between the lower walls of the maxillary sinus cavity was examined, it was seen that the implants were placed with an average distance of 1.93 ± 1.5 mm (0-6.2 mm). In 19 patients (25.3%) who underwent sinus-lifting operation, the implants were found to be up to 5.5 mm high in the maxillary sinus cavity in the radiographic image. The average angle of the implants placed in the upper jaw with the y-axis was measured as 5.22° ± 3.74 (0.30-16.10°). A strong negative correlation was found between the diameter and length of the implants applied to the upper jaw ($p < 0.01$) (Table V).

IV. DISCUSSION

In this study, in which the implants that are frequently used in the treatment of edentulism cases were evaluated only on the radiographic images, positive results for forensic case identification procedures were obtained. Differential findings should be identified among dental remains, which are important evidence in identification of forensic cases, to facilitate diagnosis. As far as it is known, our study is a pioneering study in which the diameter, length and localization of the implants are evaluated through orthopantomographic images among those who have been treated with implant applications in the same region of edentulous problems.

In non-visual identification of victims, DNA analysis, fingerprints and comparison of dental remains are used as primary scientific identifiers. In cases where a victim is cremated, fingerprint detail and DNA denaturation may be involved. Although it is extremely durable, loss of tooth structure can also occur at extreme temperatures, and dental implants, if any, remain the only physical identification data available. In a study[6], after obtaining radiographic images of a series of implants from different implant brands, the implants were kept at 1125 ℃. It has been observed that oxidation occurs on the surface of titanium alloy implants and this causes some changes in appearance. When the same radiographic images were obtained again later, it was determined that the implants were still recognizable. High heat, which is frequently encountered in forensic cases, can destroy both teeth and traditional dental restorative materials.However, although fabricated dental implants do not have personal features, their resistance to corrosion and their high melting point make them an element of evaluation in forensic cases. Therefore, in our study, the importance of radiographic images of implant restorations, which are frequently applied in our clinic, in forensic cases was highlighted.

While determining the study group, patients with the most frequently missing first molar tooth[10] were preferred. When examining the relation of the implant with the neighboring anatomical formations, the presence of the second premolar and second molar teeth adjacent to the first molar tooth in the mouth was taken as the basis of patient criteria in order to provide standardization.

The diameter and length information of the implants applied to the first molar region was obtained from the records taken by the implant representatives. Orthopantomographic images were used to evaluate the distance of implants from neighboring teeth and anatomical structures and the angle made with the y-axis. In the orthopantomographic imaging system, different images may occur depending on the exposure settings and the position of the patient. For this reason, differences may occur in the measurements

obtained. However, orthopantomographic images are still frequently used in implant surgery today. That is why these images are included in the methodology of the study. It is contemplated to conduct another study in which standardized radiographic images can be included in the future.

When the radiographic images of implants of the same diameter and length applied to the same location of different implant brands were evaluated, distinctive findings were observed as stated in the literature[11, 12]. In cases where edentulous cases in the same area were treated using the same implant brand, it was determined that none of the cases fully matched with each other and there were differences between them.

In Periodontology and Implantology books, Çağlayan et al[13] stated that for a successful implant surgery, the implants should be examined clinically in terms of bone distance where they will be placed, and care should be taken to ensure that the implant is surrounded by 1-1.5 mm bone. It was stated that for an implant with a diameter of 4 mm and a length of 10 mm, the buccolingual width of the alveolar bone should be at least 6-7 mm, the height should be 12 mm, and for an implant of the same diameter and length that will remain between two natural teeth, the mesiodistal bone width should be at least 7 mm. In radiological evaluation, the distance between the first molar tooth and the second premolar was measured as 3.32 mm for the lower jaw and 2.60 mm for the upper jaw. It was determined that the distance between the lower wall of the maxillary sinus cavity and the upper wall of the mandibular canal and the implants was 1.93 mm and 3.69 mm, respectively. The results were consistent with the literature recommendations.

In a study involving odontologists and police officers, Korkchi et al[14] noted that out of 26 radiographic image-matched cases with implanted prosthetic restorations, 12 were correctly matched by all observers. The design of the implants, the shape of the abutments, the shape of the bridges and the bone anatomical structure of the jaws are taken into consideration as parameters. In our study, while examining the differences between implant brands, attention has been paid to the implant macro design, abutment shape, thread shape and frequency as parameters.

In another study[15] where odontologists and dentists were asked to compare antemortem and postmortem radiographs, it was determined that odontologists performed better. As in every field, training and experience in the field of forensic dentistry will be useful in identifying cases.

In order for the implant restorations to be used more effectively in identification procedures, when evaluating the pre and post images of the laser engraved serial number on the implant body using a microscope connected with a digital camera, it was shown that the serial number was permanent even after high temperature exposure. Implants produced in accordance with this design can be used as sufficient and accurate findings that facilitate identification studies thanks to their serial numbers[16]. However, most of the implant brands used do not have serial numbers on the implant bodies. This situation causes difficulties in the identification of the implant. In another study[11], it was stated that implants without serial numbers can be classified according to their brands as a result of radiographic examinations. The implant brands evaluated in our study also do not have a serial number on the implant. However, the ability to identify implant brands supports the literature.

In a study[17] in which the radiographic images of dental implant materials were evaluated, 15 periapical radiographic images were obtained with different vertical and horizontal angulations and the most ideal implant radiography was tried to be obtained by superposition. As a result, sample radiographs were obtained to enable comparison of relevant dental implants if needed. Preparation of a catalog containing the description of the implants used, clinical and radiographic images will also be useful in identifying the implants. Clues obtained from the type of implants used in unidentified cases will contribute to the research.

One of the current studies[18, 19] in this field is an implant recognition software consisting of a large database that determines different implant systems and is fed with a series of questions. In addition, radiographic and clinical images of implant systems are also included in the software database. At the end of the research, a complete dental implant identification system is obtained, which can aid in the recognition of cases and simplify the job of a forensic dentist.

V. CONCLUSIONS

It has been observed that implants with different diameters, lengths, distances and angles to anatomical structures are applied with the effect of the physician's preference and anatomical formations in the treatment of edentulism in the same regions. In this way, it has been determined that the radiographic images of dental implants can be used as an auxiliary material in determining the brand of the implant and in identification studies. However, an implant by itself would not establish a dental ID but would be a piece of the bigger picture

and totality of the comparative evidence.

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Table I. Localization and implant brand distribution of evaluated implants.

		Upper jaw		Lower jaw		Total
		Number of implants				
		16	**26**	**36**	**46**	
Brand of implants	Nucleoss	6	10	15	14	45
	Bredent	6	8	10	7	31
	Osteem	25	20	17	12	74
Total		37	38	42	33	150
		75		75		150

Table II. Diameter distribution of implants applied to the upper and lower jaw

	Diameter distribution of implants (mm)						Total
	3.5	4.0	4.1	4.5	4.8	5.0	
Upper jaw	13 %17.3	29 %38.7	6 %8.0	14 %18.7	6 %8.0	7 %9.3	75 %100
Lower jaw	35 %46.7	15 %20.0	15 %20.0	4 %5.3	1 %1.3	5 %6.7	75 %100
Total	48 %32.0	44 %29.3	21 %14.0	18 %12.0	7 %4.7	12 %8.0	150 %100

Table III. Length distribution of implants applied to the upper and lower jaw

	Length distribution of implants (mm)										Total
	5.0	6.0	7.0	8.0	8.5	10.0	11.5	12.0	13.0	14.0	
Upper jaw	1 %1.3	1 %1.3	7 %9.3	8 %10.7	13 %17.3	20 %26.7	8 %10.7	9 %12.0	5 %6.7	3 %4.0	75 %100
Lower jaw	–	1 %1.3	1 %1.3	4 %5.3	5 %6.7	19 %25.3	11 %14.7	30 %40.0	4 %5.3	–	75 %100
Total	1 %0.6	2 %1.3	8 %5.3	12 %8.0	18 %12.0	39 %26.0	19 %12.7	39 %26.0	9 %6.0	3 %2.0	150 %100

Table IV. The distance of the implants evaluated in the lower jaw from the adjacent anatomical structures and the measurements of the angle with the y-axis.

Number of Patient	**Number of İmplant**	**Diameter**	**Length**	**Distance1 (mm)**	**Distance2 (mm)**	**Angle (°)**
1	36	4,1	12	5,6	3,8	7,8
2	46	4,1	12	2,2	6,7	-11,2
3	36	4,8	10	3,4	3,6	17,9
4	46	3,5	10	3,7	2,1	-8,1
5	36	3,5	10	2,9	3,4	0
6	36	3,5	12	3,1	5,7	7,7
7	46	3,5	12	1,5	6,3	-6,8
8	36	3,5	12	4	2,2	15,9
9	46	3,5	12	3,7	3,6	-12,8
10	46	3,5	8	4,5	4,7	-3,7

11	36	4,1	10	6,6	1,6	22,2
12	46	4,1	10	2,6	5,6	-14,7
13	36	4,1	12	5,1	3,7	2,7
14	36	4,1	12	4,2	5,5	5,8
15	46	4,1	12	2,9	2,8	-6,1
16	46	4,1	12	2	3	-0,6
17	46	3,5	12	1,5	2,9	-4,9
18	36	4,1	8	4,2	4,6	14,8
19	36	4,1	10	2,9	5,7	1,6
20	36	4,1	12	5,3	3,2	6,4
21	46	4,1	12	5,4	1,5	-17,1
22	46	3,5	12	1,4	3	4,4
23	46	3,5	12	3	5	-5,3
24	36	3,5	10	1,6	1,8	-5,8
25	46	4,1	10	1,2	2,8	4,1
26	36	4,1	12	2,6	4,6	-3,7
27	46	3,5	12	7,7	4,6	-20,8
28	36	4,1	12	3,5	4	0,7
29	36	3,5	12	2,3	3	-3,4
30	36	4,5	8	5,7	2,2	0,2
31	46	4	8	4,7	1,8	-9,3
32	46	3,5	12	5,4	3,8	-18,7
33	36	3,5	12	1,8	4	5,2
34	46	3,5	12	2,3	3,7	-6,2
35	36	3,5	12	2,7	5,1	0,7
36	36	3,5	12	3,6	5	17,5
37	46	3,5	12	3,2	4,4	-12,6
38	36	3,5	10	4,1	4,8	-3,7
39	46	3,5	10	2,5	2,9	3,9
40	36	3,5	12	1,9	3,9	7,4
41	46	4	10	2,6	2,2	9,6
42	36	4,5	12	3,6	5,3	12,9
43	36	3,5	10	3	3,3	12
44	46	3,5	12	2,7	4,2	-0,7
45	36	4	12	1,1	5	7,5
46	36	4	12	3,1	5,5	14,5
47	46	3,5	10	2,1	1,1	-0,9
48	46	4	13	4,3	5,3	-8,5
49	46	4	13	2,4	5,1	-13,7
50	46	3,5	8,5	2,9	2,9	-2,8
51	46	5	10	5,4	2,9	-15,1
52	36	5	11,5	1,8	10,3	8,8
53	46	5	8,5	2,5	4,9	-17,6
54	36	4	11,5	1,1	4,2	5,4
55	36	4	8,5	2,6	1,9	0,3
56	36	3,5	10	3,6	3,5	4,7
57	46	4	13	2	2,9	-7,6
58	36	4	11,5	4,6	5	2,3
59	46	3,5	11,5	4,1	1,8	1,9
60	36	4	8,5	3,1	2,7	-8,3
61	46	4	11,5	2,2	1,4	-3,8
62	46	3,5	10	3,7	2,7	-5,1
63	36	5	11,5	3,8	4,6	15,1
64	46	3,5	11,5	2,4	1,2	1,3

65	36	4,5	11,5	4,4	3,3	9,6
66	36	3,5	11,5	3,4	2,1	13,7
67	36	4	7	3,4	1,9	8,3
68	46	5	6	3,4	1,3	-0,6
69	36	3,5	10	3,6	6,5	10,1
70	36	3,5	10	3,4	3,6	3,4
71	36	4	11,5	3,2	2,6	7,1
72	36	4,5	10	6,2	1,8	17,4
73	36	4	8,5	3,8	3,4	4,8
74	36	3,5	13	2,9	2,8	0,8
75	36	3,5	11,5	2,6	5,4	22,2

Table V. The distance of the implants evaluated in the upper jaw with neighboring anatomical structures, measurements of the angle made with the y-axis and the status of sinus lifting operation.

Number of patient	**Number of İmplant**	**Diameter**	**Length**	**Distance1 (mm)**	**Distance2 (mm)**	**Sinus Lift**	**Angle (°)**
1	26	4,8	8	5,4	-2,5	Done	13,1
2	26	3,5	10	1,7	1,7	Not done	4,2
3	16	4,1	10	2,3	-2	Done	-0,9
4	16	3,5	12	2,7	1,5	Not done	-4,4
5	26	4,8	6	2,7	0,6	Not done	-3,2
6	26	4,1	12	2,9	0,3	Not done	-6,4
7	16	4,8	8	2,4	-2,3	Evet	-16,1
8	26	4,1	12	2,1	3,7	Not done	8,1
9	26	4,8	10	4,5	-2,4	Done	-4,6
10	26	4,1	8	2	1,8	Not done	8,2
11	16	4,8	10	4,3	0	Not done	13,8
12	16	4,8	8	4,5	1,2	Done	2,2
13	26	3,5	12	1,3	-0,9	Not done	-1,7
14	16	4,1	10	3,2	-3,3	Done	1,5
15	26	4,1	12	2,4	0,3	Not done	0,3
16	26	3,5	10	11	1,3	Not done	-0,4
17	16	3,5	12	3,3	6,2	Not done	12
18	26	4	14	2,5	2,8	Not done	-4
19	26	4,5	8	3,8	2,6	Not done	-1,8

20	16	5	5	1,8	0,7	Not done	0,9
21	26	4,5	8	1,3	-0,4	Not done	1,4
22	16	4	8	1,8	1,3	Not done	5
23	26	4	12	3,4	1,1	Not done	-10,1
24	16	3,5	12	1,6	1,3	Not done	8,4
25	26	3,5	10	1,9	2	Not done	-8,1
26	26	4	8	0,9	1,1	Not done	-6,8
27	26	4	10	3,6	2,7	Not done	-3,3
28	16	3,5	14	1,9	4,6	Not done	4,4
29	26	3,5	14	2,3	2,3	Not done	3,1
30	16	4	12	2,1	5,1	Not done	-2,5
31	26	4	7	2,5	0,9	Not done	-3,5
32	26	4	8,5	2,1	0,8	Not done	5,4
33	16	3,5	11,5	1,5	2,9	Not done	-3,2
34	16	4	13	2,9	5,3	Not done	-9,6
35	16	4	11,5	2,5	1,7	Not done	2,1
36	26	5	10	2,4	0,3	Not done	-2,2
37	26	4,5	8,5	2,4	-3,2	Done	4,6
38	16	5	10	3,1	-1,9	Done	-1,9
39	16	4,5	10	1,3	0,7	Not done	9
40	26	3,5	10	2,7	2,2	Not done	2
41	16	3,5	10	1,6	1,5	Not done	1,4
42	26	5	10	2,3	-2,1	Done	-2,9
43	16	4	8,5	3,5	1,4	Not done	-11,4
44	16	4	7	1,7	-4	Done	-10
45	16	4	13	2,3	0,8	Not done	2,4
46	26	4	11,5	2,1	0	Not done	-0,8
47	16	4,5	8,5	2,8	-5,5	Done	3,8
48	26	4	8,5	2,2	5,4	Done	4,4
49	16	4	11,5	0,8	1,7	Not	-3,2

						done	
50	26	5	8,5	0,6	0,8	Not done	0,7
51	16	4,5	10	2,6	-1,9	Done	2,9
52	26	4,5	10	2,1	2,1	Not done	1,3
53	16	4	11,5	2,8	0,7	Not done	2,4
54	26	4	11,5	2,3	-5,1	Done	6
55	26	5	7	2	-0,6	Not done	1,7
56	16	4,5	7	2,7	-1,2	Done	-4,5
57	26	4	8,5	2,4	3,2	Not done	8,6
58	16	3,5	13	1,7	0,2	Not done	-9
59	26	4,5	7	1,6	0	Not done	8,5
60	16	4,5	8,5	1,8	0	Not done	-3,9
61	26	4	8,5	3,3	1,2	Not done	9,4
62	16	4	8,5	3,5	-1,9	Done	-3,6
63	16	4	7	2,2	2,6	Not done	-9,3
64	26	5	8,5	7,5	0,7	Not done	-16
65	16	4	13	2,9	0,7	Not done	5,7
66	26	4	11,5	2,3	0,5	Not done	0,3
67	16	4	13	3,8	1,2	Not done	4,1
68	16	4	10	2,7	-3,7	Done	6,3
69	16	4	7	2,5	0,6	Not done	-6,7
70	26	4	8,5	2,7	-3,3	Not done	6
71	16	4,5	10	3,3	1,5	Not done	6,5
72	16	4,5	8,5	3,2	3,2	Not done	-9,8
73	26	4,5	11,5	3,9	-2,2	Done	5
74	26	4,5	10	4,2	3,6	Done	-5,1
75	16	4	10	2,1	0	Not done	-3,7

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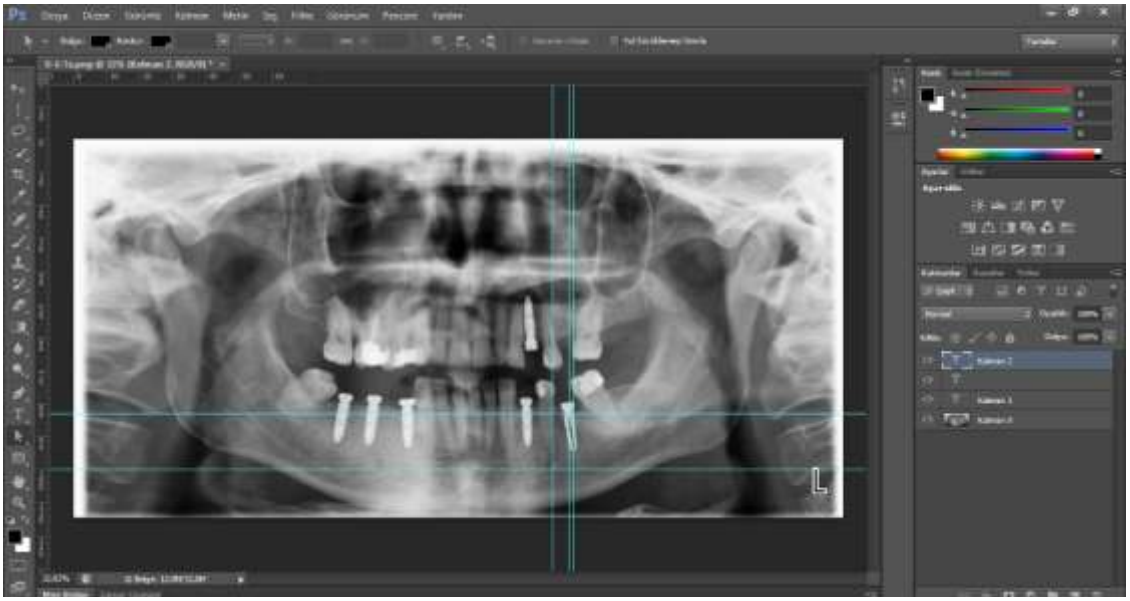

Figure I. Millimetric measurements of the implant treatment applied to the tooth area numbered 36 using Adobe Photoshop CS6 program using Adobe Photoshop CS6 program.

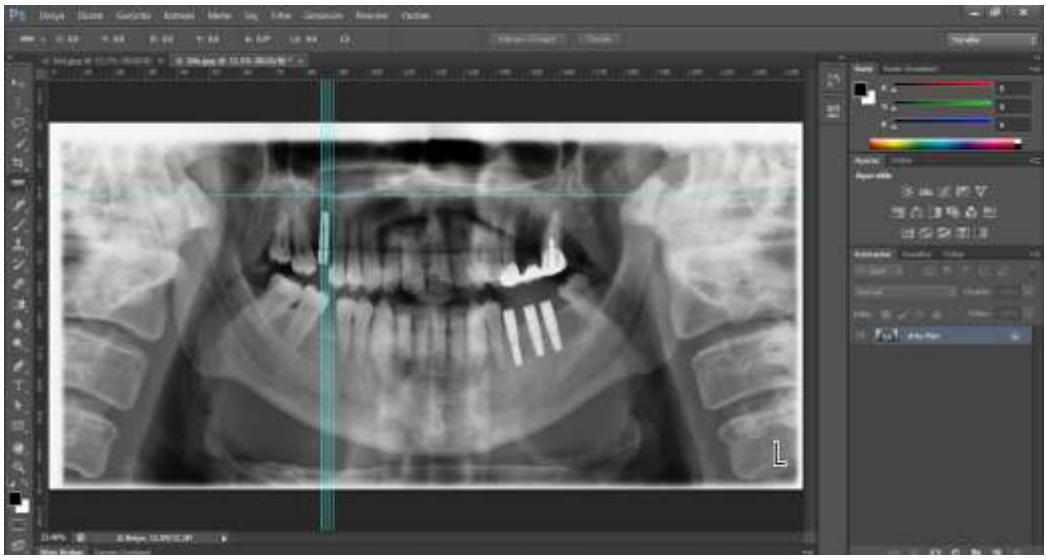

Figure II. Millimetric measurements of single tooth implant treatment applied to the tooth area number 16 using Adobe Photoshop CS6 program.

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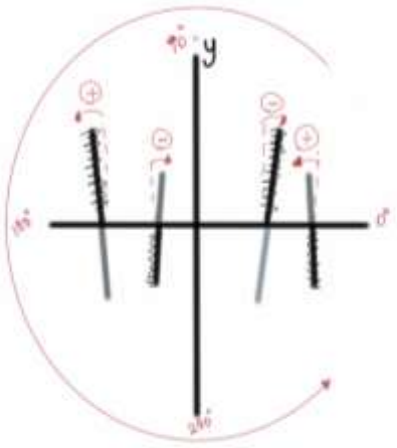

Figure III. Assessment of implants according to their y-axes

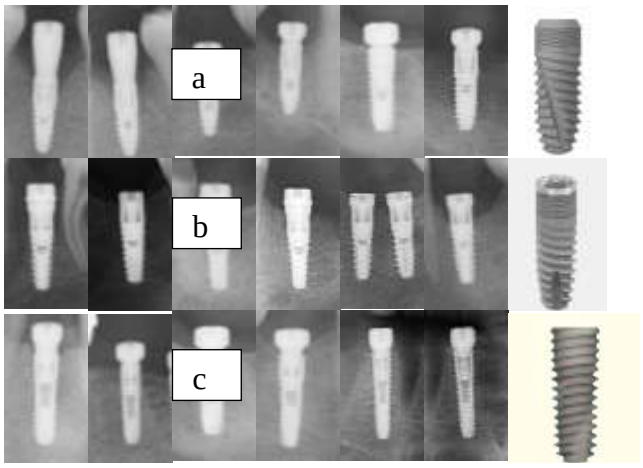

Figure IV. Three different implant brands applied to the tooth areas numbered 36 and 46 of different patients (a. Nucleoss T-6 (Nucleoss, Izmir, Turkey), b. Bredent Narrow (KG GmbH & Co. KG, Senden, Germany), c. Osstem TSII SA Fixture (Implant Co., Ltd. Seoul, Korea