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Original Article

Clinical and radiological of the effects of two different implant surfaces on marginal tissues

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Abstract

Aim: In this study, our aim is to compare the effects of dental implants with nano laser excimer technology surface (NLE) and dental implant surfaces (MTX) with micro-roughened surface on marginal tissues with clinical and radiological data.
Methodology: A total of 117 dental implants were followed clinically and radiologically. Clinically; Plaque index (silness-löe), bleeding index in boring, pocket depth were evaluated and recorded one week after the insertion of the healing cap, three months, six months and 12 months after the end of the prosthesis. In the same periods, periapical x-rays were taken with the Rinn Holder method, and the amount of marginal bone loss was measured. The data were analyzed with IBM SPSS Statistics Version 22 package program.
Results: There was no loss in the implants included in the study. There was no statistically significant difference between the groups in terms of plaque index, bleeding index values (p>0,05). However, the pocket depth of the dental implant group with nano laser excimer technology surface is significantly lower than the micro-roughened surface group. There are statistically significant differences between the groups in terms of radiological marginal bone loss at 0, 3, 6, and 12 months (p<0,05). Radiological marginal bone loss values of the micro-roughened surface group at 0, 3, 6, and 12 months were significantly lower compared to the same periods of the nano laser excimer technology group.
Conclusion: It has been determined that the surface properties of dental implants can be effective on marginal tissues. In addition, we believe that routine checks by dentists who perform dental implant applications will increase the success of dental implants.

Keywords: dental implant, marginal bone loss, implant surfaces

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Introduction

Dental implants are biocompatible materials that are widely used in prosthesis rehabilitation to regain function and aesthetics for totally or partially edentulous patients (1). Since implants compensate for tooth loss, dental implants of various materials, designs, and surface properties have been developed (2). This is important in order to compare the results of clinical studies on different implants and to evaluate the success of the treatment. Undoubtedly, in order to show the accuracy and success of the data obtained as a result of these scientific researches, objective and evidence-based information is required (3).

It is possible in long-term follow-up to evaluate the success of dental implants by parameters such as the bleeding index, pocket depth at probing, mobility of the implant, the presence of infection, pain, and paresthesia. In addition to these, radiological marginal bone loss is used as a criterion (4).

To be able to evaluate an implant as successful, it must be clinically non-mobile and osseointegrated. The concept of osseointegration is a histological term and has been defined by Branemark and his colleagues as "direct structural and functional connection between the living bone tissue and the implant surface under loading" (5, 6).

Dental implants fail to achieve complete osseointegration for a number of reasons, including insufficient bone quality and quantity, medical treatment negatively affecting bone healing, patient habits (bruxism, excessive smoking, inadequate oral hygiene), insufficient surgical planning and competence in technique, occlusal overload and stress, and peri-implantitis (7,8). As a result, implants may fail because of bone loss occurring around the implant (5, 9). Therefore, the most common parameter used in evaluating the success of dental implants is marginal bone loss (10).

In dental implant applications, bone loss of 1.5 mm in the first year after prosthetic loading and 0.2 mm in the following years is considered normal (11). The most widely accepted criteria on this subject have been defined by Albrektsson et al. Clinically, the implants are not mobile, and there is no radiolucency in the peri-implant areas on radiography (5, 11).

The aim of this study was to investigate clinical and radiological differences in radiographs and periodontal indexes of 117 dental implants with two different surface properties.

Materials and Methods

Our research was supported by Dicle University Scientific Research Projects Coordination with project number DİŞ.17.025. Ethical approval for the study was obtained from Dicle University, Faculty of Dentistry, Local Ethics Committee, with the protocol number 2017/11.

The study groups consisted of individuals in Dicle University Faculty of Dentistry, Department of Oral and Maxillofacial Surgery, where two different dental implant models (micro-roughened surface (MTX) and one with nano laser excimer (NLE) technology) were applied. A total of 117 dental implants were placed in these individuals.

Implant patients were subjected to clinical examinations that formed the basis of our research, using the clinical parameters of plaque index (Silness-Löe), bleeding index on probing, and pocket depth data.

Periapical films were taken from the patients for radiological controls at certain periods using the parallel technique with the aid of Rinn's holders. Both clinical and radiological parameters were evaluated at the same time, namely one week after the healing cap was attached, at three months, at six months, and 12 months after the end of the prosthesis.

Patient Selection Criteria

Patients selected for the study were non-smokers or smokers of no more than ten cigarettes per day; without any systemic illness, suspicion of pregnancy, or pregnancy. Additionally, eligible patients had not undergone tooth extraction or had undergone tooth extraction at least three months earlier in the areas to be implanted, and they had not undergone advanced surgical procedures such as sinus floor elevation or onlay grafting.

Further, their oral hygiene practices were deemed to be adequate, and they had no general or local contraindications for dental implant treatment.

Included also were patients with dental implant-supported fixed prosthesis indication.

The implant surgical procedure was conducted in line with the permission obtained from the Ethics Committee of Dicle University Faculty of Dentistry. In addition, a signed informed consent form was obtained from each patient.

Materials

In this study, two different implant models, one with NLE technology (Biohorizons®, Bone Level, USA) and one with micro-roughened surface properties (Zimmer®, Bone Level, Germany), were used.

Procedure

Panoramic and periapical x-rays were taken from the patients before the procedure in order to design the appropriate treatment. In addition, patients were informed extensively about possible complications before the dental implants were applied.

Surgical stage

Dental implants were applied to patients under local anesthesia of the area to be implanted. Following anesthesia, the mucoperiosteal flap was removed to prepare the implant cavity by making an appropriate crestal incision with the aid of a No. 15 scalpel. The implant slot was first identified with a marking drill, after which the cavity was prepared using the correct burs. After preparing the implant cavity, the appropriate implant was placed in the socket with the help of carrier parts.

Two-stage surgical closure screws were preferred to achieve standardization in all patients, and the wound edges were sutured with 3.0 silk suture (Doğsan®, Istanbul, Turkey), as primer had been sutured. After the surgical procedure, the patients were asked to apply ice compresses on the skin around the operated area. Further, nonsteroidal anti-inflammatory tablets (550 mg 2x1) and antibiotics (1 gr amoxicillin + ß-clavulanic acid 2x1) were prescribed. Post-operative instructions were given to the patients orally and in writing. Sutures were removed 10 days after surgery.

Prosthetic Stage

At the end of the third month following the dental implant application, periapical X-rays were taken from the patients, and a second surgical procedure was performed. Healing caps were attached during this procedure to shape the gum. Prosthetic restorations started to be made 10 days after the surgery.

Clinical Follow-up

1- Modified gingival groove bleeding index

This index was used to assess bleeding around the dental implants, specifically the lingual (L), distal (D), buccal (B), and mesial (M) surfaces. The measurements were made with the aid of a periodontal probe (Hu-Friedy®, Chicago, IL, USA).

2- Modified Silness-Löe Plaque Index

Using this plaque index, the presence of plaque was measured from the mesial, distal, buccal, and lingual surfaces around the implants. The plaque indices were recorded with the aid of a periodontal probe (HuFriedy®).

3- Probing depth

The probing depth was measured using a periodontal probe (Hu-Friedy®).

4- Marginal bone loss measurements

Periapical radiographs (Foma Dentix, Film Speed E; Foma, Hradec Kralove, Czech Republic) were taken using the parallel cone technique with the aid of the XCP Kit (Rinn, Elgin, IL, USA). All the films were processed in a bath with automatic temperature control, according to the manufacturer's recommendations (Velopex Intra-X; Velopex, Saint Cloud, FL, USA). Examinations on periapical radiographs were transferred to the computer using the same monitor. In measuring marginal bone loss, the measurement area was taken to be the reference point of the implant, namely the interval between the OsseoSpeed surface and the polished surface. Measurements were taken from this reference point between the lowest part of the marginal bone and from the mesial and distal surfaces (Fig. 1).

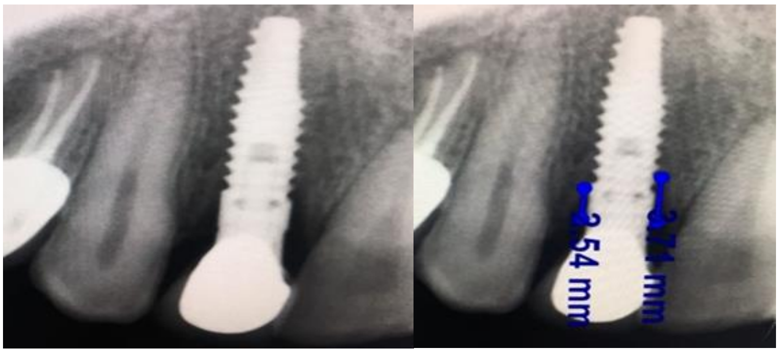


Figure 1. Marginal bone loss measurements

Statistical analysis

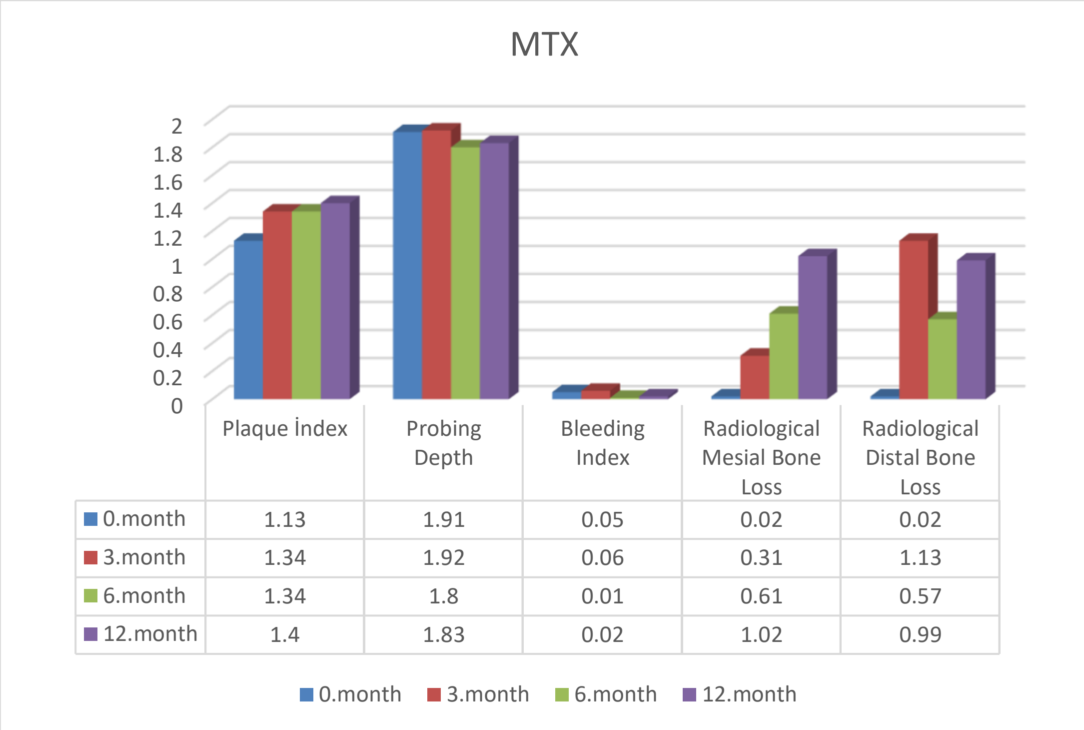
The data obtained in this study were analyzed with the IBM SPSS Statistics Version 22 package. The Shapiro-Wilk test was used to investigate the status of variables from normal distribution.

The Mann-Whitney U-test was used to examine the differences between groups. In order to examine the relationships between groups of nominal variables, Chi-square analysis was applied. Kappa fit analysis was applied to measure the fit between dependent nominal variables. A significance level of $p=0.05$ was used in interpreting the results; there was a significant relationship when $p<0.05$ and no significant relationship when $p> 0.05$.

Results

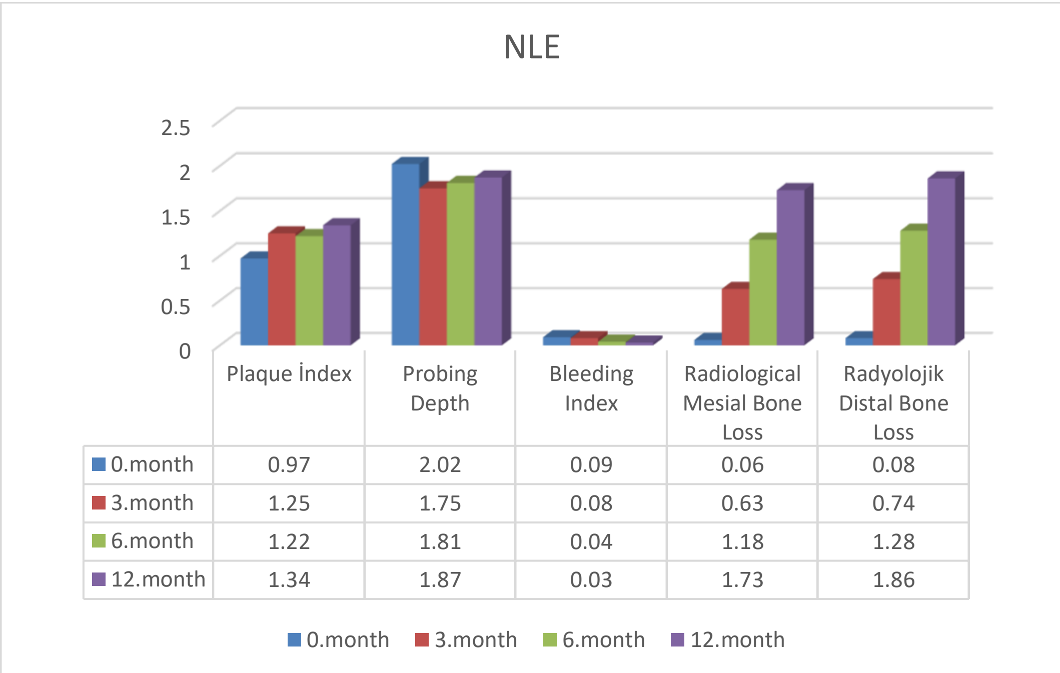
There was no loss in the implants included in the study, but complications occurred in four out of 59 implants in the NLE technology group. All of the complications that occurred were peri-implantitis. Complications developed in six of 58 implants in the MTX surface group. Soft tissue loss developed in four of these six implants, and a free gingiva graft operation was performed on these patients. There was an abutment fracture in one of the other implants and a prosthesis fracture in another.

There was no statistically significant difference between the groups in terms of plaque index, or bleeding index values ($p>0.05$). However, the pocket depth of the dental implant group with the NLE technology surface was significantly lower than the MTX surface group. There was no statistically significant difference between the groups in terms of pocket depth values for other assesement times ($p>0.05$). There were statistically significant differences between the groups in terms of radiological marginal bone loss at 0, 3, 6, and 12 months ($p<0.05$). Radiological marginal bone loss values of the MTX surface group at 0, 3, 6, and 12 months were significantly lower compared to the NLE technology group at the same time points (Fig. 2 and 3).



	Plaque İndex	Probing Depth	Bleeding Index	Radiological Mesial Bone Loss	Radiological Distal Bone Loss
0.month	1.13	1.91	0.05	0.02	0.02
3.month	1.34	1.92	0.06	0.31	1.13
6.month	1.34	1.8	0.01	0.61	0.57
12.month	1.4	1.83	0.02	1.02	0.99

Figure 2. Intra-group comparisons on micro roughened surfaces



	Plaque İndex	Probing Depth	Bleeding Index	Radiological Mesial Bone Loss	Radyolojik Distal Bone Loss
0.month	0.97	2.02	0.09	0.06	0.08
3.month	1.25	1.75	0.08	0.63	0.74
6.month	1.22	1.81	0.04	1.18	1.28
12.month	1.34	1.87	0.03	1.73	1.86

Figure 3. In-group comparisons in nano laser excimer technology

Although there was no statistically significant difference between the times in terms of plaque index values in the MTX surface group, the plaque index value at 0 months in the NLE technology group was significantly lower than the values at 3 and 12 months ($p<0.05$) (Table 1, Figure 4).

There is no statistically significant difference between the times in terms of pocket depth values in

MTX surface group and NLE technology group (p> 0.05) (Table 3, Fig. 3).

There was a statistically significant difference between the times in terms of bleeding index values in the MTX surface and NLE technology groups (p<0.05). In the MTX surface group, the bleeding index values at six months were significantly lower than the values at 0 and 3 months. In the NLE technology group, the 6 month and 12-month values of the bleeding index were significantly lower than at 0 months (Table 1, Fig. 4).

Table 1. Differences between groups

	MTX	NLE		p
	Mean	Mean	ss	
Plaque İndex 0.month	1,13	0,97	0,53	0,13
Plaque İndex 3.month	1,34	1,25	0,5	0,547
Plaque İndex 6.month	1,34	1,22	0,48	0,1
Plaque İndex 12.month	1,4	1,34	0,47	0,464
Probing Depth 0.month	1,91	2,02	0,73	0,527
Probing Depth 3.month	1,92	1,75	0,5	0,031
Probing Depth 6.month	1,8	1,81	0,51	0,848
Probing Depth 12.month	1,83	1,87	0,49	0,522
Bleeding Index 0.month	0,05	0,09	0,18	0,265
Bleeding Index 3.month	0,06	0,08	0,14	0,218
Bleeding Index 6.month	0,01	0,04	0,1	0,051
Bleeding Index 12.month	0,02	0,03	0,08	0,33
Radiological mesial bone loss 0.month	0,02	0,06	0,16	0,007
Radiological mesial bone loss 3.month	0,31	0,63	0,58	0,002
Radiological mesial bone loss 6.month	0,61	1,18	0,64	0,001
Radiological mesial bone loss 12.month	1,02	1,73	0,77	0,001
Radiological distal bone loss 0.month	0,02	0,08	0,19	0,001
Radiological distal bone loss 3.month	1,13	0,74	0,48	0,001
Radiological distal bone loss 6.month	0,57	1,28	0,57	0,001
Radiological distal bone loss 12.month	0,99	1,86	0,7	0,001

There was a statistically significant difference between the times in terms of radiological marginal bone loss values in the MTX surface and NLE technology groups (p<0.05). Radiological marginal bone loss in the MTX surface group was lower than the 0, 3, 6, and 12-month values; radiological marginal bone loss was higher than the values at 3 months, 6 months, and 12 months; the radiological marginal bone loss value at 6 months was significantly lower than at 12 months. In the NLE technology group, the radiological marginal bone loss value at 6 months was significantly lower than at 12 months (Table 1, Figure 4).

It occurred in the marginal bone over time in both groups. However, in dental implants with NLE technology, the resorption was higher than with the MTX surface. In both groups, increasing bone loss over time reflected the finding that implants cause physiological bone loss in the first year.

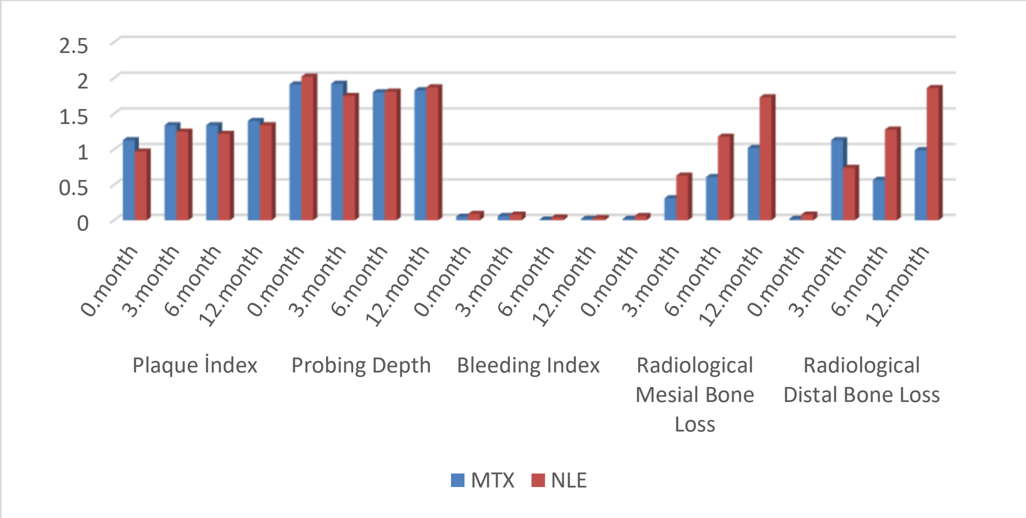


Figure 4. Intergroup comparisons

Discussion

Dental implants have been used successfully in the treatment of tooth deficiencies in recent years. Due to the high success rate, the use of dental implants in dentistry has increased, and therefore many implant systems have been developed. In order to receive long years of service from dental implants, it is necessary to perform routine controls. In order to treat any adverse events in the early period, the patient should be kept under control by using all kinds of clinical and radiological diagnostic methods (12).

Clinicians who will apply dental implants need to know very well the design, surface properties, and interface geometries of dental implants in order to perform a correct and successful treatment. In addition, it provides the opportunity to evaluate the long-term clinical performance and to observe the changes that may occur in the crestal region better (13).

Cohen et al. argued that individuals who received dental implant treatment should be evaluated using periodontal parameters. The parameters recommended for use are plaque index, bleeding on probing, pocket depth, and amount of crestal bone loss (14). In our study, we used these parameters to evaluate the condition of periimplanter tissues and the long-term success of dental implants.

Schrotenboer et al. Reported that in implants with roughened neck region, the tensions on the surrounding bone after loading are 29% higher than implants with a shiny neck part, but with the application of a narrower abutment and the application of the platform switching protocol, the tensions in the bone decreased. In the same study; stated that the application of the platform switching protocol in implants with roughened neck part significantly reduced the stresses in the bone compared to the application in implants with bright neck parts (15).

In our study, we did not find implant loss in either NLE technology or dental implants with the MTX surface. Regarding implant surface preparation methods, morphological methods are reportedly more successful than physico-chemical methods (16). While the surface of dental implants with NLE technology is covered with resorbable blast texturing, the surface of dental implants with a micro-roughened MTX surface is modified with MP-1 hydroxyapatite or MTX. We attribute the success of the dental implants that were included in our study to the fact that their surface properties had been modified.

Halperin-Sternfeld et al. Applied 164 dental implants with micro-roughened surface (Zimmer®, Bone Level, Germany) and acid-roughened surface (MIS®, Bone Level, USA) to 61 patients, and these implants were applied in terms of vestibular depth. They followed the plaque index values for six years. Statistically, they could not detect a significant difference between the groups. They attributed the lack of a meaningful relationship between the groups to oral hygiene motivation (17).

In a three-year study by Gültekin et al. (2016), no significant difference was found between the different neck design groups in terms of plaque index values. They attributed this result to good oral hygiene (18). In our study, similar results were obtained between the groups in terms of plaque index. We believe that patients' motivation to maintain good oral hygiene and routine periodic controls accounted for this situation.

In our study; no statistically significant difference was found between the micro-roughened surface and nano laser excimer technology groups in terms of plaque index values ($p > 0.05$). Parallel to the studies of Halperin-Sternfeld et al. and Gültekin et al., We obtained similar results between the groups in terms of plaque index in our study. We believe that oral hygiene motivation and routine periodic controls set the ground for this situation.

Although there is no difference between times in the micro-roughened surface group, we see the increasing plaque index values in the implant group produced with nano laser excimer technology starting from the 0th month. Mean plaque index value was 0.97 at 0 months and 1.34 at 12 months. Consistent with the study of Weber et al. (19), we can explain the increasing plaque values in the nano laser excimer technology group over time by the decrease in oral hygiene motivation, as well as the different geometric structure of dental implants or the retentive surfaces of the prosthetic restorations. Although the study of Farronata et al. (20) claimed that the neck design found in dental implants with nano laser excimer technology prevents plaque accumulation, results that are consistent with our study were not obtained.

In their study, Al Amri et al. Evaluated the changes in the surrounding soft and hard tissue at the crestal and subcrestal levels during the 6^{th}, 18^{th}, and 36^{th} month follow-up of 46 dental implants with platform switch feature. Significant results were obtained in terms of bleeding index and pocket depth in the study. They explained the decreasing measurements in both groups in pocket depth measurements by the patients' good oral care checks and the high motivation (21).

We attribute our finding decreasing pocket depth values in both groups over time, to our recommendation for the patient to clean more effectively in routine controls and to intervene when necessary. In line with the work done by Al-Amri and his friends; Due to the fact that the patients we followed up were given training on oral hygiene after the operation and their controls were made at certain intervals, there was no increase in pocket depth in probing over time.

Pecora et al. Examined the soft and hard tissue changes in dental implants with laser-lok surface. The researchers, who stated that although there were increasing values in pocket depth measurements over time, did not obtain statistically significant results, they explained that there was no statistically significant increase in pocket depth over time with the neck design in the nano laser excimer technology used (22).

However, it was observed that the pocket depth of the dental implant group with nano laser excimer technology surface was significantly lower than the micro-roughened surface group. In line with the results of the work of Pecora et al., We think that the reason for the difference between dental implants in terms of pocket depth in the 3rd month may be due to the different designs in the neck region of the implants. In the light of the literature we examined, we think that pocket depth is insufficient by itself, but can be significant when evaluated with other clinical parameters.

No differences were found in bleeding index values in Crespi's study on 372 implants and Al-Amri's study on patients with diabetes (23,24). In line with the literature, there was no statistically significant difference between the groups in bleeding index values in our study ($p>0.05$). We believe that this shows that oral rinses used by patients in both groups can be effective. However, the initial bleeding index value in the MTX group was 0.05 ± 0.11, while the 12-month value was found to be 0.02 ± 0.08. In the NLE technology group, the initial bleeding index value was 0.09 ± 0.18, while the 12-month value was 0.03 ± 0.08. This may be due to the decrease in the bleeding index values in the groups over time, the increase in the thickness of the gingival tissue around the dental implants, and the change in its shape, as well as the patients' motivation to maintain oral hygiene motivation and the suitability of the implant surfaces.

Doornewaard et al., As a result of 2566 study scans, in which they evaluated the relationship between crestal bone loss occurring in dental implants with the patient factor and implant surface properties in the long term, it is possible that the dental implant surface can be effective in evaluating the bone loss radiologically, as well as the implant neck design, surgical technique, and the patient's systemic condition. They also stated that it should be taken into consideration (25).

In the light of the data we have obtained, radiologically, both the mesial and distal marginal bone loss values of the MTX surface group were significantly lower than the NLE technology group in all periods. NLE technology is a system that aims to improve the implant surface through microchannels. Specifically, it prevents the migration of the epithelium to the apical region by changing the direction of Sharpey's fibers, using the Laser-Lok® system. Compared to the laser area on the neck of dental implants with NLE technology, we think that the 1.00 mm untreated area on the neck of dental implants with an MTX surface prevents bacterial involvement. In both groups, the increase in mesial and distal bone loss over time appears to be due to the fact that implants cause physiological bone loss in the first year. Albrektsson et al. suggested that a marginal bone loss of 1-2 mm for the first year and 0.2 mm for each following year should be evaluated a success after dental implants become functional (26).

Studies have suggested that repetitive insertion and removal of the spacers on the implant should be avoided in order not to disrupt the biological gap (27,28,29). In line with the literature, we explain that there is less crestal bone loss in dental implants with an MTX surface compared to the NLE technology group, and the abutment-implant connection can be more comfortable. With a beveled structure for the abutment to be placed in the implant comfortably, MTX implants are easier to place.

Conclusions

In this study, we determined that the surface properties of dental implant materials used in the rehabilitation of tooth deficiencies can be effective on marginal tissues. In addition, we believe that routine checks by dentists who perform dental implants will increase the success of such implants.

Acknowledgments: This study was presented as a full-text oral presentation at the 1st International Dental Research and Health Sciences Congress held between 20-22 May 2021.

Ethical Approval: Ethical approval for the study was obtained from Dicle University Faculty of Dentistry Local Ethics Committee, with the protocol number 2017/11.

Peer-review: Externally peer-reviewed.

Author Contributions: Conception – M.B.B.; Design – B.G.; Supervision – M.B.B.; Materials – B.G.; Data Collection and/or Processing – M.B.B.; Analysis and/or Interpretation – B.G.; Literature Review – M.B.B.; Writer – B.G.; Critical Review – M.B.B.

Conflict of Interest: No conflict of interest was declared by the authors.

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