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One-year clinical evaluation of bone-level and tissuelevel implants

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Abstract

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Aim: This study aimed to retrospectively examine and compare the clinical conditions of different implant levels at the end of 1 year. The clinical success is closely related to the loading time, the primary stability, oral hygiene, the features of the implant neck, and the bone structure.

Methodology: A total of 41 implants were applied to patients with a mean age of 52.76 ± 11.39 years. Among these patients, 10 (47.6%) were female, and 11 (52.4%) were male. Out of the total of 19 implants, 46.3% were placed in the left mandible. Specifically, 14.6% were placed in the premolar area and 31.7% were placed in the molar region. The 22 (53.7%) remaining cases were placed in the right mandible, with 10 (24.4%) in the premolar region and 12 (29.3%) in the molar region. In all, 21 implants (51.2%) were placed at the bone level, whereas 20 implants (48.8%) were placed at the tissue level. Out of the total of 41 implants, 25 (61%) had a diameter of 3.3 mm, whereas 16 (39%) had a diameter of 4.1 mm. X-rays were taken to detect bone loss in the mesial and distal regions, transferred to the computer, and evaluated via IBM SPSS Statistics V22 software.

Results: In the study, 19 (46.3%) of the implants were placed in the left mandible and 22 (53.7%) in the right mandible. Approximately 51.2% of the implants were placed at the bone level, and 48.8% were at the tissue level. Initial Osstell values ranged from 72.88 \pm 6.4 ISQ to 75.83 \pm 5.92 ISQ. The initial X-ray results varied between 0.03 \pm 0.09 mm and 0.38 \pm 0.99 mm, whereas the final X-ray measurements were 0.15 \pm 0.24 mm to 0.71 \pm 1.54 mm.

Conclusion: Bone loss was determined to be less than 2 mm in both groups. Plaque accumulation occurred in the lingual region; however, it was observed more at the bone level. Hygiene control is the key for success, which could easily be accomplished with the gingival level of implants or the gingival positioning height of the abutments.

Keywords: Bone-level implant, tissue-level implant, implant survival rate, mandible, tooth loss

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Introduction

Large-scale studies have shown that dental implants have long-term survival rates ranging from 93.3% to 98%; this indicates that dental implants are a highly successful therapy for edentulousness (1, 2, 3). Several factors have been proposed to decrease the long-term success of dental implants. These factors include the location of the implant in the jaw (anterior vs. posterior region and maxilla vs. mandible), the size (length, diameter) and the design of implant, implant characteristics (dimensions, coating, loading, etc), the need for bone augmentation procedures, the density of the bone at the implant site (quantity and quality of bone), and patientrelated risk factors such as general patient health status, age, smoking, oral hygiene maintenance, history of periodontal disease, diabetes, and osteoporosis (1, 4).

The survival rates of dental implants are also closely related to the clinical experience of the dentist, the preferred surgical procedure, the loading time of the prosthesis, the adequate stability of the implant during surgery, the patient's ability to maintain proper oral hygiene, the design features of the implant neck, and local factors such as the health of the hard and soft tissues where the implant is placed (5). The stability of the implants is closely related to the primary stability obtained when first placed. Primary stability depends on the patient's bone structure, the presence of infection in the area where the implant is placed, and the properties of the implant surface (6). Clinical data such as less than 5 mm pocket depth, bleeding index, plaque index, and less than 2 mm bone loss radiological evaluations where marginal bone loss is determined are essential auxiliary factors in evaluating soft and hard tissues around the implant (7).

Our hypothesis was that tissue-level implants would clinically exhibit less bone loss in the posterior region than bone-level implants. In addition, their clinical evaluation would be better.

The present study aimed to retrospectively examine and compare the clinical conditions of different implant levels at the end of one year.

Materials and Methods

Approval for this study was obtained from the Ethical Committee of the Non-Invasive Clinical Research of Kocaeli University (No: KAEK-2015-205).

The study included individuals older than 18 years of age who were literate, signed patient consent, had good oral health, had a single tooth loss in the posterior mandible with a bone width of 6 mm, and were treated with implants with bone level 3.3 mm or tissue level 3.3 mm and 4.1 mm diameters with sandblasted, large grit, acid-etched implant (SLA) surface. In the study, 41 implants were applied to patients with an average age of 52.76 \pm 11.39 years, of which 10 (47.6%) were female, and 11 (52.4%) were male. 19 (46.3%) implants were

placed in the left mandible, with 6 (14.6%) in the premolar region and 13 (31.7%) in the molar region. The 22 (53.7%) remaining cases were placed in the right mandible, with 10 (24.4%) in the premolar region and 12 (29.3%) in the molar region. Overall, 21 (51.2%) implants were bone level, while 20 (48.8%) were tissue level. The implant diameter of 25 (61%) implants had a diameter of 3.3 mm, and 16 (39%) 4.1 mm.

Patients with implants that were considered clinically osteointegrated because of resonance frequency analysis (Osstell[™] ISQ, Integration Diagnostics AB, Gothenburg, Sweden) had porcelain-fused to metal restorations applied as permanent restorations. The counter-arch of all implants was restored using fixed partial dentures. Plaque, bleeding index, and pocket depth were measured in the implants and were evaluated periodically.

To detect bone loss in the mesial and distal regions, X-rays were taken using the parallel technique after surgery and in the following one-year period. Images were transferred to the computer environment and evaluated using Photoshop CC (Adobe Inc., San Jose 2017, CA, USA) (Fig. 1).

To determine the marginal bone loss, the distance to the top of the bone was measured, taking the apex of the implant in the bone as a reference point. These measurements were made immediately after surgery as well as 6 and 12 months thereafter. The measurements were proportioned to the actual thread lengths to obtain realistic measurements. The criteria for success were based on the criteria announced by the International Congress of Oral Implantologists in 2007 (8), which included no clinical pain or tenderness upon function, no exudate history, zero mobility, and no bone loss larger than 2 mm within one year.



Figure 1. Bone loss measurement

Statistical analysis

Analyses were performed by using SPSS software (IBM SPSS Statistics version 22, IBM Inc., Armonk, NY, USA).

The consistency of the parameters with a regular distribution was assessed using the Shapiro-Wilk test. In

addition to descriptive statistical methods (mean, standard deviation, frequency), the Mann-Whitney U test was used to compare the parameters that did not indicate a regular distribution between the two groups in comparison with quantitative data.

The Wilcoxon signed-rank test was utilized for the in-group comparisons of parameters that did not indicate a regular distribution. Significance was evaluated at a level of p<0.05.

Results

The initial mesiodistal Ostell values of the right region (72.88 \pm 6.4 ISQ) were significantly different from those of the left region (75.83 \pm 5.92 ISQ) (*p*=0.036). No statistically significant difference was determined between the right and left regions in terms of the final mesiodistal Ostell values (*p*>0.05). No statistically significant difference was recorded between bone - and tissue-level applications and among all bone-level implants in terms of initial and final mesiodistal Ostell values (*p*>0.05). As for tissue-level implants, the increase in the final mesiodistal Ostell values (76.95 \pm 4.29 ISQ) compared to the initial values (74.75 \pm 6.51 ISQ) was statistically significant (*p*=0.034).

The initial and final buccolingual Ostell values between the right and left regions were not statistically different (p>0.05). The difference between the bone-level and tissue-level implants or between the initial and final buccolingual Ostell values within the groups was not significant (p>0.05).

We found no statistically significant difference between the right and left regions in terms of initial mesial X-ray values (p>0.05). The final mesial X-ray values for the right section (0.55 \pm 1.75 mm) were determined to be significantly higher than those of the left region (0.35 \pm 0.32 mm; p=0.038). The difference between the initial (0.38 ± 0.99) and final (0.71 ± 1.54) mesial X-ray values of the bone-level implants was found to be significantly higher (p=0.001). The difference between the initial $(0.03 \pm 0.09 \text{ mm})$ and the final mesial X-ray values (0.15 ± 0.24 mm) was significantly high (p=0.018). There were significant differences between the initial and final mesial X-ray values of the bone-level and the tissue-level implants (p=0.007; p=0.012), and the increase observed in the final measurement compared to the initial mesial X-ray values of the bone level was statistically significantly higher than the increase observed in the final measurement compared to the initial mesial X-ray values from the tissue level (Table 1).

Table 1. Changes recorded in the Ostell, periodontal, and X-ray between two implant levels

		Implant level		
		Bone-level	Tissue-level	р
		Mean ± SD (Median)	Mean ± SD (Median)	-
Ostell measurements	Mesial change	1 ± 5.01 (1)	2.2 ± 4.36 (2.5)	0.582
	Buccal change	0.57 ± 4.93 (1)	3 ± 4.59 (2)	0.106
X-ray data	Mesial change	0.33 ± 0.57 (0.3)	0.12 ± 0.2 (0)	0.041*
	Distal change	0.32 ± 0.29 (0.3)	0.11 ± 0.21 (0)	0.006*
Periodontal measurements				
Pocket depth	Mesial change	0.38 ± 0.59 (0)	0.45 ± 0.6 (0)	0.677
	Buccal change	0.57 ± 0.68 (0)	0.3 ± 0.73 (0)	0.251
	Distal change	0.19 ± 0.6 (0)	0.3 ± 0.57 (0)	0.498
	Lingual change	0.62 ± 0.86 (1)	0.4 ± 0.5 (0)	0.413
Bleeding index	Mesial change	-0.1 ± 0.62 (0)	0.05 ± 0.69 (0)	0.479
	Buccal change	-0.33 ± 0.66 (0)	0.2 ± 0.62 (0)	0.012*
	Distal change	-0.1 ± 0.44 (0)	0.1 ± 0.72 (0)	0.291
	Lingual change	0.05 ± 0.59 (0)	0.4 ± 0.68 (0.5)	0.067
Plaque index	Mesial change	-0.1 ± 0.44 (0)	-0.05 ± 0.39 (0)	0.720
	Buccal change	-0.05 ± 0.38 (0)	-0.05 ± 0.39 (0)	0.983
	Distal change	-0.05 ± 0.5 (0)	0 ± 0.32 (0)	0.705
	Lingual change	0.24 ± 0.44 (0)	0.15 ± 0.37 (0)	0.482

Mann-Whitney U Test *p<0.05

The difference between the right and left regions in terms of the initial and final distal X-ray values (p>0.05) was not statistically significant; however, the initial (0.38 ± 0.99 mm) and final (0.62 ± 0.85 mm) distal X-ray values of the implants at the bone level (p=0.000) and the initial (0.02 ± 0.07 mm) and final (0.12 ± 0.23 mm) distal X-rays within the implants from the tissue level (p=0.043) were significantly different. We also found statistically significant differences between the initial and final distal X-ray values of the bone-level and the tissue-level implants (p=0.005; p=0.001), and the initial and final distal X-ray values of the bone level were determined to be significantly higher than the tissue level.

There was no statistically significant difference between the right and left regions in terms of mesial and distal pocket depth values before and after the intervention (p>0.05) and between bone and tissue levels in terms of initial and final mesial and distal pocket depth values (p>0.05). The difference between the initial $(2.67 \pm 0.73 \text{ mm})$ and final mesial pocket depth $(3.05 \pm$ 0.59 mm) values of the implants at the bone level was found to be statistically significantly higher (p: 0.011). The difference between the initial $(2.65 \pm 0.59 \text{ mm})$ and final (3.1 ± 0.79 mm) mesial pocket depth values of the implants at the tissue level was determined to be statistically significant (p=0.007). At the tissue-level implant level, the increase in the final measurement (2.7 ± 0.92 mm) compared to the initial distal pocket depth (2.4 ± 0.6) was statistically significant (p=0.034).

Discussion

Our hypothesis was that tissue-level implants would clinically exhibit less bone loss in the posterior region than bone-level implants. In addition, we thought their clinical evaluation would be better. In line with all our findings, we rejected our hypothesis. We believe that patients can clinically benefit from both types of implants.

Previous studies have stated that the RFA values of the implant provide information regarding the condition of the bone during implantation, and an increase in this value indicates that the implant is effective in osseointegration and can be used as a reference in the subsequent healing period (9, 10). In our study, stability values were determined using an Osstell device during surgery and prior to restoration. The clinical success of bone- and tissue-level implants performed by late loading of the mandible was evaluated.

In RFA studies performed on implants applied to the mandible, Osstell values were reported to be an average of 74.1-76.2 ISQ (11-15). The mean ISQ values of bone and tissue-level implants in our study were measured as 75.2 \pm 4.90 ISQ. These results are consistent with the measurements of implants applied to the mandible. A statistically significant difference was determined in the first Osstell measurements in the mesial-distal direction between the right and left sections. The surgeon's

operating technique resulted in this difference. There were no significant differences between these values in the second measurement. During the evaluation of the tissue-level implants, the values of the second measurement were determined to be higher, which was attributed to the success of osteointegration and that the bone structure was ideal for implant treatment.

Determining the amount of marginal bone around the implant plays an essential role in evaluating the success of dental implant treatment (16-19). Radiographs obtained by the parallel technique, as a non-invasive method, were used to evaluate the bone around the implant (20-22). In our study, we used intraoral radiographs with a parallel technique to assess changes in the marginal bone level. We measured the changes in marginal bone level on the mesial and distal surfaces of the implants on radiographs taken 1 and 18 months after implant placement.

In the clinical follow-up of different implant brands, no significant relationship was found between the amount of bone loss and implant brands, diameters, or quality of the bone on which the placement was made; however, time was reported to significantly affect the amount of bone loss (23). It has been stated that the most significant destruction occurs within the first year; less than 2 mm of destruction up to 5 years was clinically acceptable and was within the admissible range for the implant to be deemed successful (24-29). In our study with a total of 41 implants, bone losses in the mesial and distal regions at the end of 1 year were 0.71 ± 1.54 mm and 0.62 ± 0.85 mm, respectively, at the bone level. As for the tissue-level implants, it was measured as 0.15 \pm 0.24 mm and 0.12 \pm 0.23 mm. The lower loss at the tissue-level is related to the ability of patients to clearly see the implant and restoration borders; better results were obtained from the target-oriented intraoral care since it was mentioned that the implant should be bright.

To identify the factors and specific problems that would affect the success of implant treatment, it was essential to evaluate the long-term implant success and complication rates for each system. Clinically, implant periphery evaluation is necessary to detect early signs of peri-implantitis and treatment planning. Objective evaluation of different implant systems was possible by defining appropriate clinical parameters and indices (30). In our study, we evaluated implants using clinical evaluation parameters.

The indexes used in the evaluation of periodontal tissues around natural teeth (31, 32) were modified to examine the tissues around the implants. Thus, the plaque and bleeding indexes were improved, and a relationship was found between the microbial characteristics of the peri-implant area and bleeding and plaque indices. In our study, modified Mombelli plaque and bleeding indices were used to evaluate the soft tissues.

Probing bleeding has been used in the prognosis of attachment loss in teeth. Researchers investigated the prevalence of bleeding during probing and concluded that this parameter was a highly reliable indicator for future periodontal stability, where the predictive values were negative, and there was no bleeding during probing (31, 33). In the studies conducted, evaluations were made on the annual average bone loss, bleeding on probing, pocket depth, and success and survival rates. No statistically significant difference was observed between the groups in terms of bleeding during probing (p>0.05)(22, 34, 35). In our study, no significant difference was observed in the time-dependent evaluation of bleeding index scores between the two groups (p>0.05). In evaluating plaque scores, lingual plaque scores of bonelevel implants were determined to be significantly higher than those of other surfaces, and the bone-level final bleeding index was significantly higher than the first bleeding index (p < 0.05). This is due to the difficulty patients experience in manipulating the brush on lingual surfaces rather than on buccal surfaces.

It has been reported that the pocket depth measurement used in the clinical evaluation of implants may disrupt the connection between the soft tissue and implant surface. Therefore, it was recommended to avoid probing within three months after the implantabutment connection (16, 36). Because of the difference in the attachment between the gingiva and the root surface between the implant surface and the mucosa, pocket measurements taken around the tooth and implant were not entirely comparable (32, 37, 38). Since many collagen fibrils run parallel to the implant axis, there could be differences in determining the probing depth due to many factors such as probing force and angle, probe diameter, the roughness of the implant surface, and the hardness of marginal tissue (39, 40). In addition, the periodontal probe could penetrate approximately 0.52 mm deeper in the peri-implantitis than in healthy peri-implant tissues (41). Considering the criteria determined for soft tissues in a successful implant, it was stated that the depth of the pocket should be <5 mm. Studies have shown that pocket depth might increase over time (33, 42, 43). In our study, because the initial and final measurements were taken from the right and left sections, and the bone- and tissue-level implants were taken after the adaptation process of the soft and hard tissues around the implant, it was observed that the depth of the pocket was less than 5 mm, and had increased in the final measurements. In our study, where we evaluated two different implant levels, the success rate of implants was determined to be 100% based on the implant success criteria (bone loss <2 mm, mobility [-], pain/tenderness upon function [-], and no exudate history specified in the International Congress of Oral Implantologists.

This study has a few limitations. Since our inclusion criteria were very specific, the number of cases that could be included was limited. Another limitation is that the time of observation was limited to one year; the same case series will be reported after five years. However, since most of the recession occurs within the first year, the present follow-up will give us a good perspective of the situation.

In summary, our findings revealed that the survival rate of bone-level and tissue-level implants was 100%. At both dental implant levels, an increase was observed in the Osstell measurements in the mesiodistal and buccolingual directions. Although there was no difference between the two groups, an increase was observed in the final Osstell measurements compared to the initial measurements. Although a significant loss was observed over time when comparing the initial and final peri-implant bone measurements in both implants, the bone loss was observed to be within normal limits. An increase in pocket depth was observed for both implants over time. These values are clinically acceptable, as they are <5 mm in size. Particularly in bone-level implants, the increase in plaque and bleeding index was caused by the difficulty of cleaning the lingual areas with a brush, and the implant prosthesis margin could not be observed clearly. Therefore, to set the acceptable established hygiene habits of the patients correctly, 3-month controls should be made upon the delivery of the prosthesis, and the control frequency should be decreased after the right habits are maintained.

Conclusion

This study aimed to investigate the clinical success of different-level implants in the mandibula posterior region in the 1-year follow-up. Oral hygiene is key in the clinical success of implants. If the patients are able to visualize and clean the margins of the crowns and the implants, their hygiene control could easily be improved; thus, this can be accomplished with the gingival level of implants or the gingival positioning height of the abutments.

Disclosures

Ethical Approval: Ethics committee approval was received for this study from Kocaeli University Ethical Committee of the Non-Invasive Clinical Research, in accordance with the World Medical Association Declaration of Helsinki, with the approval number: KAEK-2015-205).

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References

- Busenlechner D, Fürhauser R, Haas R, Watzek G, Mailath, GJ, Pommer B. Long-term implant success at the Academy for Oral Implantology: 8-year follow-up and risk factor analysis. J Periodontal Implant Sci. 2014;44:102-8. https://doi.org/10.5051/jpis.2014.44.3.102
- Chrcanovic BR, Kisch J, Albrektsson T, Wennerberg A. (). Analysis of risk factors for cluster behavior of dental implant failures. Clinical Implant Dentistry and Related Research, 2017;19(4),632-642. https://doi.org/10.1111/cid.12485
- Krebs M, Schmenger K, Neumann K, Weigl P, Moser W, Nentwig G. Long-term evaluation of ankylos® dental implants, part i: 20-year life table analysis of a longitudinal study of more than 12,500 implants. Clinical Implant Dentistry and Related Research, 2013;17(S1). https://doi.org/10.1111/cid.12154
- Levin L. Dealing with dental implant failures. J Appl Oral Sci. 2008;16(3):171-5. https://doi.org/10.1590/s1678-77572008000300002.
- Eckert SE, Hueler G, Sandler N, Elkattah R, McNeil DC. Immediately Loaded Fixed Full-Arch Implant-Retained Prosthesis: Clinical Analysis When Using a Moderate Insertion Torque. Int J Oral Maxillofac Implants. 2019;34(3):737-744. https://doi.org/10.11607/jomi.7193
- Planinić D, Dubravica I, Šarac Z, et al. Comparison of different surgical procedures on the stability of dental implants in posterior maxilla: A randomized clinical study. J Stomatol Oral Maxillofac Surg. 2020;21:2468-7855(20)30179-8.
- Cosola S, Marconcini S, Boccuzzi M, et al. Radiological Outcomes of Bone-Level and Tissue-Level Dental Implants: Systematic Review. Int J Environ Res Public Health. 2020; 22;17(18):6920. https://doi.org/10.3390/ijerph17186920
- Misch CE, Perel ML, Wang HL, et al. Implant success, survival, and failure: the International Congress of Oral Implantologists (ICOI) Pisa Consensus Conference. Implant Dent. 2008;17(1):5-15. https://doi.org/10.1097/ID.0b013e3181676059
- Huang H-L, Tsai M-T, Su K-C, et al. Relation between initial implant stability quotient and bone-implant contact percentage: an in vitro model study. Oral Surg Oral Med Oral Pathol Oral Radiol. 2013;116(5):356-361. https://doi.org/10.1016/j.0000.2012.01.037
- Nedir R, Bischof M, Szmukler-Moncler S, Bernard J-P, Samson J. Predicting osseointegration by means of implant primary stability. Clin Oral Implants Res. 2004;15(5):520-8. https://doi.org/10.1111/j.1600-0501.2004.01059.x
- Turkyilmaz I, Tözüm TF, Tumer C, Ozbek EN. Assessment of correlation between computerized tomography values of the bone, and maximum torque and resonance frequency values at dental implant placement. J Oral Rehabil. 2006;33(12):881-8. https://doi.org/10.1111/j.1365-2842.2006.01692.x
- Turkyilmaz I, Tözüm TF, Tumer C, Ozbek EN. A 2-year clinical report of patients treated with two loading protocols for mandibular overdentures: early versus conventional loading. J Periodontol. 2006;77(12):1998-2004. https://doi.org/10.1902/jop.2006.060115
- Liddelow GJ, Henry PJ. A prospective study of immediately loaded single implant-retained mandibular overdentures: preliminary one-year results. J Prosthet Dent. 2007;97(6):126-37.
- Stephan G, Vidot F, Noharet R, Mariani P. Implant-retained mandibular overdentures: a comparative pilot study of immediate loading versus delayed loading after two years. J Prosthet Dent. 2007;97(6):138-45. https://doi.org/10.1016/S0022-3913(07)60017-1
- https://doi.org/10.1016/S0022-3913(07)60017-1
 Schliephake H, Sewing A, Aref A. Resonance frequency measurements of implant stability in the dog mandible: experimental comparison with histomorphometric data. Int J Oral Maxillofac Surg. 2006;35(10):941-6. https://doi.org/10.1016/j.ijom.2006.05.002

- Åstrand P, Engquist B, Dahlgren S, Gröndahl K, Engquist E, Feldmann H. Astra Tech and Brånemark system implants: a 5-year prospective study of marginal bone reactions. Clin Oral Implants Res. 2004;15(4):413-20. https://doi.org/10.1111/j.1600-0501.2004.01028.x
- Brägger U, Häfeli U, Huber B, Hämmerle CH, Lang NP. Evaluation of postsurgical crestal bone levels adjacent to non-submerged dental implants. Clin Oral Implants Res. 1998;9(4):218-24.
- https://doi.org/10.1034/j.1600-0501.1998.090402.x
- Bischof M, Nedir R, Abi Najm S, Szmukler-Moncler S, Samson J. A five-year life-table analysis on wide neck ITI implants with prosthetic evaluation and radiographic analysis: results from a private practice. Clin Oral Implants Res. 2006;17(5):512-20.
- https://doi.org/10.1111/j.1600-0501.2006.01271.x 19. Karlsson U, Gotfredsen K, Olsson C. A 2-year report on
- Karlsson U, Gotfredsen K, Olsson C. A 2-year report on maxillary and mandibular fixed partial dentures supported by Astra Tech dental implants. A comparison of 2 implants with different surface textures. Clin Oral Implants Res. 1998;9(4):235-42.

https://doi.org/10.1034/j.1600-0501.1998.090404.x

- Leonhardt Å, Gröndahl K, Bergström C, Lekholm U. Longterm follow-up of osseointegrated titanium implants using clinical, radiographic and microbiological parameters. Clin Oral Implants Res. 2002;13(2):127-32. https://doi.org/10.1034/j.1600-0501.2002.130202.x
- Brägger U. Use of radiographs in evaluating success, stability and failure in implant dentistry. Periodontol 2000. 1998;17(1):77-88. https://doi.org/10.1111/j.1600-0757.1998.tb00125.x
- Garg AK, Vicari A. Radiographic modalities for diagnosis and treatment planning in implant dentistry. Implant Soc.
- 1995;5(5):7-11.
 23. Ozkan Y, Ozcan M, Akoglu B, Ucankale M, Kulak-Ozkan Y. Three-year treatment outcomes with three brands of implants placed in the posterior maxilla and mandible of partially edentulous patients. J Prosthet Dent. 2007;97(2):78-84.-219

https://doi.org/10.1016/j.prosdent.2007.01.004

- 24. Caetano GM, Pauletto P, Mezzomo LA, Rivaldo EG. Crestal Bone Changes in Different Implants Designs: A Prospective Clinical Trial. Eur J Dent. 2019;13(4):497-502. https://doi.org/10.1055/s-0039-1697216
- 25. Brägger U. Use of radiographs in evaluating success, stability and failure in implant dentistry. Periodontol 2000. 1998;17(1):77-88. https://doi.org/10.1111/j.1600-0757.1998.tb00125.x
- Ebler S, Ioannidis A, Jung RE, Hämmerle CH, Thoma DS. Prospective randomized controlled clinical study comparing two types of two-piece dental implants supporting fixed reconstructions-results at 1 year of loading. Clin Oral Implants Res. 2016;27(9):1169-77., https://doi.org/10.1111/clr.12721
- 27. Laurell L, Lundgren D. Marginal bone level changes at dental implants after 5 years in function: a meta-analysis. Clin Implant Dent Relat Res. 2011;13(1):19-28. https://doi.org/10.1111/j.1708-8208.2009.00182.x
- Behneke A, Behneke N, d'Hoedt B. The longitudinal clinical effectiveness of ITI solid-screw implants in partially edentulous patients: a 5-year follow-up report. Int J Oral Maxillofac Implants. 2000;15(5):633-45.
- Gultekin BA, Gultekin P, Leblebicioglu B, Basegmez C, Yalcin S. Clinical evaluation of marginal bone loss and stability in two types of submerged dental implants. Int J Oral Maxillofac Implants. 2013;28(3):815-23. https://doi.org/10.11607/jomi.3087
- Kandasamy B, Samson EP, Yaqoob A, Pandey P, Deenadayalan S, Das I. Evaluation of Clinical Parameters in Implant Maintenance Phase for Prevention of Periimplantitis. J Int Soc Prev Community Dent. 2018;8(4):361-364.

https://doi.org/10.4103/jispcd.JISPCD_64_18

31. Elemek E, Agrali OB, Kuru B, Kuru L. Peri-implantitis and Severity Level. Eur J Dent. 2020;14(1):24-30. https://doi.org/10.1055/s-0040-1701162

- 32. Mombelli A, Marxer M, Gaberthüel T, Grander U, Lang NP. The microbiota of osseointegrated implants in patients with a history of periodontal disease. J Clin Periodontol. 1995;22(2):124-30. https://doi.org/10.1111/j.1600-051X.1995.tb00123.x
- Yildiz P, Zortuk M, Kiliç E, Dinçel M, Albayrak H. Clinical outcomes after immediate and late implant loading for a single missing tooth in the anterior maxilla. Implant Dent. 2016;25(4):504-9. https://doi.org/10.1097/ID.000000000000397
- Tolentino L, Sukekava F, Seabra M, Lima LA, Garcez-Filho J, Araújo MG. Success and survival rates of narrow diameter implants made of titanium-zirconium alloy in the posterior region of the jaws-results from a 1-year follow-up. Clin Oral Implants Res. 2014;25(2):137-41. https://doi.org/10.1111/clr.12113
- 35. Lee KY, Shin KS, Jung JH, Cho HW, Kwon KH, Kim YL. Clinical study on screw loosening in dental implant prostheses: a 6-year retrospective study. J Korean Assoc Oral Maxillofac Surg. 2020;46(2):133-142. https://doi.org/10.5125/jkaoms.2020.46.2.133
- 36. Narayan SJ, Singh PK, Mohammed S, Patel RK. Enhancing the zone of keratinized tissue around implants. J Indian Prosthodont Soc. 2015;15(2):183-6. https://doi.org/10.4103/0972-4052.158083
- Berglundh T, Lindhe J, Ericsson I, Marinello CP, Liljenberg B, Thornsen P. The soft tissue barrier at implants and teeth. Clin Oral Implants Res. 1991;2(2):81-90. https://doi.org/10.1034/j.1600-0501.1991.020206.x

- Souza JGS, Bertolini MM, Costa RC, Nagay BE, Dongari-Bagtzoglou A, Barão VAR. Targeting implant-associated infections: titanium surface loaded with antimicrobial. iScience. 2020;29;24(1):102008. https://doi.org/10.1016/j.isci.2020.102008
- Listgarten MA. Soft and hard tissue response to endosseous dental implants. Anat Rec. 1996;245(2):410-25. https://doi.org/10.1002/(SICI)1097-0185(199606)245:2<410::AID-AR20>3.3.CO;2-2
- 40. Kohal RJ, Spies BC, Vach K, Balmer M, Pieralli S. A Prospective Clinical Cohort Investigation on Zirconia Implants: 5-Year Results. J Clin Med. 2020 10;9(8):2585. https://doi.org/10.3390/jcm9082585
- Sánchez-Martos R, Samman A, Priami M, Arias-Herrera S. The diode laser as coadyuvant therapy in the non-surgical conventional treatment of peri-implant mucositis: A systematic review and meta-analysis. J Clin Exp Dent. 2020;12(12):1171-1182. https://doi.org/10.4317/jced.57630
- Hämmerle CHF, Cordaro L, Alccayhuaman KAA, et al. Biomechanical aspects: Summary and consensus statements of group 4. The 5thEAO Consensus Conference 2018. Clin Oral Implants Res. 2018 Oct;29 Suppl 18:326-331. https://doi.org/10.1111/clr.13284
- 43. Gerber JA, Tan WC, Balmer TE, Salvi GE, Lang NP. Bleeding on probing and pocket probing depth in relation to probing pressure and mucosal health around oral implants. Clin Oral Implants Res. 2009 Jan;20(1):75-8. https://doi.org/10.1111/j.1600-0501.2008.01601.x