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ORIGINAL ARTICLE

Comparison between two different techniques for peri-implant soft tissue augmentation: Porcine dermal matrix graft versus tenting screw

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Abstract

Background: The thickness of the soft tissues around dental implants is crucial for both the preservation of the marginal bone and esthetic profile. Many authors have showed the thickened soft tissues favor a better peri-implant bone stability; however, different thickening techniques can be used for this aim.

Methods: Forty-seven patients were enrolled in this study, each one had one implant included in this analysis. According to the thickening procedure, patients were assigned into group A (porcine dermal matrix, $n = 24$) or B (healing abutment used as tenting screw to sustain the soft tissues, $n = 23$), soft tissue thickness was measured after flap elevation in a standardized way. Six months after implant placement, implants were uncovered and soft tissue thickness measured again.

Results: At second stage, 6 months after implant placement, the mean vertical thickness was 3.01 ± 0.58 mm in group A and 2.25 ± 0.53 mm in group B. The difference between the two groups at 6 months was significant ($P < 0.001$). The mean vertical gain in group A was 1.33 ± 0.71 mm, whereas it was 0.43 ± 0.55 mm in group B. This difference was also statistically significant ($P < 0.001$).

Conclusion: The use of a healing abutment for "tenting effect" has limited efficacy to obtain a significant increase in soft tissue thickness. The use of a porcine dermal matrix at time of implant placement is effective to thicken peri-implant tissues.

KEYWORDS

acellular dermal matrix, dental implant-abutments, dental implants, soft tissue augmentation

1 | INTRODUCTION

The thickness of the soft tissues around dental implants plays an important role for both the preservation of the marginal bone and esthetic profile.[1,2]

The importance of enhancing quality and quantity of deficient soft tissues through surgical techniques was described by Silverstein & Lefkove.[3] The proposed soft tissue augmentation technique involved the placement of a connective tissue graft harvested from the palate on to the implant site. The procedure was intended to optimize an esthetic outcome in the treated area and to prevent the exposure of metal in case of resorption of the buccal bone. In a subsequent systematic review, Thoma et al. 2014[4] highlighted how a soft tissue graft,

applied in the area of implant placement, guarantees a better esthetic outcome. Wiesner et al. 2010[5] tested the increase of peri-implant tissue thickness with autologous connective tissue grafts in a randomized controlled split-mouth study achieving an average thickness increase in grafted sites of 1.3 mm, which allowed for an esthetic improvement. In addition to the esthetic concerns, many authors have also demonstrated that there is higher rate of marginal bone loss in cases in which the vertical soft tissue thickness is <2 mm around implants.[6,7]

In recent years, biomaterials of human or animal origin have been introduced to the market as substitutes to autologous connective tissue. These are harvested from the patient, obliging to a second surgical intervention, with an increase in morbidity, discomfort, and longer duration of the intervention itself. The use of deproteinized human dermis was first introduced in plastic surgery[8] and ophthalmology[9] in the second half of the 1990s and then in oral surgery.[10] Puisys and Linkevicius 2015[11] used deproteinized dermis of human origin, placed at the same time of implant placement, to assess whether the thickening of peri-implant tissues reduced marginal bone resorption after prosthetic loading. Their study showed that the areas that received a graft had reduced marginal bone loss compared to areas with thin soft tissues. However, the authors did not quantify the mean increase in soft tissue. In another prospective study, Lorenzo et al. 2012[12] compared the connective tissue grafts to a dermal matrix of porcine origin to obtain an increase in the band of keratinized mucosa. The two techniques gave similar results. Even in this case, the increase in thickness of the soft tissues was not evaluated. These latter cited studies have shown that the use of xeno- or allogeneic dermal acellular matrix gives satisfactory results. In some cases, the outcomes are even comparable to the use of autologous soft tissue grafts.

It is our intention to verify the possibility of increasing the vertical thickness of the peri-implant soft tissues, without resorting to autologous graft in order to avoid a second surgical site and thus reduce the invasiveness of the procedure. Therefore, the objective of this observational study was the evaluation of the increase of peri-implants soft tissues thickening using a xenogenic dermal matrix of porcine origin or using a "tenting screw" technique, in which a 2 mm healing screw is covered by the repositioned flap, after the surgical insertion of the implant.[13]

2 | MATERIALS AND METHODS

The present study was a prospective multicenter non-randomized clinical study. Five clinical centers recruited and treated patients with thin peri-implant crestal soft tissues (≤2 mm), with the placement of a dental implant in the mandibular premolar or molar sites, and the simultaneous placement of a xenogenic porcine dermal matrix membrane (group A) or a healing cap used as "tenting-screw" (group B). The thickness of the soft tissues was assessed during surgical implant placement and again, 6 months after the first surgery during the second stage procedure. All clinical procedures were performed in full compliance with the Declaration of Helsinki and subsequent revisions (Fortaleza 2013) and the study protocol was approved by the Ethics Committee of the Calabria Region – North Area Section (Prot. N. 145 – 72/2016) and was conducted in strict adherence to the criteria of the STROBE (strengthening the reporting of observational studies in epidemiology) check list.[14]

All patients were consecutively enrolled in each center and surgeries were performed by one surgeon for center that was considered well trained and experienced in order to have a homogeneous distribution of the operator-related variables. Before enrollment, all patients were required to sign an informed consent form to document that they understood the purpose of the study (including procedures, follow-up appointments, and any potential risks or complications). All patients were informed about therapeutic alternatives and all possible questions were answered.

The inclusion criteria were:

1. Partial edentulism in the posterior mandible
2. Presence of a residual bone crest with a minimum surgical height of 7 mm, and a thickness of at least 6 mm at planned implant sites
3. Completely healed bone (at least 6 months after the loss/extraction of the tooth)
4. Soft tissue thickness ≤2 mm
5. Absence of regenerated bone
6. No need for simultaneous bone augmentation
7. Plaque index (PI)[15] ≤25% and bleeding index (BI)[16] ≤20%
8. Buccal width of the keratinized mucosa ≥4 mm
9. Age >18 years
10. Patients able to examine and understand the study protocol
11. Signed informed consent

The exclusion criteria were:

1. Acute myocardial infarction in the previous 6 months
2. Uncontrolled coagulation disorders
3. Uncontrolled diabetes (HbA1c >7.5%)
4. Head/neck radiotherapy in the last 24 months
5. Immunocompromised patients (HIV infection or chemotherapy in the last 5 years)
6. Present or past treatment of intravenous bisphosphonates

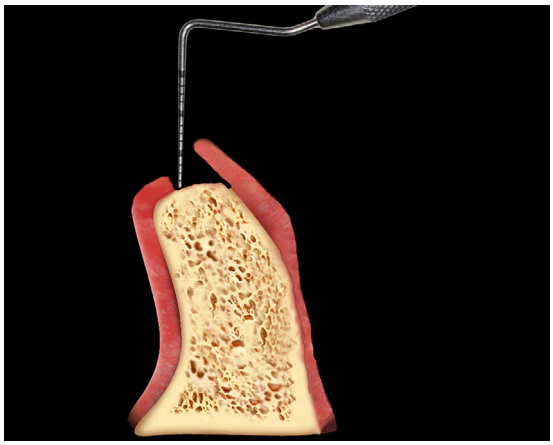

FIGURE 1 Flap elevation and standardized measurement of soft tissues thickness

7. Psychological or psychiatric diseases
8. Alcohol and/or recreational drug abuse
9. Uncontrolled periodontal disease

Patients who, for various reasons (e.g., allergy to porcine collagen, religious or life ethics—vegetarian or vegan—personal choices), refused to receive a graft of animal origin, were automatically assigned to group B.

2.1 | Surgical procedure

All patients received antibiotic prophylaxis, 2 g of amoxicillin 1 hour before surgery. After local infiltration (4% articaine with 1:100000 adrenaline),* a crestal incision was made. Attention was given to preserve the keratinized tissue. With the aid of a periosteal elevator, a vestibular full thickness flap was carefully elevated. The vertical thickness of the soft tissues was measured with a probe marked every 1.0 mm† positioned in the exact area of the subsequent implant osteotomy (Figure 1), thus allowing for a precise and repeatable measurement point.[16] Full thickness elevation of the lingual flap was completed and the site for implant placement was prepared. Implants used by all centers were: cylindrical, diameter 3.7 to 5 mm, 8.5 to 13 mm in length, internal hexagon connection. All implants were placed at least 1.5 mm from the adjacent teeth and surrounded by at least 1 mm of bone on both buccal and lingual sides. Primary stability was achieved for all placed implants, with torque values no lower than 25 Ncm.

Before suturing the flap, according to the decision taken during the formulation of the treatment plan, two different procedures were performed. In group A, a cover screw was placed onto the implant (Figure 2) and a porcine dermal matrix membrane (thickness 2.0 ± 0.2 mm)‡ was hydrated in warm saline solution, cut and adapted over the implanted area and below the flap (Figure 3). In group B, a healing screw of 2 mm in height was tightened into the implant to act as a vertical support for connective tissue formation and covered by the flap (Figures 4 and 5). In both groups flaps were sutured with non-resorbable synthetic monofilament§ and primary closure was achieved. Patients from both groups were instructed to disinfect the site by rinsing twice a day for 1 week for 1 minute with 0.12% chlorhexidine digluconate and to chew on the contralateral side. The sutures were removed between 10 and 14 days after surgery.

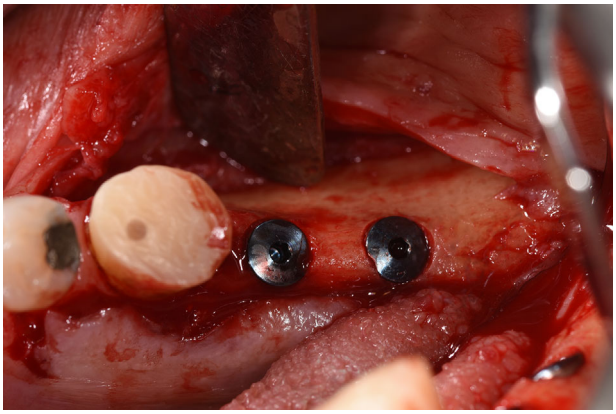

FIGURE 2 Cover screws positioned over implants in group A

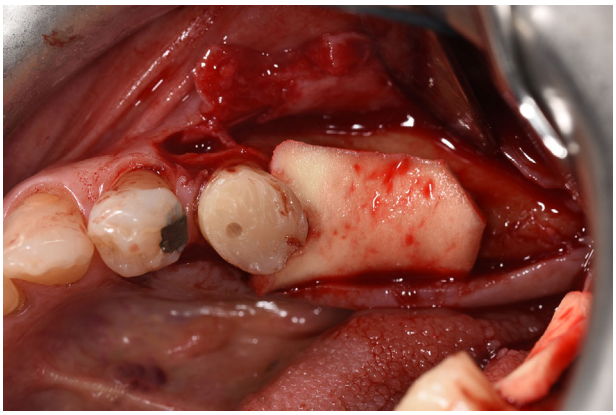

FIGURE 3 Porcine dermal matrix adapted over implants in group A

The second stage procedure was performed 6 months after implant placement. A full-thickness flap was elevated (see Figure S1 in online *Journal of Periodontology*) and, with the previously described modalities, the thickness of the soft tissues was measured with a probe positioned perpendicularly to the crest at the implant site. The implants were considered

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§ 4-0, PTFE, Omnia, Fidenza, Italy.

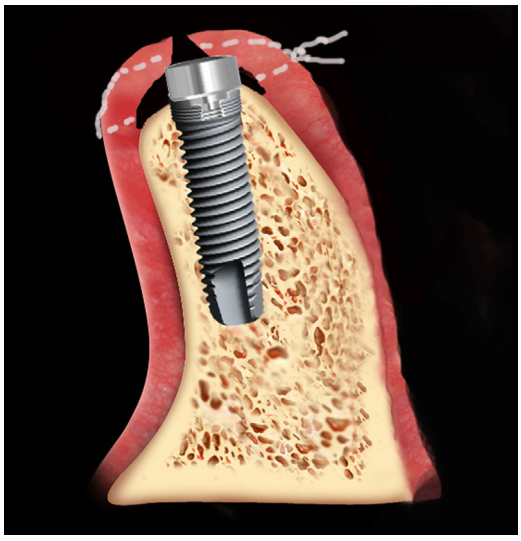

FIGURE 4 Schematic image of the suturing of the flap over an implant in group B

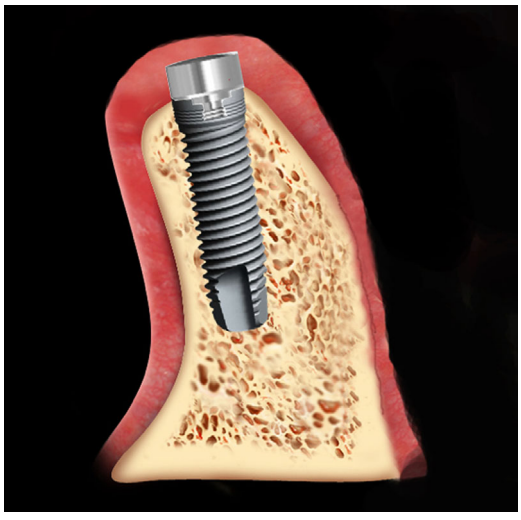

FIGURE 5 Schematic image of the healing of the soft tissues around an implant in group B

successfully osseointegrated if clinically immobile, without signs of inflammation, bone loss, obvious radiolucency and if the patients reported no pain. Healing abutments of adequate length were then placed on the implants and the flaps re-sutured.

2.2 | Statistical analysis

The data were analyzed using statistical software,* with the patient as statistical unit. Descriptive statistics were calculated, including means, standard deviations, medians, and confidence intervals. Assuming a difference between the two groups of 0.5 ± 0.5 mm[11] and setting the power at 80% and alpha = 0.05, the minimum calculated sample size needed was 17 patients/group. Non-normality of the distribution of the dataset was detected by the Shapiro-Wilk test; therefore, non-parametric Mann-Whitney test was used.

* SPSS 25.0 for Windows, SPSS Inc., Chicago, IL.

3 | RESULTS

A total of 79 patients were screened for inclusion, 31 were not included for the following reasons: seven had active periodontal disease, five stated they could not comply with follow-up appointments, three had uncontrolled diabetes, one had received intravenous bisphosphonates in the last 4 years, two did not want to participate in the study and 13 had a soft tissue thickness >2 mm measured at the time of flap elevation. A patient dropped out in the B group because of a peri-implant infection that lead to implant removal 3 weeks after surgery.

In total, 47 patients were included in the final analysis, 24 in the A group (13 females – 11 males) and 23 in the B group (12 females – 11 males), with an age ranging between 29 and 80 years (average 58.3 ± 13.4, A group 60.7 ± 12.2 years – B group 55.8 ± 14.5 years). The age difference between groups was not statistically significant ($P > 0.05$). Four smoking patients (2 test group – 2 control group) and 43 non-smoking patients (22 A group – 21 B group) were counted in the total patient pool.

At baseline, the mean vertical soft tissue thickness was 1.72 ± 0.38 mm in the A group; in the B group it was 1.79 ± 0.37 mm: the difference between the two groups was not significant ($P = 0.43$).

All patients were seen monthly until second stage procedure, during this period no adverse events were reported for group A, whereas 18 with exposure of the healing abutment were registered for group B.

At second stage, 6 months after implant placement, the mean vertical thickness was 3.01 ± 0.58 mm in group (A) and 2.25 ± 0.53 mm in group (B). The difference between the two groups at 6 months was significant ($P < 0.001$). The mean vertical gain in group A was 1.33 ± 0.71 mm, whereas it was 0.43 ± 0.55 mm in group B. This difference was also statistically significant ($P < 0.001$) (Figure 6).

4 | DISCUSSION

The aim of this study was to evaluate the increase of vertical thickness of peri-implant soft tissues, obtained by grafting a porcine dermal matrix at the time of surgery or by placement of a 2 mm healing abutment as vertical support for the soft tissues, 6 months after the procedure. Both the final thickness measurement and the soft tissue vertical increase were statistically significant compared to the baseline in favor of group A (porcine dermal matrix use).

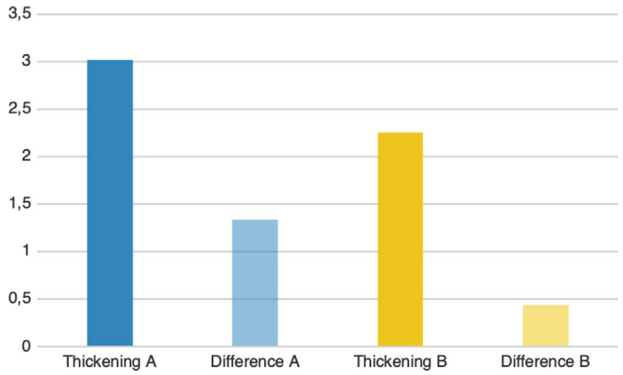

FIGURE 6 Bar graph showing the final tissue thickness (first column) and the difference between initial and final thickness (second column) for each group

This study was limited to assessing the effectiveness of two different methods to obtain a mucosal thickness that can be beneficial for the peri-implant health. Only the values relating to the gain of soft tissues were therefore provided, because it was not the purpose of this preliminary analysis to evaluate the peri-implant bone parameters. Similarly, we decided not to compare the porcine dermal matrix to an autologous graft because it was the intention of the authors to compare between them two minimally invasive methods and thus alternatives to autologous soft tissue grafts. In this case we wanted to investigate the possibility to achieve an increased thickness, with the simple use of commercially available materials such as the healing screw or an animal origin soft tissue replacement. The duration of whole surgical intervention was not affected by the soft tissue augmentation procedure, no second surgical site was needed, no tissue harvesting was performed. The simple act of placing a dermal matrix over the bone ridge was performed in a few seconds, the screwing of a taller abutment is something already encompassed in the normal protocol. Measuring the tissue thickness with a probe takes nearly no time. So, no additional discomfort was caused to the patient.

There is a wide debate in the literature concerning the factors which may influence biological width establishment around dental implants after abutment connection. It has been shown in several studies that peri-implant soft tissues thicker than 2 mm lead to less marginal bone resorption at 1 year.[6,7,11,17,18] However, other authors[19,20] suggest that a primary role is played by the abutment height: short abutments (<2 mm) lead to greater marginal bone loss in comparison with longer ones (>2 mm). A recent randomized controlled trial[19] confirmed that implants restored with short abutments (1 mm) show significantly greater marginal bone loss than identical implants with long abutments (3 mm), in patient with mucosal thickness ≥3 mm. In a following study, the same group of authors demonstrated how long abutments can have the same beneficial effect even when used in patients with thin mucosa.[21] Hence, the use of a long abutment even in the presence of thin mucosa (<2 mm) seems to be useful in minimizing marginal bone loss, but possibly resulting in questionable esthetic outcomes, because of the supra-marginal location of the crown-abutment margin.[22] Vertical mucosal thickening is then recommended in the presence of thin peri-implant tissues, to use long abutments without the risk of esthetic issues.

In particular Puisys & Linkevicius,[11] showed that soft tissue thickening procedures using dermal matrices resulted in comparable marginal bone levels at 1 year to those obtained in tissues already thicker than 2 mm at the baseline. The same authors of this study, report in a different article the mean values of increase of soft tissues obtained using the same dermal matrix of human origin.[23] In this last study, in patients with an initial mean soft tissues thickness of 1.54 ± 0.51 mm at the time of implant surgery and grafting, at 3 months, the average thickness was 3.75 ± 0.54 mm, with an average gain of 2.21 ± 0.85 mm. These results may seem even more encouraging than the ones of our investigation; however, one must consider that—in our case—the second stage procedure was performed at 6 months, when most of the original grafted tissue was completely resorbed.

The reason for a re-entry at 6 months was dictated by the need to have a complete, or almost complete, resorption of all the grafted material, in order to have the most definitive results and avoid overestimation of the treatment effect because of an incomplete dissolution of the graft material. In fact, Fickl et al.[24] on an animal model, at 4 months showed histological evidence of residuals porcine dermis although surrounded by healthy connective tissue and no signs of inflammation. In the aforementioned study, the values relating to the increase in thickness and height of the soft tissues, achieved with the porcine dermal matrix, were comparable to those obtained with connective tissue grafting.

The successful use of acellular porcine dermal matrix has been demonstrated in case series in humans,[25,26] achieving excellent results in terms of root coverage; however, thickness parameters were not provided.

The 6 months results of the present investigation are comparable to those obtained by Wiesner et al.[5] with autologous connective tissue, even if the latter were measured 1 year after loading with possible further reabsorption of the graft. Another interesting study[27] compares the use of dermal acellular matrix to free gingival grafting in patients with absence or deficiency of keratinized tissue, obtaining results of increase in thickness with the acellular dermis comparable to the present investigation (1.17 ± 0.23 mm); however, significantly lower than the use of autologous graft (2.04 ± 0.26 mm). It should be noted that this latter mentioned study by de Resende et al.[27] used a dermal matrix of allogeneic origin not a xenograft.

The main objective of this study was to verify the possibility to increase the peri-implant soft tissue vertical thickness

through a non-invasive technique, without harvesting an autologous graft. This was achieved either with the use of dermal matrices of xenogeneic origin or using the “tenting" effect of a 2 mm healing abutment. The result of the present investigation indicates the limited effectiveness of this technique.

The major limitations of this study are the short duration of the follow up period and the lack of data concerning the marginal bone levels (MBL). These are preliminary results, data recording at longer follow up periods which include standardized radiographic controls in order to measure MBL are planned and already in progress.

In regards to the generalizability of the results of this study, given its multicentric nature and the homogenous results, it is likely to assume that different operators can obtain the same results using the same procedures.

5 | CONCLUSIONS

In conclusion, the preliminary results of this study indicate that a vertical tissue support technique using a "tenting" effect with a healing screw has limited efficacy to obtain a significant increase in soft tissue thickness. The use of a porcine dermal matrix at time of implant placement is effective to thicken peri-implant tissues.

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AUTHORS CONTRIBUTION

Verardi, Simone: clinical treatment of cases; measurements of cases treated by him, study plan; coordination of clinical centers; collection of data; manuscript revision. Orsini, Marco: clinical treatment of cases; measurements of cases treated by him. Lombardi, Teresa: clinical treatment of cases; measurements of cases treated by her; study plan. Ausenda, Federico: clinical treatment of cases; measurements of cases treated by him. Testori, Tiziano: clinical treatment of cases; measurements of cases treated by him. Pulici, Alessandro: clinical treatment of cases; measurements of cases treated by him. Oreglia, Francesco: clinical treatment of cases; measurements of cases treated by him. Valente, Nicola A: manuscript writing and review of statistical analysis. Stacchi, Claudio: clinical treatment of cases; measurements of cases treated by him; study plan; statistical analysis.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

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