CLINICAL ORAL IMPLANTS RESEARCH

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Soft tissue conditions and marginal bone levels of implants with a laser-microtextured collar: a 5-year, retrospective, controlled study

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Key words: clinical study, laser microtextured surface, marginal bone loss, soft tissue conditions

Abstract

Aim: To compare clinical and radiographic outcomes of implants with a Laser-Lok®-microtextured collar to implants with a resorbable blast textured (RBT) collar after a 5-year follow-up period.

Materials and methods: Thirty-four implants with a Laser-Lok®-microtextured collar (test group [TG]) and 31 implants with an RBT collar (control group [CG]) were placed in 45 non-smoking, periodontally healthy patients. The full-mouth plaque score, full-mouth bleeding score, number of sites with plaque, and the number of sites with bleeding on probing (BOP) were recorded at baseline, and at 1-, 2-, 3-, 4-, and 5-year follow-up. Probing depth (PD) and mucosal recession were assessed at baseline and after the 5-year follow-up period. The radiographic marginal bone loss (MBL) was calculated by subtracting the bone level at the time of crown insertion from the bone level at the 5-year follow-up.

Results: An implant survival rate of 94% and of 90% was reported for the TG and the CG, respectively. No statistical differences were found between the study groups for presence of plaque (10.1% vs. 25%) or for number of sites with BOP (10.3% vs. 23%). The differences between both study groups were statistically significant for mean MBL (0.81 ± 0.24 vs. 2.02 ± 0.32 mm), mean PD (2.32 ± 0.44 vs. 4.25 ± 0.87 mm), and mean mucosal recession (0.16 ± 0.3 vs. 0.22 ± 0.3 mm).

Conclusions: Within the limitations of this study, results suggest that the laser-microtextured implant collar surface may provide more favorable conditions for the attachment of hard and soft tissues, and reduce the level of MBL.

In recent years, one of the most important focuses in implant dentistry has been the study of marginal bone loss (MBL) patterns to better achieve a predictable and long-term esthetic and healthy result. The concept of early MBL after prosthetic reconstruction of an implant was introduced by Albrektsson et al. (1986) more than two decades ago. Marginal bone loss represents an important indicator of peri-implant health, and the measure of its level is considered a determining factor in the evaluation of the quality of survival as peri-implant bone loss may induce pocket formation (Hermann et al. 1997; Albrektsson et al. 2012). The values generally accepted as a reasonable guideline for MBL are 1.5 mm for the first year following loading of the implants and 0.2 mm of additional loss for each subsequent year (Albrektsson et al. 1986; Albrektsson et al. 2012). Several studies have reported that MBL may result from implant design, the density of bone, surgical trauma at implant insertion, occlusal overload, apical migration of the crevicular epithelium in an attempt to isolate bacterial-induced infection or to establish a biological width, blood supply interruption, or development of a pathogenic bacterial biofilm, periodontal status, and smoking habit (Berglund & Lindhe 1996; Hermann et al. 1997, 2000; Matarasso et al. 2010; Aglietta et al. 2011). However, the precise mechanisms of this phenomenon are not yet completely known. The influence of the implant collar surface on MBL around implants has been discussed only recently and has received little attention in comparison with other factors (Bateli et al. 2011). Implant collars have traditionally had smooth surfaces

Date:
Accepted 28 September 2014

To cite this article:
Iorio-Siciliano V, Matarasso R, Guarnieri R, Nicolò M, Farronato D, Matarasso S. Soft tissue conditions and marginal bone levels of implants with a laser-microtextured collar: a 5-year, retrospective, controlled study.
Clin. Oral Impl. Res. **26**, 2015, 257–262
doi: 10.1111/clr.12518

to prevent the accumulation of plaque along the top edge of the implant, but this too is considered a contributor to marginal bone die-back to the first implant thread (Albrektsson et al. 1986; Aalam & Nowzari 2005). Some strategies have been developed to improve hard and soft tissue integration and to prevent MBL. One of these strategies is using a laser-microtextured surface (LMS) (Fig. 1). Tissue culture studies have demonstrated cellular attachment by osteoblasts and fibroblasts to a LMS (Ricci et al. 2000; Alexander et al. 2007). These data were later confirmed histologically in animal and human models (Nevins et al. 2008, 2010). The presence of a physical connective tissue attachment onto laser-produced, microgrooved implants and abutments has been documented. This form of attachment differs significantly from the one traditionally associated with implants, around which collagen fibers present as a fibrous capsule with fibers oriented parallel and circumferential to the implant collar surface (Degidi et al. 2012). The most important aspects of a physical connective tissue attachment onto an LMS has to be that its position is determined by the laser microgrooves layout (Nevins et al. 2008) and that connective tissue fibers are perpendicularly oriented to the implant surface. Thus, it has been hypothesized that an implant with an LMS on the collar might provide opportunities for a more stable, coronal, fibrocollagenous physical attachment and might potentially mitigate or eliminate the negative sequelae connected with MBL. However, the biological and clinical impact of this novel kind of attachment must continue to be investigated, especially in terms of stability over time and soft tissue level maintenance. Therefore, the aim of this study was to compare clinical and radiographic outcomes of implants with a Laser-Lok® microtextured collar to implants with an resorbable blast textured (RBT) collar after a 5-year follow-up period.

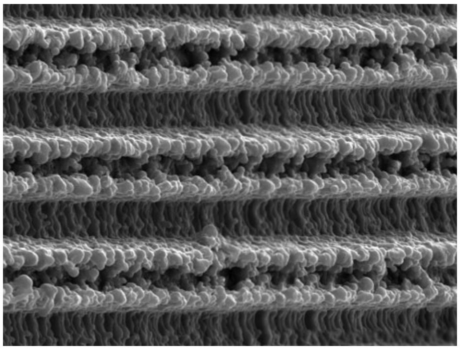

Fig. 1. Laser-microtextured surface (original magnification ×4000).

Material and methods

Study design

This study was designed as a retrospective clinical and radiographic analysis. Implants were divided into two groups:

- The test group (TG): implants with the most coronal 0.3 mm being smooth, machined metal and the next 1.5 mm of the collar being laser-microtextured (BioHorizons Laser-Lok®; Internal Implants, Birmingham, AL, USA);
- The control group (CG): implants with the most coronal 0.3 mm being smooth, machined metal and the next 1.5 mm of the collar treated with resorbable blast texturing (BioHorizons RBT; Internal Implants).

This research study used a retrospective clinical database that included patients who were previously treated either as part of an approved research protocol or as part of routine periodontal care using accepted therapy for each patient's specific clinical needs. As the current research involves a retrospective analysis of pre-existing data and current investigators did not have access to identifiable private information, this research did not require approval by an institutional ethics board or committee. Written informed consent was obtained, and the study was conducted according to the principles of the Declaration of Helsinki on experimentation involving human subjects.

Patients' selection

The subjects were recruited from the patient pool of the Department of Periodontology, "Federico II" University, in Naples, Italy. The clinical charts of patients receiving a dental implant with either a laser-microtextured or a RBT collar between January 2008 and December 2008 were screened. No randomization was performed, being this a retrospective study, and the choice of the implant type depended on the clinician and on the stock availability.

Out of this cohort, 45 patients, who had received a total of 65 dental implants, were available for re-evaluation after 5 years.

To be included in the study, the following criteria had to be fulfilled:

- Age ≥18 years;
- Male or female;
- Implants placed in healed bone (type 4 implant placement according to Hämmerle et al. 2004);
- Loading was performed 3–6 months after implant placement;
- Availability of a periodontal chart and periapical radiograph obtained using the parallel long cone technique at the time of crown insertion and at the 5-year follow-up period.
- The implant supported a single crown or fixed partial dentures
- Patient was willing to enroll in a regular supportive periodontal therapy (SPT) program.

Patients were excluded on the basis of:

- Presence of relevant medical conditions contraindicating surgical interventions;
- Tobacco smoking;
- Periodontally compromised patients;
- Full-mouth plaque score (FMPS) ≥25%;
- Full-mouth bleeding score (FMBS) ≥25%;
- Unloaded implants;
- Implant-supported overdentures;
- Screw-retained crown
- Erratic compliance with the SPT program

Clinical procedures

All implants included in the study had been placed following the classic, two-stage protocol according to the manufacturer's instruction. One hour prior to surgery, the patients received 1 g amoxicillin and were prescribed 1 g twice a day for a week after the surgical procedure. Surgery was performed under local anesthesia (octocaine 20 mg/ml, with adrenaline, 1 : 80,000). The implants of both groups were placed with the smooth collar portion at the level of the bone crest and then covered with the mucosal flap. Thus, the laser-microtextured and RBT portion of the implant collars were in a subcrestal position. Patients were prescribed an analgesic (Ibuprofene, DOC Generici S.r.l., Milano, Italy, 600 mg) immediately after the surgical intervention and after 8 h, and a chlorhexidine–digluconate solution 0.12% rinse (twice daily for one minute). Sutures were left in place for 10 days. The second-stage surgery and the installation of the healing cap were performed 3–6 months thereafter. Definitive crowns were cemented 4–6 months after second-stage surgery.

Baseline examination

After prosthesis cementation at baseline, an intraoral radiograph was obtained using the parallel long cone. At baseline, the following parameters were assessed: FMPS, FMBS, number of sites with plaque (P), probing depth (PD), and number of sites with bleeding on probing (BOP). The PD and BOP were recorded at four sites around each implant (mesial, buccal, distal, and oral) using a graduated manual periodontal probe.

Follow-up examination

All patients were recalled every 6 months for professional oral hygiene. Every year during the recall visit, the following parameters were considered: FMPS, FMBS, and BOP. For the patients who experienced implant loss, data related to the causes and the timing of explantation were collected. After 5 years, the PD and mucosal recession (REC) were recorded.

Radiographic analysis

Radiographic examinations were performed at time of crown placement (baseline [BSL]), and after 5 years of observation. All the radiographs were taken by applying the long cone technique and using a film holder. The films were digitized at a precision of 1200 dpi. The location of the marginal bone levels in relation to the implant shoulder was assessed at the mesial and the distal aspect using a software program (VixWin Platinum Imaging Software; Gendex, Des Plaines, IL, USA). The digitized images were scaled to the known distance between the implant threads. The radiographic MBL was calculated by subtracting the marginal bone level at baseline (MBL0) from marginal bone level at the 5-year follow-up (MBL5).

Statistical analysis

Patient was considered as the statistical unit. For clinical parameters (PD and REC) and radiographic MBL, data were calculated for each implant and reported as the mean ± SD at BSL and at T5 examination. To avoid pseudoreplication, an average of the clinical values related to implants placed in the same patient was performed. FMPS, FMBS, number of sites with plaque, and number of sites with bleeding at BSL, T1, T2, T3, T4, and T5 were reported. Non-parametric methods (Kruskal–Wallis test) were used to compare age and gender between groups at baseline; PD, REC, and MBL, both within and between groups, at BSL and at T5; and FMPS and FMBS between groups at BSL, T1, T2, T3, T4, and T5.

The Mantel–Haenszel chi-squared test was used to compare frequency distributions of outcomes (number of sites with plaque, number of sites with bleeding and PD scores) between test and control procedures. An alpha error of 0.05 was set to accept a statistically significant difference.

All the statistical analyses were performed with IBM SPSS statistic software (IBM Corp. Released 2011. IBM SPSS Statistics for Windows, Version 20.0; IBM Corp., Armonk, NY, USA).

Results

Table 1 shows the characteristics of the patient population. Forty patients (21 patients in the TG; mean age 47.2 ± 10.7 years and 19 patients in the CG; mean age 47.7 ± 12 years) were available for the analysis. In the TG, seven patients were recalled every 3 months for oral hygiene procedures, while 16 patients were recalled every 6 months. In the CG, six patients were recalled every 3 months and 13 every 6 months.

After the 5 year follow-up period, the survival rate was 94% and 90% for implants of the TG and the CG, respectively. A total of five implants were lost during the observation time (Table 2). Two implants were lost in TG (after 2 and 4 years of function) and three in CG (two after 3 years and one after 4 years). All implants were lost for peri-implantitis. The means and standard deviation of FMPS and FMBS are illustrated in Table 3. No statistically significant differences were found at baseline or at 1-, 2-, 3-, 4-, and 5-year follow-up.

At the 5 year follow-up, no significant differences were found between the study groups regarding the presence of plaque and BOP ($P > 0.05$). The number of sites with plaque was 13 (10.1%) for the TG and 23 (25%) for the CG, whereas the mean number of sites with BOP was 14 (10.3%) for TG and 26 (23%) for CG (Table 4). Table 5 summarizes the PD recorded at baseline and after the 5-year follow-up. Test implants showed at baseline a PD of 2.3 ± 0.4 mm at the mesial aspect, 2.1 ± 0.3 mm at the buccal aspect, 2.2 ± 0.4 mm at the distal aspect, and 2.4 ± 0.4 mm at the oral aspect. After the 5-year follow-up period, the PD was 2.9 ± 0.7 mm at the mesial aspect, 2.8 ± 1.1 mm at the buccal aspect, 2.6 ± 0.8 mm at the distal aspect, and 2.7 ± 1.1 mm at the oral aspect. No significant differences were found between the baseline and the 5-year follow-up period ($P > 0.05$). The control implants showed at baseline a PD of 2.1 ± 0.6 mm at the mesial aspect, 2.8 ± 0.3 mm at the buccal aspect, 2.6 ± 0.6 mm at the distal aspect, and 2.3 ± 0.4 mm at the oral aspect. At the 5-year follow-up, the PD was 4.1 ± 0.8 mm at the mesial aspect, 4.3 ± 1.1 mm at the buccal aspect, 4.4 ± 0.6 mm at the distal aspect, and 4.2 ± 1.0 mm at the oral aspect. A statistically significant difference was noted ($P < 0.05$) (Table 5). In Table 6, the PD values and REC values after the 5-year follow-up are reported. A comparison of the mean PD with the test implants vs. the control implants was statistically significant ($P < 0.05$).

After the 5-year observation time, the REC of the TG was 0.0 ± 0.0 mm at the mesial aspect, 0.15 ± 0.3 mm at the buccal aspect, 0.0 ± 0.0 mm at the distal aspect, and 0.18 ± 0.3 mm at the distal aspect, while the REC of the CG was 0.17 ± 0.3 mm at the mesial aspect, 0.21 ± 0.4 mm at the buccal aspect, 0.22 ± 0.2 mm at the distal aspect, and 0.28 ± 0.4 at the oral aspect. All measurements had a statistically significant difference ($P < 0.05$). The frequency distribution of the PD after the 5-year follow-up is summarized in Table 7. Statistically significant differences ($P < 0.05$) were observed between the two groups in all PD categories. A PD of 2–3 mm was found in 80.6% of sites in the TG and in 20.3% of sites in the CG. A PD of 4–5 mm was observed in 17.9% of test implants and in 71.2% of control implants. A PD ≥6 mm was found in 1.5% of sites in the TG and in 8.5% of sites in the CG (Table 7). Radiographic results are reported in Table 8. The TG and the CG showed different marginal bone levels. After the 5-year follow-up period, the MBL in the TG was 0.87 ± 0.21 and 0.75 ± 0.25 mm at the mesial and distal aspects, respectively, while a MBL of 0.75 ± 0.25 mm at the mesial aspect and 2.01 ± 0.34 mm at the distal site was recorded in the CG. A statistically significant difference was noted ($P < 0.05$).

Table 1. **Patients' population**

	Test group (N = 21)	Control group (N = 19)
Age (years; mean ± SD)	47.2 ± 10.7	47.7 ± 12.0
Gender (male/female)	10/11	11/8
SPT Recall Patients/months	7/3 14/6	6/3 13/6

SPT, supportive periodontal therapy.

Table 2. **Number of implants lost and survival rates**

	Number of implants	Number of implants lost	Survival rate (%)
Test group	34	2	94
Control group	31	3	90
Total	65	5	92.3

Table 3. **Patients' full-mouth plaque score (FMPS) ± SD, and full-mouth bleeding score (FMBS) ± SD**

	Baseline	1 year	2 year	3 year	4 year	5 year
FMPS						
Test group (%)	20.7 ± 1.4	19.6 ± 1.9	20.3 ± 2.4	19.9 ± 2.0	20 ± 2.2	20.4 ± 2.3
Control group (%)	21.2 ± 3.3	19.2 ± 3.3	20.3 ± 3.4	20.6 ± 3.2	19.7 ± 3.2	19.7 ± 3.2
Significance	0.27	0.56	0.94	0.19	0.29	0.15
FMBS						
Test group (%)	19.6 ± 1.7	18.3 ± 1.5	19.6 ± 1.8	18.7 ± 1.8	19.1 ± 1.3	18.7 ± 1.5
Control group (%)	19.7 ± 3.1	18.7 ± 3.0	19.5 ± 3.2	19.8 ± 3.1	19.1 ± 3.4	19.0 ± 3.0
Significance	0.59	0.42	0.87	0.06	1.00	0.38

Table 4. **Number of sites with plaque and bleeding on probing (BOP) at baseline and after 5 years**

Number of sites with plaque	Baseline	1 year	2 year	3 year	4 year	5 year
Test group	7	7	7	9	12	13
Control group	12	10	7	8	11	23
Significance	0.23	0.31	0.53	0.22	0.82	0.21
Number of sites with BOP	**Baseline**	**1 year**	**2 year**	**3 year**	**4 year**	**5 year**
Test group	2	10	9	13	10	14
Control group	6	10	4	12	13	26
Significance	0.08	0.75	0.51	0.67	0.41	0.07

Table 5. **Comparison of probing depths on four aspects at baseline and after the 5-year follow-up period**

Mean PD ± SD (mm)	Mesial	Buccal	Distal	Oral
Test group				
Baseline	2.3 ± 0.5	2.1 ± 0.3	2.4 ± 0.5	2.4 ± 0.5
5-year follow-up	2.8 ± 0.8	2.8 ± 1.0	2.6 ± 0.7	2.7 ± 1.0
Significance	0.0001	0.0001	0.0001	0.0001
Control group				
Baseline	2.7 ± 0.7	2.8 ± 0.4	2.5 ± 0.6	2.4 ± 0.5
5-year follow-up	4.1 ± 0.6	4.3 ± 0.9	4.3 ± 0.7	4.1 ± 0.9
Significance	0.0001	0.0001	0.0001	0.0001

Table 6. **Comparison of probing depths (PD) and mucosal recessions (REC) assessed at four aspects at 5-year follow-up period between test and Control group**

Mean PD ± SD (mm)	Mesial	Buccal	Distal	Oral
Test group (n = 32)	2.8 ± 0.8	2.8 ± 1.0	2.6 ± 0.7	2.7 ± 1.0
Control group (n = 28)	4.1 ± 0.6	4.3 ± 0.9	4.3 ± 0.7	4.1 ± 0.9
Significance	0.0001	0.0001	0.0001	0.0001
Mean REC ± SD (mm)	**Mesial**	**Buccal**	**Distal**	**Oral**
Test group (n = 32)	0 ± 0	0.1 ± 0.3	0 ± 0	0.2 ± 0.4
Control group (n = 28)	0.2 ± 0.4	0.2 ± 0.4	0.0 ± 0.0	0.4 ± 0.5
Significance	0.26	0.63	1.00	0.39

Table 7. **Frequency distribution (%) of probing depths (PD) around implants with and without laser-lok collar after the 5-year follow-up period**

Probing depth	2–3 mm	4–5 mm	≥6 mm
Test group (32)	28.6	71.4	0
Control group (28)	0	84.2	15.8

Table 8. **Mean radiographic bone loss ± SD (mm) after the 5-year follow-up period**

	Test group	Control group	Significance
Mesial	0.87 ± 0.21	2.03 ± 0.30	0.001
Distal	0.75 ± 0.25	2.01 ± 0.34	0.001

Discussion

Marginal bone loss is an important indicator of peri-implant health. It is considered a determining factor of esthetic outcome and survival as peri-implant bone loss may induce pocket formation which could be unfavorable for the long-term health of the peri-implant tissues (Hermann et al. 1997; Albrektsson et al. 2012). Measurements of marginal bone on periapical radiographs are generally accepted as a reliable method to measure bone levels at the proximal side of the implant from the moment of placement to years thereafter. Radiographic measurements at the mesial and distal sites revealed statistically significant differences in bone loss around the test and the control implants. The TG showed a mean mesial MBL of 0.87 ± 0.21 mm and a mean distal MBL of 0.75 ± 0.25 mm, while the CG had a mean mesial MBL of 2.01 ± 0.34 mm and a mean distal MBL of 2.03 ± 0.30 mm. Radiographic results of this study are aligned with those of previous studies that have compared implants with a laser-microtextured collar and implants with another surface treatment. Pecora et al. (2009), who analyzed prospective, controlled data for a group of 15 patients and 20 fixtures, reported a mean crestal bone loss of 0.59 mm for implants with LMS on the collar and of 1.94 mm for control implants with a smooth collar. Farronato et al. (2014) in a randomized clinical trial (39 test implants and 39 control implants) reported, after 2 years of function, a mean marginal crestal bone loss of 0.49 ± 0.34 mm for implants with a laser-microtextured collar and of 1.07 ± 0.30 mm for implants with an RBT collar. Similar results are also reported by Guarnieri et al. (2014) who compared implants with a laser-microtextured collar (test) and implants with an RBT collar (control) using four different placing and loading protocols. In that study, implants with an LMS on the collar showed a mean marginal crestal bone loss of 0.58 mm compared to 1.09 mm for the implants with an RBT collar. Although these clinical data and all other available in the literature (Ketabi & Deporter 2013) indicate that laser microtexturing treatment of the implant collar reduces crestal bone loss, the impact and the additional value of this kind of collar surface on peri-implant bone level is currently unclear. The fact that laser microtexturing on the implant collar may allow a higher marginal bone attachment to the implant would be reasonable in light of the significant influence that the mechanical substrate supporting biologic tissue can have on cell growth and development (Brunette 1998). *In vitro* tissue culture studies have observed that fibroblast and osteoblast precursors, when applied to an LMS, demonstrated different attachment, growth, spreading, and orientation in function of the laser microgrooves layout (Inoue et al. 1987; Ricci et al. 2000). These *in vitro* results have provided the hypothesis that microtextured surfaces could be used to control bone and soft tissue responses to implant surfaces. It has in fact been suggested that on dental collar implants, the LMS might act to establish a predetermined site to attract a physical connective tissue attachment. Histological research in an animal model (Nevins et al. 2010), and in humans (Nevins et al. 2008), has subsequently confirmed this hypothesis, documenting the presence of a physical connective tissue attachment onto laser-produced microgrooves on implant and abutment surfaces. The most important aspects of this physical connective tissue attachment may be the fact that its position is determined by the laser microgrooves layout, the connective tissue fibers are perpendicularly oriented to the implant surface, and these fibers act as a seal to apical migration of gingival epithelial cells and fibroblasts. The clinical implication of these *in vitro* findings are important, and several manufacturers have moved toward providing moderate surface roughness on implant collars. Nevertheless, unlike a LMS, particle-blasted and/or acid-washed surfaces, or the Ti-Unite surface do not elicit functionally oriented gingival attachment to their roughened implant neck regardless of whether they have microthreads (Abrahamsson et al. 2002; Glauser et al. 2005; Berglundh et al. 2007; Yamano et al. 2011; Bates et al. 2013). This different behavior may relate to the fact that laser microgrooves are an order of magnitude smaller in dimension than machine-tooled microthreads. Moreover, the nanotopography of LMS is more pronunciated, having knobs with rounded edges and some undercuts (Fig. 1), while blasted surfaces on machine-tooled microthreads show random nanoroughness and somewhat sharp edges. As nano features influence fibroblast behavior and the strength of adhesion through filopodial sensing (Dalby et al. 2004; Wang et al. 2011), one might speculate that repetitive nanosize surface features created with a laser have the ability to allow fibroblasts to form a physical connective tissue attachment to titanium implants that restricts apical migration of gingival epithelium and preserves the coronal level of bone. While the implications of the marginal bone level are important for the stability of an implant, there are further considerations that relate to the peri-implant soft tissues. First, the level of the peri-implant marginal bone has been suggested to determine the level of the peri-implant mucosa (Bengazi et al. 1996; Chang et al. 1999). Second, MBL may induce pocket formation, which could be unfavorable for the long-term health of the peri-implant tissues (Rams et al. 1984; Hermann et al. 2001). In the present study, the mean PD values in the TG and the CG were 2.75 ± 0.9 and 4.25 ± 0.87 mm, respectively, while the mean mucosal recession value in the TG was 0.16 ± 0.3 mm and in the CG was 0.22 ± 0.3 mm. These results are in agreement with published data reporting a consistent difference in PD between the implant pairs with and without the LMS treatment. The fact that implants with a laser-microtextured collar yield minimal bone loss could also be an explanation for the peri-implant tissue condition results we observed. As is the case around the teeth, epithelium seems to play an important role in implant function by sealing dental implants from contaminants in the external environment (Listgarten et al. 1991). Around implants, epithelial downgrowth could be impeded by firm attachment of the connective tissue to the implant, with cells and fibers attached to the implant surface, as is the case with Sharpey's fibers around natural teeth. In the case of a dental implant, smooth collars and RBT collars do not permit connective tissue attachment; hence, stability of the peri-implant soft tissue is lacking (Cochran et al. 1997). The LMS, while not analogous to the cemental surface of the natural teeth, appears to provide soft tissue support in addition to that provided by the marginal bone.

As a retrospective analysis, the present study lacks the random allocation of patients into treatment and CGs. Another limitation may lie in the fact that the selection of the implant type was based on the choices of the patient and, where applicable, the dentist. However, to minimize the differences between the two groups, considerable effort was taken to identify test and control sites which were as similar as possible regarding implant size, diameter and position, bone volume, and prosthetic factors, such as abutment selection, occlusion, and accuracy of fit.

Moreover, the clinical indexes that were used to evaluate the soft tissues (i.e. BOP, FMBS, PD, and REC) are not specifically designed to assess the quality of the soft tissues surrounding the implants. Nevertheless, the analysis of these data provides some information of the conditions of the soft tissues.

Conclusions

Within the limitations of this study, results suggest that a laser-microtextured implant collar may provide more favorable conditions for the attachment of hard and soft tissues, and reduce the level of marginal bone resorption, PD, and soft tissue recession.

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