

Clinical Comparison between Implants with 2 Chemically Different Surfaces, Placed in the Maxilla Previously Treated with Bone Block Graft

SUMMARY

Aim. Evaluation of the survival rate and the level of bone resorption (LBR) between the implants with SLA® (the control group) and SLActive® (the test group) surfaces, placed in the maxilla previously treated with bone block grafts.

Methods. 17 patients were treated with 20 implants (10 with SLA and 10 with SLActive surface). The abutments were tightened with 35 Ncm, after 12 weeks (the control group) and 6 weeks (the test group). Periapical radiographies were made and evaluated after implant placement, after abutment tightening, 1 and 3 months with crown in function.

Results. Survival rate in the control group was 100% comparing to 80% in the test group. The mean value of LBR was 0.192 mm in the control group comparing to 0.106 mm in the test group.

Conclusion. The test group had smaller survival rate, as well as bone resorption, 3 months after loading.

Keywords: Implant; Bone Graft; Single Crown

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Introduction

In the last years the use of dental implants has given new solutions for prosthodontic rehabilitation. First cases began in seventies¹. Initially, implants with machined surface were used; they would be placed in bone and covered with flap. Many researches indicated the use of rough surface with 1-stage implants². On that way the bone-to-implant contact was enhanced, which diminished time of osseointegration, while surgical treatment needed only 1 surgery. Comparing bone resorption between 1- and 2-stage implants, the biggest resorption occurred in the first 12 months after prosthodontic treatment. According to Cecchinato et al³ bone resorption around 1- stage implants was 0.02 mm while it was 0.17 mm around 2-stage implants (standard deviation was 0.38 and 0.51 mm respectively).

In 1990 SLA® surface was introduced (Institute Straumann AG, Basel, Switzerland), which diminished the healing time to 6 (I, II and III bone type) and to 12 weeks (IV bone type)⁴. Principal characteristics of the implant surface are: topography, chemical composition, energy, and hidrofilicity. These characteristics influence on protein adsorption and relation between the implant

surface and bone cells. Hypothetically, high surface energy enlarges the hidrofilicity, what consequently enhances the reaction with biological environment⁵.

The first implant surface, chemically activated, was introduced in 2004 (SLActive®, Institute Straumann AG, Basel, Switzerland). SLActive surface has the same microstructure as SLA; however, it is chemically different. Zhao et al⁶ compared the chemically and physically differentiated surfaces and concluded that chemical treatment can enlarge surface energy; due to special way of fabrication, it is protected of contamination, and has faster histological answer. The researches used the disks with SLA surface, wetted with water in the atmosphere with nitrogen, without any contact with air. After gamma sterilization the implants were placed in physiological solution, protecting them of contact with carbon and hydro-carbon. According to Buser et al⁷ the concentration of carbon and hydro-carbon is smaller on SLActive surface (C, 18.4 ± 2.7 at%) then on SLA (C, 37.3 ± 3.3 at%). Kasemo and Lausmaa⁸ showed that SLActive surface has dynamic contact angle of 0° comparing to 139.9° on SLA surface. It confirms the hidrofilicity, with high free surface energy of the mentioned chemically treated surface. It is possible that

chemical characteristic causes faster bone answer after the placement of implant with SLActive surface.

Independently of the implant surface, edentulous region should have adequate bone width and height to receive the implants. Otherwise, in the atrophic region, bone block graft should be used for succeeding necessary bone quantity⁹. In the literature, there is a little data explaining prosthodontic rehabilitation with single crown on the implant with SLActive surface, placed in the region that previously had been treated with bone block graft. The **aim** of this paper was to compare: (1) Survival rate between implants with SLA and SLActive surfaces, placed in the maxilla previously treated with bone block grafts; and (2) Level of bone resorption (LBR) between implants with 2 chemically different surfaces.

Material and Method

Patient Selection

In this study 20 Straumann implants were used, placed in 17 patients chosen according to inclusion and exclusion criteria. Every single implant was placed in the region between central incisor and second premolar, and prosthodontically treated with single screwed crown. When possible, the patients received 2 implants with 2 chemically different surfaces, while patients with 1 missed tooth received randomly chosen implant (SLA or SLActive).

The scientific project received approval from Ethic Committee (FOP-UNICAMP, Piracicaba, Brazil) and all patients assigned the Term of collaboration and research.

Inclusion Criteria. The patients were older than 18 years. All of them had lack of bone width in the region between central incisor and second premolar, which was treated with bone block graft, taken from the chin. The mentioned area planned for treatment with dental implants had either 7 to 9 mm from mesial do distal side of neighboring teeth, indicated for 1 implant with platform 4.8 mm, or 14 to 18 mm planned for 2 implants. Apico-coronal space, necessary for adequate crown height, had at least 6 mm. After treatment with bone block graft, the bone had at least 6.1 mm of width, and 10 mm of height, indicating 8 mm implant's length. The patients were instructed to maintain oral hygiene properly.

Exclusion Criteria. Smokers were excluded from this study, as well as pregnant or lactating females, patients with uncontrolled diabetes mellitus, alcohol or drug abusers, patients with a presence of residual roots, and patients with clinical signs of bruxism. Beside that, there were excluded patients with removable lower dentures, or patients with 3 or more teeth lost in the region between the upper central incisor and second premolar. Also, we did not treat patients with loss of bone height, or inadequate bone quantity in chin region.

Procedure

All patients underwent initial periodontal therapy, basal motivation, information about oral hygiene, scaling, and root planning of all teeth. Each bone block had approximately 10 mm of length, 6 mm of width, and 4 mm of thickness. The patients were divided in 2 groups. In the first group, 6 months after the grafting of recipients site, 10 implants with SLA surface were placed. The same procedure was done in the test group, however with 10 Straumann implants with SLActive surface. 10 weeks after the SLA implants placing, and 4 weeks in case of SLActive implants, prosthodontic treatment began; it was finished 12 and 6 weeks afterward, respectively.

Preoperative Treatment. Initially, on each patient periapical radiographs, orthopantomography, and tomography were done. The bone width and height were evaluated using tomography on the recipient and donor sites. Before surgery, the patients were submitted to basic periodontal treatment, during 2 visits. Beside that, they got 4 mg of dexametason and 2 g of amoxicillin, 1 hour before the surgery.

Surgical Procedure. For intraoral cleansing 0.12% chlorhexidine was used, while 0.2% chlorhexidine was used for extraoral cleansing. After that, the access in the recipient edentulous region was done, while the defect was analyzed and measured, planning the size of the bone graft. The recipient region was perforated with drill to stimulate bleeding. In the donor site, in the region of the mandible symphysis, the bone block graft was harvested according to dimension confirmed in the recipient site. The donor site was sutured in 2-steps approach. After block adaptation, it was fixed with the screw (Fig. 1), the borders were rounded, and the gap was fulfilled with cancelous bone. The sutures were removed 7 days postoperatively.

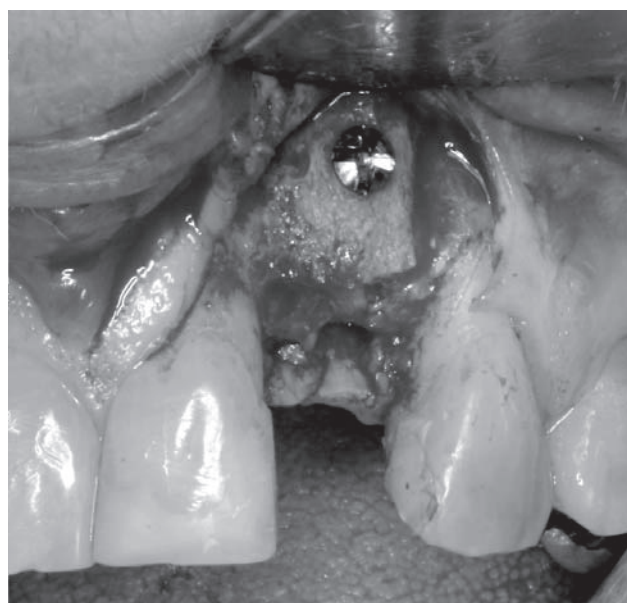


Figure 1. Bone block graft

Implant Placement. The implant placement was done according to the ITI protocol¹⁰. After intraoral and extraoral cleansing, horizontal and sulcular incisions were done, accessing the edentulous region treated with bone block graft. The screw was taken out, the bone ridge was scalloped, and implant site perforated with 600 rpm drill speed. The Straumann Implants, 4.1 x 8 mm SP were placed with contra angle (NSK[®], 20:1, Japan) with minimum torque value of 20 Ncm. Bone around the surgical implant site, on the vestibular and palatal sides, had at least 1 mm and on mesial and distal sides from 1.5 to 3 mm (Fig. 2). All implants were placed with rough surface completely in bone. The implants were closed with healing caps according to gingival height.

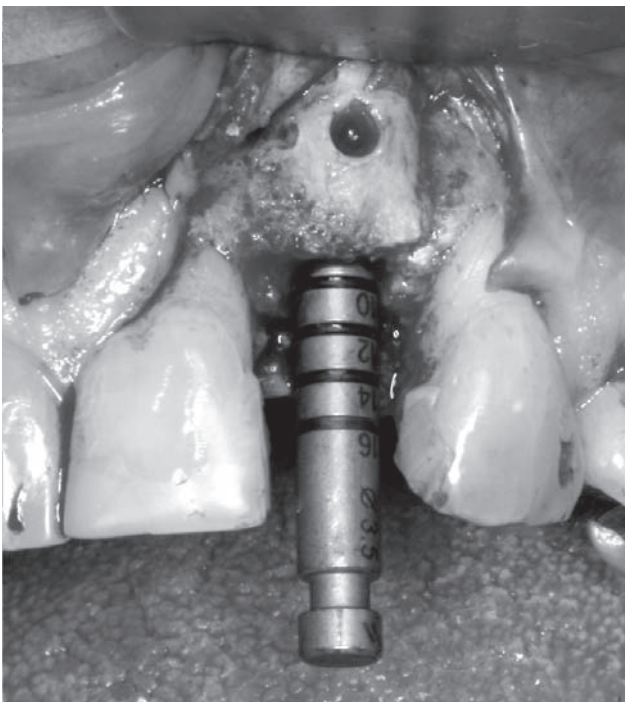


Figure 2. Implant site

The same surgical procedure was done for SLA and SLActive implants.

Postoperative Period. Patients were advised to use paracetamol 750 mg, 4 times per day, during 2 days. 7 days postoperatively the sutures were removed, while patients maintained oral hygiene regime in the treated region with 0.12% chlorhexidine, 1 min, 3 times per day, during 2 weeks.

Prosthodontic Procedure. During the period of osseointegration, none of the implants had mobility, pain, infection or any transparency on radiography. The patients were evaluated 10 weeks after SLA implant placement and 4 weeks after SLActive implants. The healing caps were removed, the implants were cleaned with an air and washed, and impression was taken

with original components (Institut Straumann, Basel, Switzerland - Fig. 3). SynOcta[®] abutments were defined and screwed on the plaster model for each case, and single screwed crowns were done (Fig. 4). All abutments were tightened with 35 Ncm and all crowns with 15 Ncm after clinical probe, adaptation on the implant shoulder and radiographic confirmation (Figs. 5 and 6). The crowns were closed with gutta-percha and photo-polymerized resin, with adequate occlusal relation and adjustment (Fig. 7).



Figure 3. Healing cap in position



Figure 4. Impression cap

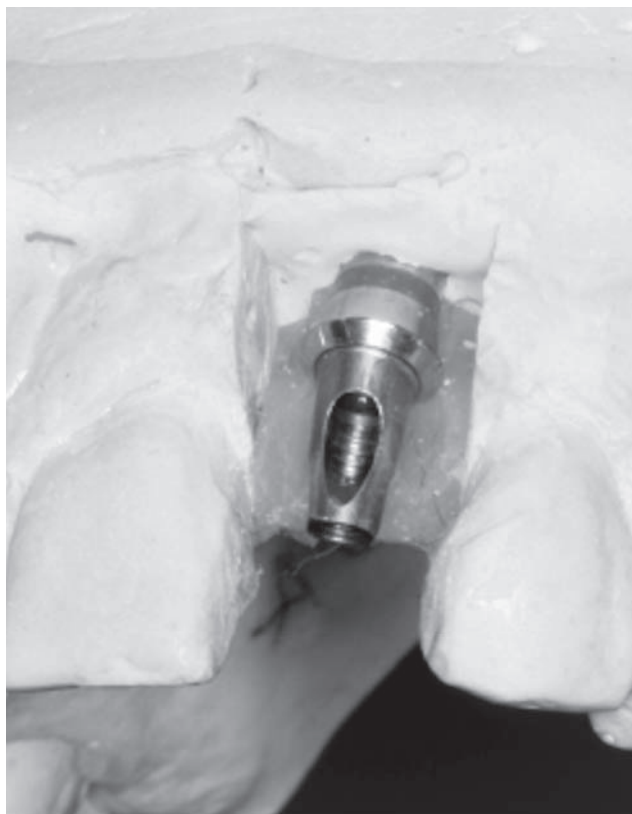


Figure 5. SynOcta® abutment on the model

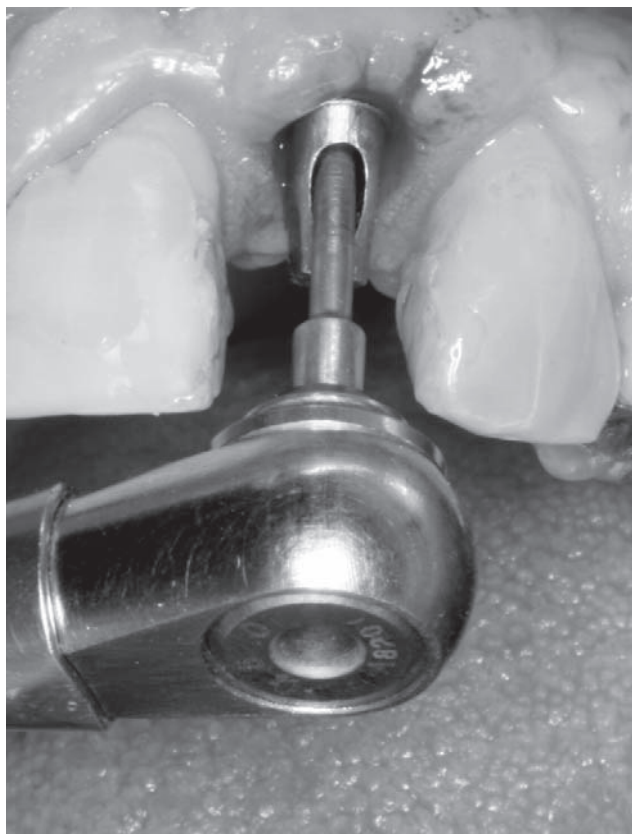


Figure 6. manual tightening in the mouth



Figure 7. Metalo – ceramic crown definitely tightened on Straumann® implant

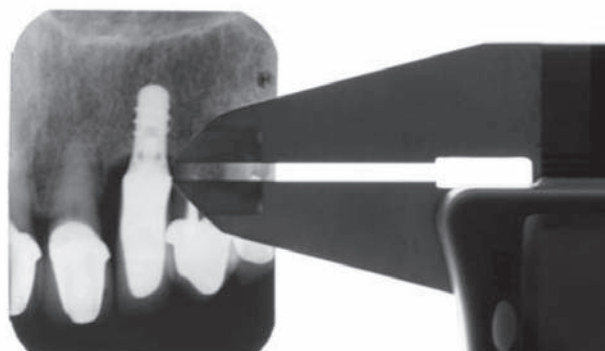


Figure 8. Radiographical evaluation with caliper

Radiographic Evaluation. After implant placement, periapical radiographies were done in the determined periods, listed below:

- T0 - after implant placement;
- T1 - impression taking, after 4 (SLActive surface) to 10 (SLA surface) weeks;
- T2 - definitive tightening of synOcta abutment;
- T3 - 1 month after definitive crown fixation;
- T4 - 3 months after definitive crown fixation.

All radiographies were taken with prefabricated positioners, with the cone perpendicular to the radiographic film. The measurements were done with digital caliper (Digimess® Instrumentos de precisão Ltda., Brazil - Fig. 8). The percentage of distortion was calculated based on knowing measures of implant (9.8 mm = 8 mm implant body + 1.8 mm of trans-gingival part). The measure from radiography was diminished for the real value of implant length. Then, the distance between the implant shoulder and the first bone-to-implant contact was measured. From this value was

diminished 1.8 mm (which corresponds to the implant neck) plus the value of distortion in millimeters.

Finally, from this value the percentage of distortion was diminished, showing the level of bone resorption (LBR). LBR was defined as a distance from a border between rough and machined part of implant, until first bone-to-implant contact. The LBR was measured and evaluated from mesial and distal side of implant for every single implant, in each group, during 5 periods planned for analysis. Also the mean values of LBR on both side of the implant were measured and compared, as well as the difference between LBR of 2o groups. Finally, was compared mean value between 2 groups in the following periods: T0-T1; T0-T2; T0-T3 and T0-T4.

Results

The control group (SLA implants) was treated with single screwed crowns 12 weeks after implant placement. The abutments were tightened with 35 Ncm torque value. The same procedure was done with the test group (SLActive implants), while osseointegration time was 6 weeks before definitive tightening of screwed crowns. In the text bellow, we detected the alterations of LBR in the control as well as in the test group.

LBR around SLA surface

Bone resorption basically began in the third period of evaluation, with single crown in function. In table 1, the LBR was observed in 4 periods of evaluation. The smallest relation was in the period: implant placing - abutment tightening. In other periods higher bone resorption values were found, particularly 3 months after tightening.

Table 1. Comparison of LBR around SLA implants in various periods of evaluations

Period	LBR ± SD
Implant placing - impression	0.033 ± 0.017
Implant placing - tightening	0.029 ± 0.024
Implant placing - 1 month after tightening	0.099 ± 0.044
Implant placing - 3 months after tightening	0.161 ± 0.043

Table 4. Comparison of mean value of LBR on both sides of SLA and SLActive implants

Period	Implant placing		Impression		Tightening		1 Month		3 Months	
	Mesial	Distal	Mesial	Distal	Mesial	Distal	Mesial	Distal	Mesial	Distal
SLA	0.054	0.008	0.096	0.032	0.089	0.106	0.138	0.122	0.231	0.153
SLActive	0.011	0.039	0.083	0.039	0.051	0.046	0.090	0.063	0.109	0.104

LBR around SLActive surface

According to evaluation of LBR around the SLActive surface, it was relatively stable, particularly in the first periods of evaluation. The main alteration occurred after abutment tightening and with the crowns in function (Tab. 2). The LBR diminished in the second period, but increased later. In this group, 2 implants were lost.

Table 2. The LBR around the SLActive surface between different periods of evaluation

Group SLActive	
Period	LBR ± SD
Implant placing - impression	0.036 ± 0.015
Implant placing - tightening	0.024 ± 0.007
Implant placing - 1 month later	0.052 ± 0.008
Implant placing - 3 month later	0.081 ± 0.012

Comparison between 2 implant types

In the control group, no implant was lost during 3 months of evaluation (Tab. 3). In the test group, 2 implants lost stability in the moment of torque application, and they were removed 3 weeks after. Accordingly the survival rate in the test group, 3 months after crown tightening, was 80%.

Table 3. Percentage of survival rate of SLA and SLActive implants

Implants	SLA	SLActive
No	10	10
Loss	0	2
Survival rate	100%	80%

The value of LBR on the mesial and distal side enlarged with the time. The highest level was 0.231 mm and 0.153 mm in SLA group 3 months after the crown was placed, while in the SLActive group it was 0.109 mm and 0.104 mm, respectively (Tab. 4).

Table 5. Mean value of LBR in SLA and SLActive group

Period	Implant placing	Impression	Tightening	1 Month	3 Months
SLA	0.031	0.064	0.097	0.130	0.192
SLActive	0.025	0.061	0.048	0.076	0.106

Table 6. The LBR in different periods of evaluation between two groups

Period	SLA	SLActive	Difference	(%)
Implant installation/impression	0.033	0.036	0.003	9.1
Implant installation/ abutment tightening	0.029	0.024	0.005	17.24
Implant instalation/1 month after tightening	0.099	0.052	0.047	47.47
Implant instalation/3 months after tightening	0.161	0.081	0.080	49.69

% - The percentage of difference between 2 groups

Table 5 shows mean values of each period planned in this research. The biggest LBR was 0.192 mm in the SLA group, 3 months after definitive crown placing. In the group with SLActive implants, the biggest value was 0.106 mm, in the same period.

The difference of LBR was 9.1% smaller in the SLA group, but only in the first period (Tab. 6). In other periods, the difference was significantly higher, and group SLActive had smaller value. In the last period, the difference was almost 50% smaller in the SLActive group, comparing to SLA.

Discussion

The dental implants are, nowadays, one of the main solutions for rehabilitation of edentulous regions. Depending of implant type, bone characteristics, indication, and patient profile, time for osseointegration varies between 6 weeks to 6 months^{4,10}. The patient's necessities and possibilities of the modern implantology bring time reduction. As a possible solution to reduce healing time even more, chemical and physical treatment of implant surface is used.

Our study was realized with the aim to verify the time of osseointegration of relatively short implants, chemically and physically treated, installed in the maxilla previously treated with bone block graft. The implants were loaded with single screwed crowns.

Becktor JP et al¹¹ compared implants installed in the normal alveolar ridge with implants in the region treated with bone block graft. They lost implants basically in the period after loading, what is in concordance with our research refereeing to SLActive implants. Finally, as we did not loose any of SLA implants, we suspect that other uncontrolled variables could influence the implant loss, like: some unexpected surgical act unperceived during the

block fixation or implant placement, or some biological occurrence relating to the block grafts or surgical site.

Raghoobar et al¹² evaluated the implants placed in the maxilla previously treated with bone block grafts. The authors headlined the importance of primary and secondary stability. According to them, one of the most important factors for implant stability is the technique for implant placement, and the implant length. In our research, the implants had 8 mm, and 2 of them, with SLActive surface, were lost. The length of the implants in Raghoobar's paper was bigger. However, if the basic motive for implant loss were length, we would expect the loss of SLA implants as well, simply because they had the same length (8 mm). Nevertheless, no one of them was lost. So, this could lead us to suppose that the implants of 8 mm have certain predictability, even in the grafted region.

Keller et al¹³ emphasized that if the time after bone block grafts is longer, or/and prosthodontic rehabilitation is delayed, it can cause inadequate biological answer. The period without functional loading and without the stimulus in the bone around the implants could cause additional bone resorption. Beside that, the real time for loading of implants placed in the region treated with bone block is unknown and varies from patient to patient. We believe that the reduced healing time defined for implants with SLActive surface did not influence the loss that had occurred. The healing time of 3 months, for SLA implants, apparently could be considered as adequate even in the grafted region. However, we can not forget that in our research we used only 10 implants with the mentioned type of surface. We strongly believe that longer period of evaluation, with bigger number of implants placed in same conditions, could bring clearer answers. The size of the bone block used in bone augmentation corresponded to the edentulous region, and was adapted on the well known way. However, it can be more than 1 variable, that wasn't controlled appropriately simply because it was clinical trial with certain difficulties to control.

Even though, considering this possibility of uncontrolled variable, basically relating to bone quality as possible cause of implant loss, we must headline that the graft was taken out from the chin, considering this region as an excellent donor site, with favourable bone quality. We suppose that histological analysis of bone in the region of the contact with graft, or histological analysis of bone sample trephined from the implant site could bring some responds about implant loss.

According to Lioubavina-Hack et al¹⁴, the implant stability is one of key-factors for success with dental implants. When we evaluated implants installed in both groups we did not realize any type of movements. Then, according to Albrektsson et al¹⁵, the test of mobility is unique clinical procedure that can give the evidence if the implant has adequate implant stability. Considering this fact, we can exclude the inadequate implant stability as a potential factor for implant loss, because all of the implants had insertion torque higher than 20 Ncm. Beside that, they did not have any lateral movement after insertion in the bone, perceived by surgeon. If we analyze the necessary insertion torque, we can find that there is no clear consensus in the current literature. Some authors mentioned 20 Ncm as minimum torque value necessary for implant placement, while enlarging the primary stability the chance for growing of fiber tissue getting down. Nevertheless, we can't simply subestimate evident implant loss in group with SLActive surface, perhaps due to unregistered stability failure. This can be the motive for eventual use of other ways to detect and define primary stability; much more precise measure of implant stability, perhaps, could help to predict possible loss, as well as to define exact time of implant osseointegration, and consequent loading.

So, we can share the opinion of Raghoobar et al¹² who stated that criteria of determining the minimal primary stability for implants placed in the region treated with block graft must be established. If it is to be done, it would be feasible to eliminate this variable as a possible cause of implant loss. The loss of implant stability occurred in the moment of torque application 6 weeks after the placement in the grafted region. According to Oates et al¹⁶, the implant stability can vary during time due to the histological process that occurs in bone. That is why the time of osseointegration is not unique parameter that influences the survival rate and implant loss. Considering the mentioned problems and explanations, it seems that clearer consensus could clarify the doubts about implants with chemically treated implant surface placed in the grafted region of mandible and maxilla.

The implants that were used in our study had diameter of 4.1 mm and length of 8 mm. According to research parameters, the group with SLA surface had 100% of survival rate after prosthodontic rehabilitation, during 3 months of evaluation. The control group had 80% of survival rate. However, from biological point

of view, it is a question whether the loss of 2 from 10 placed implants can be the parameter that indicates a longer period of osseointegration for SLActive surface? Due to relatively small number of implants chemically treated, we can not give strong affirmation that the time for healing must be longer than 6 weeks. Certainly, other researches can answer with more precisely that question. If we consider only numerical results, they show relatively high survival rate for SLActive implants, similar to other researches cited above.

Zolner et al¹⁷ compared LBR around SLActive implants. The evaluation was done between 383 implants loaded immediately and others with early loading. The success rate was 98% in the group with immediate loading and 97% in the group with early loading. The mean LBR was 0.82 mm \pm 0.89 mm and 0.56 mm \pm 0.73 mm, respectively. In our research, the mean LBR was 0.106 mm with definitive crown 3 months in function (Tab. 5). This result shows good bone answer around 1-stage implants. Comparing the LBR between determined periods, it varied between 0.036 \pm 0.015 mm and 0.081 \pm 0.012 mm (Tab. 2).

Cochran et al¹⁸ explained the principal reasons for bone resorption around implants, headlined that surgical trauma usually causes alterations in blood supply and consequently insufficient bone nutrition. After abutment tightening, the additional bone resorption is expectable because of functional loading that principally affects coronal part of bone around implants. Our results have shown that the value of LBR in SLA group was 0.033 mm, comparing to SLActive group, where the LBR was 0.036 mm (Tab. 6). With the prosthesis in function, the LBR continued to grow to 0.099 mm (SLA) and 0.052 mm (SLActive) after 1 month, and 0.161 mm (SLA) and 0.081 mm (SLActive) after 3 months. The difference between 2 groups was 49.69% smaller in group with SLActive implants, which can be explained with high surface energy of chemically treated implants¹⁹.

Schwarz et al²⁰ detected quantitative alteration in bone around SLActive surface that enlarged in the region with bone dehiscence prepared with the purpose for this research. The results in our research have shown low degree of bone resorption in the case of SLA surface, as well as around SLActive surface. In the group with SLActive surface, in some patients, we detected the bone growth. These data weren't statistically evaluated for the 2 groups that we had (SLA and SLActive) simply because of the fact that the number of implants was relatively small. However, if we had more SLActive and SLA implants, placed in same conditions, we could expect statistical significance. Nevertheless, the bone growth could be explained with high surface energy^{6,19,20}. Finally, it is necessary to evaluate more implants in same conditions, using the same parameters, but some new parameters as well, that can bring better and clearer explanations.

Conclusion

According to our method and the results obtained in this research, we can conclude that:

Implants with SLActive surface, placed in the maxilla in the region previously treated with block graft, and loaded with single screwed crowns 6 weeks after, have survival rate 20% smaller comparing to implants with SLA surface, in evaluation during 3 months after loading;

The LBR around implants with SLActive surface was smaller then for implants with SLA surface.

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