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Research Article

Tomographic Assessment of Collagen Matrix and Connective Tissue Graft for the Treatment of Peri-Implant Defects in Humans

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Abstract

The aim of this study was to compare tomographically the increase in peri-implant tissue thickness with the use of collagen matrix (Mucograft® Geistlich) and conjunctive graft in anterior areas of the maxilla. Were selected 14 patients with unitary implants in function, located between teeth 14 and 24, who had peri-implant defects related to loss of vestibular tissue volume. Sete casos do grupo controle (GC) foram tratados com enxerto de conjuntivo; e 07 casos similares do grupo teste foram tratados com a matriz de colágeno (Mucograft®) (TG). Preoperative tomographic examinations were performed six months after the surgery. The soft tissue thickness assessment was performed at two points: 2 mm and 5 mm from the implant platform. When comparing the measurements between the two times (initial and final), there was a statistically significant increase in thickness in both groups ($p < 0.05$). It can be concluded that both techniques were effective in promoting the increase in thickness of the peri-implant mucosa, however, the conjunctive graft promoted a significantly greater increase.

Keywords: *Peri-Implant Defect; Autogenous Soft Tissue Graft; Mucograft® Geistlich*

Introduction

Dental implants currently have a high survival rate and are a very predictable procedure. In the same way that these rates have increased, the demand with the aesthetic result has also increased in the same proportion, and for these to be possible the manipulation of peri-implant soft tissues or the red aesthetic has become a fundamental factor for a successful clinical result [1,2].

The gingival biotype is a decisive factor in obtaining peri-implant aesthetic results [3-6], avoiding gingival recessions, which are the most common complications in osseointegrated implants, mainly [7].

The most used procedures in order to increase the volume of peri-implant tissue are grafts of free or connective tissue obtained from intra-oral areas, mainly of the patient's palate [7,8]. Despite presenting excellent results both in volume increase and in the quality of tissue peri-implantation, the autogenous grafts from the oral mucosa present the need for a donor area as a major disadvantage, increasing the morbidity of the technique and decreasing the acceptance of patients to the procedure [8-10].

Several gingival substitutes are presented in the current market and described in the literature, such as the acellular dermal matrix (Alloderm®), blood plasma derived growth factors, such as fibrin plasma and platelet plasma, of human origin, and more recently, porcine collagen matrix (Mucograf). Most of the research on these materials is aimed at root coverage where they present satisfactory results, often compared to the use of autogenous conjunctive grafts [11-17].

The use of these materials for implant rehabilitation has little documentation and the results are still controversial. The porcine collagen matrix associated with autogenous gingiva showed good results in tissue repositioning after extensive reconstructions, improving the soft tissue in quality and quantity [18].

Objective of the Study

The objective of this work is to tomographically evaluate the increase in soft tissues in the vestibular of implants, due to a deficiency in thickness of soft tissue, using the porcine plasma collagen matrix comparing with the conjunctive graft removed from the palatal mucosa.

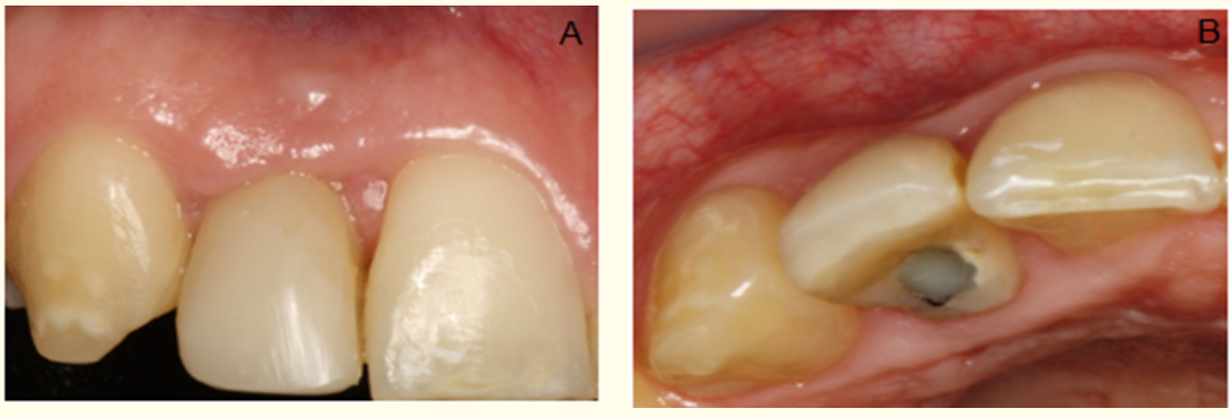
Methodology

This study is a controlled, randomized and prospective clinical study to evaluate the clinical behavior of the Mucograft collagen matrix as an option for the treatment of peri-implant defects in implants installed in the aesthetic region, with analysis and approval by the Research Ethics Committee from Universidade São Leopoldo Mandic and all patients agreed to participate in the study by signing an informed consent form.

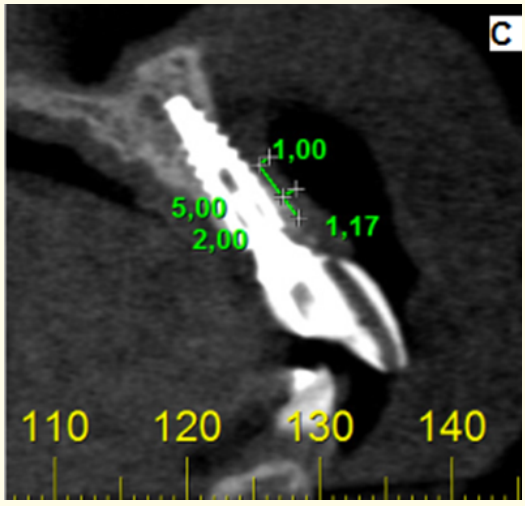
Selection of patients

Patients who had single implants in function, located between teeth 14 and 24, were selected, presenting soft tissue thickness defects on the vestibular surface of the implants. Diabetic patients, smokers, patients with some blood dyscrasia or with decompensated systemic disease, with a history of allergy to swine derivatives, poorly positioned implants, implants with bone loss above normal criteria that have previously undergone allogeneic bone or soft tissue grafts, who had absence of healthy teeth adjacent to the implant or who did not accept to participate in the research were excluded from the study.

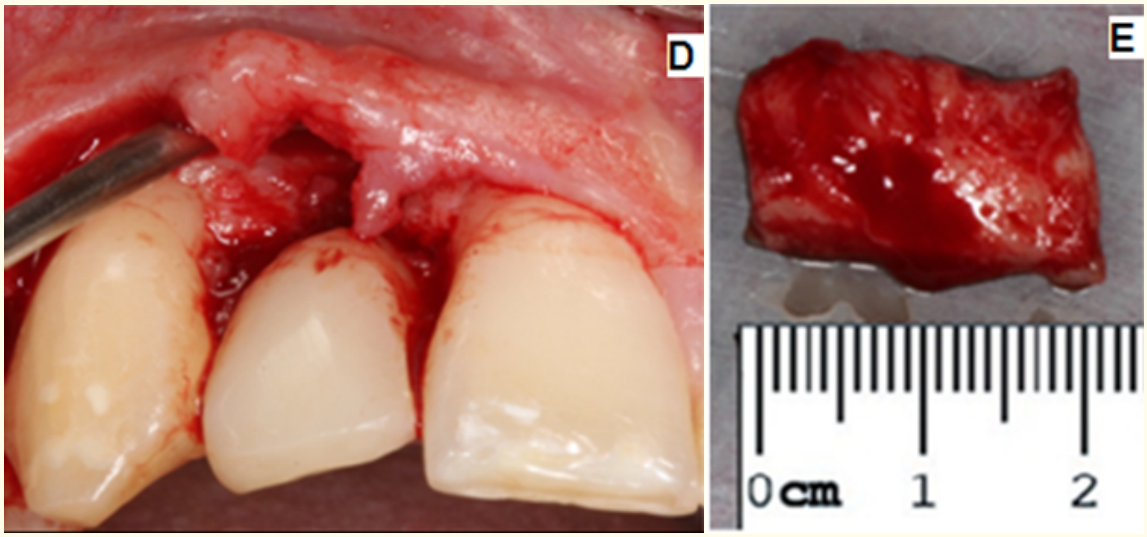
The patients who agreed to participate in the research were randomly divided into two groups, a control group that would perform the graft with connective tissue removed from the patient's own palate (Figure 1A-1J) and a test group, which would be submitted to the graft of Mucograft collagen matrix (Figure 2A-2J).



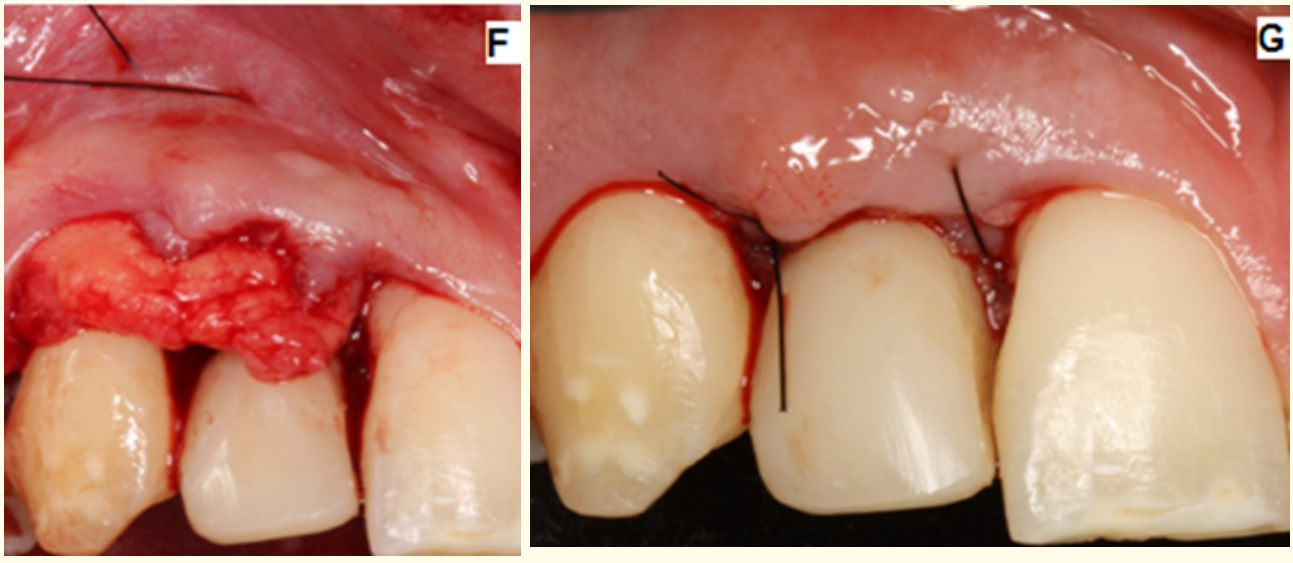
Caption: *A) Initial vestibular clinical view; B) Initial occlusal clinical view.*
Source: Own authorship.



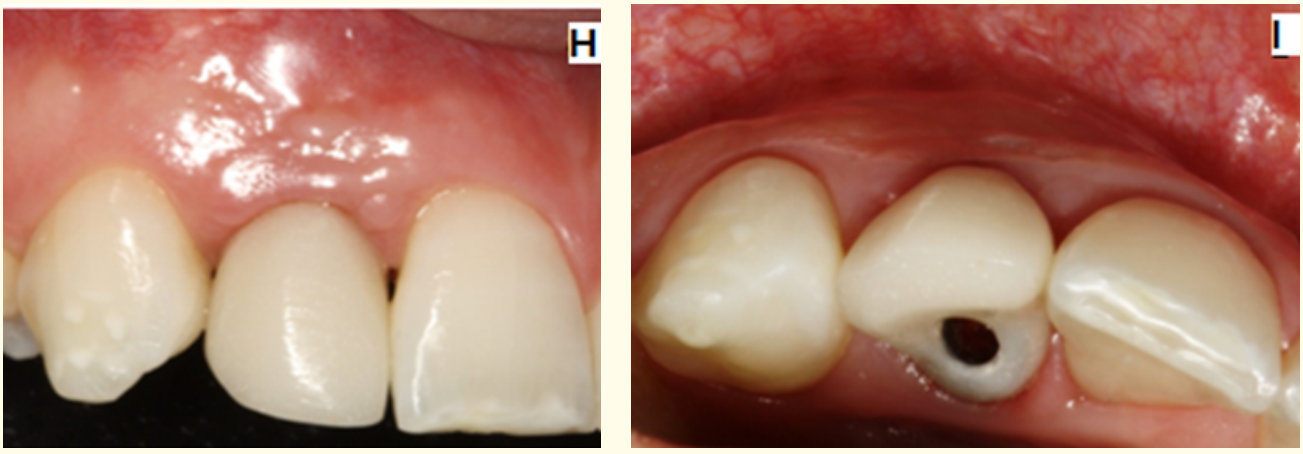
Caption: *C) Initial tomographic image.*
Source: Own authorship.



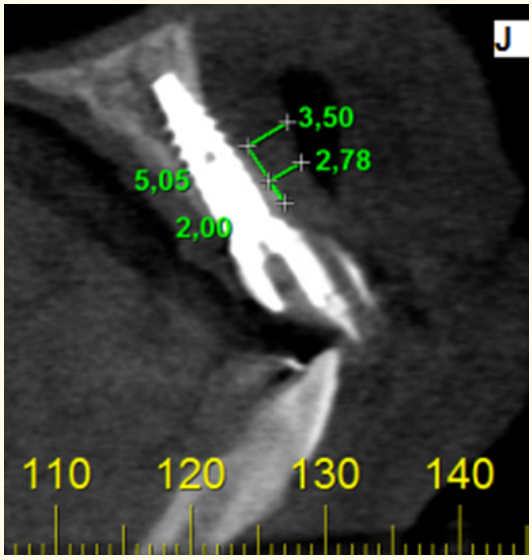
Caption: *D) Prepared flap; E) Connective graft removed.*
Source: Own authorship.



Caption: *F) Graft in position with suture; G) Flap stabilization with simple papillae sutures.*
Source: Own authorship.

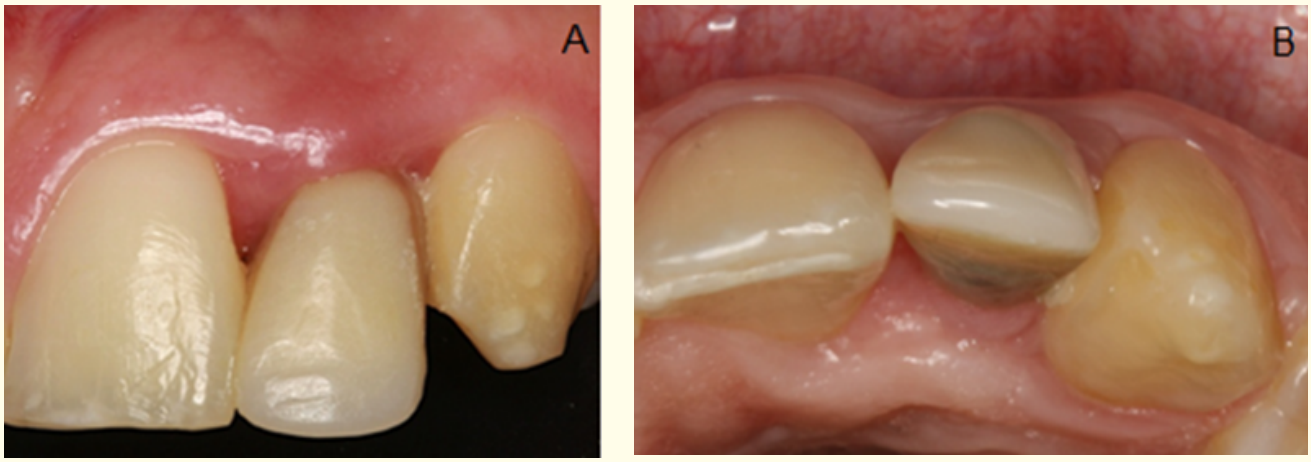


Caption: *H) Final vestibular clinical view (after 6 months); I) Final occlusal clinical view (after 6 months).*
Source: Own authorship.

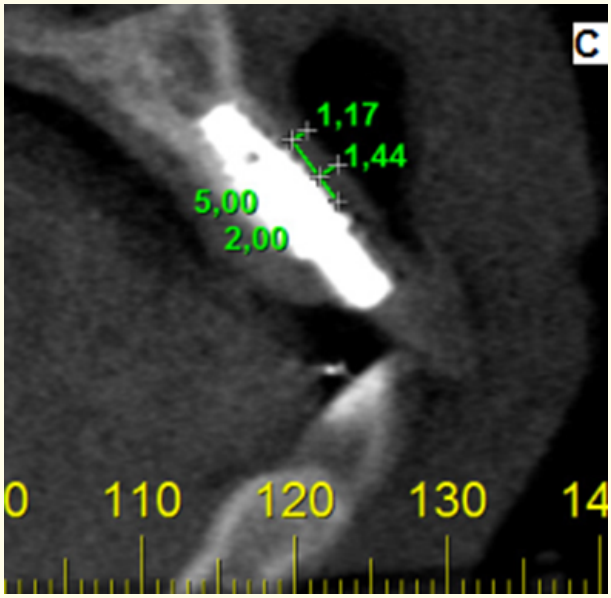


Caption: *J) Final tomographic image (after 6 months).*
Source: Own authorship.

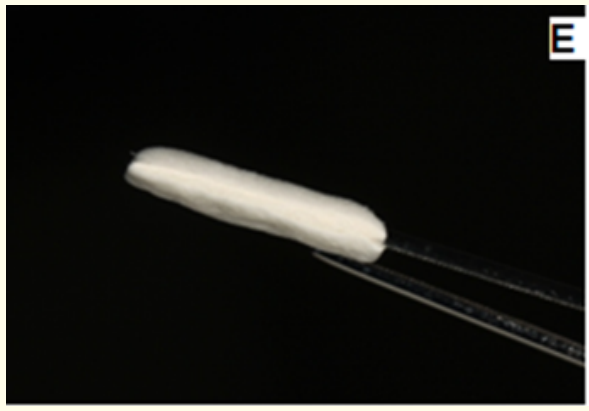
Figure 1A-1J: *Case of the control group (conjunctive graft). Implant nº 12.*



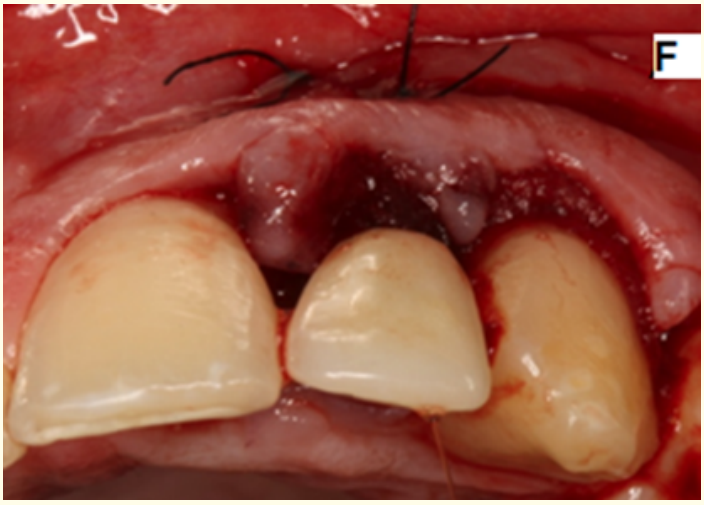
Caption: *A) Initial vestibular clinical view; B) Initial occlusal clinical view.*
Source: Own authorship.



Caption: *C) Initial tomographic image.*
Source: Own authorship.

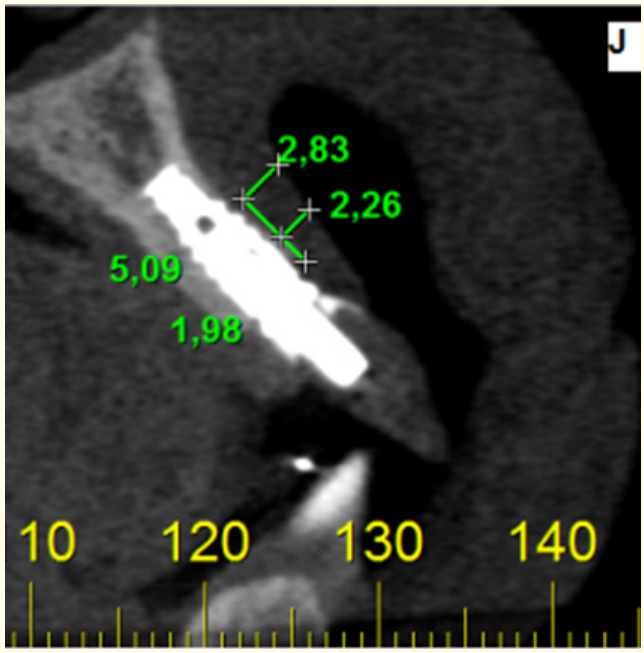


Caption: *D) Prepared flap; E) Collagen matrix.*
Source: Own authorship.



Caption: *F) Collagen matrix in position with suture; G) Flap stabilization with simple papillae sutures.*
Source: Own authorship.

Caption: *H) Final vestibular clinical view (after 6 months); I) Final occlusal clinical view (after 6 months).*
Source: Own authorship.



Caption: *J) Final tomographic image (after 6 months).*

Source: Own authorship.

Figure 2A-2J: *Case of the test control group (Mucograft® Geistlich collagen matrix). Implant nº 22.*

Patients who had more than one non-contiguous implant could be part of the research counting from the surgical beds. In these cases, one of the beds was part of the test group and the other of the control group.

Surgical procedure

The patients were also medicated with Cefadroxil 1g one hour before surgery (allergic patients will use Clindamycin 600 mg) and Dexamethasone 8 mg 2 hours before surgery, both orally. All procedures were performed under general anesthesia using 4% Articaine with adrenaline 1:100,000[1].

The surgeries were performed using the envelope technique with a linear intrasulcular incision with a 15C blade[2]**.** Afterwards, total flaps were detached with appropriate periosteal detachers for each case until a space was obtained to insert the conjunctive graft or

[1]DFL- Brazil.

[2]Trade mark.

matrix.

The removal of connective tissue from the palate was performed through a single incision with a 15C scalpel blade[3], perpendicular to the palatal bone approximately 3 mm from the cervical palatine margin of the teeth. The flap was divided, separating part of the conjunctive that was adhered to the epithelium and most of it adhered to the periosteum. Through incisions in the divided tissue and subperiosteal detachment the donor tissue was removed. This tissue contained subepithelial and periosteum connective tissue. The donor area was filled with collagen sponge[4] and sutured with suspending stitches with mononylon suture thread 4-0[5].

After the removal of the graft, it was modeled so that it was approximately the size of the swine matrix, mainly in thickness.

Both the conjunctive graft and the swine matrix[6] were inserted in the space created by the flap in the same way. A 5-0 mononylon suture thread[7] mounted on a needle was passed through the flap vestibular only once. Then, the same needle transfixed the graft from periosteum to conjunctive and in the matrix from the rough side to the smooth side, then transfixing the graft and matrix again from the reverse side. This same thread was passed again through the vestibular mucosa from the inner part to the outer part of the flap. This fixation helped in the positioning of the grafted materials and after positioning the stitch was concluded in a traditional way. Other stitches with the same type of suture were performed in order to fix the grafts to the flap and subsequently reposition the flap.

Antibiotic medication was maintained for 7 days, while patients used 100 mg Ketoprofen every 12 hours for 3 days. The patients were instructed to clean the area with a cotton swab dipped in Chlorhexidine Digluconate 0.12 solution for 15 days. After, a brushing with a small head brush indicated for patients in the postoperative period of oral surgeries was indicated.

Patients were evaluated clinically at 4, 7, 15, 30, 60, 90, 120, 150 and 180 days.

Results evaluation

Clinical evaluation: Absence or presence of inflammatory process, color and texture of the mucosa, absence of local hyperplasia and pathology, keratinized gingiva band, excess tissue or tissue loss were observed in the postoperative controls, compared to neighboring teeth.

Evaluation by images: All images were obtained by the same CT scanner and taken by the same professional. These were obtained through Cone Beam Computed Tomography with 0.2 mm voxel acquired in a small field, with axial and sagittal sections of 0.2 mm thick, transverse reconstructions with 1 mm thickness and panoramic reconstruction in the region between teeth 14 and 24 (Figure 1C and 2C).

The image evaluations were performed up to 7 days before the procedure (initial thickness) and 6 months after the soft tissue augmentation surgery (final thickness).

The measurements were performed using the software that performed the tomography.

[3]Trade mark.

[4]Collagen sponge.

[5]Ethicon.

[6]Mucograft.

[7]Ethicon

These measurements corresponded to the distance between the vestibular of the implants and the outermost point corresponding to the mucosa perpendicular to the implants at distances of 2 and 5mm below the cervical of the implants.

The difference between the initial and final measurements corresponded to the increase in tissue thickness in the vestibular of the implant (Figure 1J and 2J).

Statistical analysis

Prior to the statistical analysis itself, the Mann-Whitney test was performed for comparison between the initial group and between groups. The Wilcoxon Signed Rank test was used in the evaluation between the initial and final groups of each, considering 95% of significance.

Results

Fourteen implants installed in 12 patients were part of this work, ten of which were female and two male. Each patient had an implant with the exception of two patients who had two implants, which were not adjacent. The location of these implants, the diameter, type of connection and the shape of the prosthesis retention are shown in table 1 and 2.

Control Group				
Case	**Implant location**	**Implant diameter**	**Connection type**	**Prosthesis retainer**
01	Tooth 12	3.5	Morse	Screwed
02	Tooth 21	3.5	Morse	Cemented
03	Tooth 12	3.3	Morse	Screwed
04	Tooth 21	3.3	Morse	Screwed
05	Tooth 12	3.5	Morse	Screwed
06	Tooth 21	4.1	Internal hex.	Screwed
07	Tooth 21	4.1	External hex.	Screwed

Table 1: *Distribution of the implants of the control group regarding the location and diameter of the implant, type of connection and prosthesis.*

Caption: Numbering of teeth 12, 21; implant diameter 3.5; 3.3; 4.1; Morse and external hexagon connection: screwed and cemented. Source: Own authorship.

Test Group				
Case	**Implant location**	**Implant diameter**	**Connection type**	**Prosthesis retainer**
01	Tooth 22	3.5	Morse	Cemented
02	Tooth 14	3.3	Morse	Screwed
03	Tooth 22	3.5	Morse	Cemented
04	Tooth 21	3.5	Morse	Screwed
05	Tooth 22	3.3	Morse	Screwed
06	Tooth 11	4.1	External hex.	Screwed
07	Tooth 21	3.5	Morse	Screwed

Table 2: *Distribution of implants in the test group as to the location and diameter of the implant, type of connection and prosthesis.*

Caption: Numbering of teeth 12, 21, 14; implant diameter 3.5; 3.3; 4.1; Morse and external hexagon connection: screwed and cemented Source: Own authorship.

Clinically, none of the cases evaluated showed signs of local inflammation after the healing period.

The initial thickness of the mucosa was 1.3 ± 0.29 mm in the test group, and 1.21 ± 0.74 mm in the control group (P > 0.05). In 5mm, the initial thickness of the test group was 1.56 ± 0.30 mm, and in the control group, 1.50 ± 0.59 mm (P > 0.05). These values ensured homogeneity in the sample selection (Table 3).

Group	Initial 2 mm	Final 2 mm	Augmentation	Initial 5 mm	Final 5 mm	Augmentation
Test	1.3^{A} (0.29)	1.81^{B} (0.78)	0.51 (0.52)	1.56^{A} (0.30)	2.3^{B} (0.42)	0.74 (0.48)
Control	1.21^{A} (0.74)	2.58^{B} (0.64)	1.37* (0.79)	1.50^{A} (0.59)	3.10^{B} (0.63)	1.60* (1.06)

Table 3: *Measurements (mean and standard deviation, in mm) of the initial and final measurements (2 and 5 mm) of the mucosa thickness in the test and control groups (Mann-Whitney test and Wilcoxon Signed Rank test).*

Caption: (*) statistically significant difference between groups. Different letters indicate a statistically significant difference between the initial and final times.

Source: Own authorship.

The increase observed in both groups and in both measures was statistically significant, so both the material used in the test group and the control group showed an increase in tissue thickness, which was the initial objective of the study (Table 3). But when we compare the increase obtained with the test group and the control group, the results of the control group were significantly higher (Table 3).

Discussion

For a long time implantology was concerned only with increases in bone tissues in order to install implants in prosthetically favorable positions. Despite the enormous importance of these procedures, when used alone, they are not a guarantee of aesthetic success and longevity in implant treatments.

The quality and quantity of peri-implant mucosa is fundamental to obtain aesthetic results that mimic natural teeth. The gray color of titanium can create a problem, even after successful osseointegration, when it becomes visible due to the peri-implant soft tissue recession [7]. Another frequent problem is peri-implant gingival recession. The physiological remodeling process following the implant placement, as well as the vestibular positioning of the implant can also contribute to the occurrence of peri-implant tissue recessions [7,19]. The periodontal biotype is a significant factor for the success of the treatments since the thickness and the contour of the tissue are essential diagnostic factors to consider for a good aesthetic result of an implant-supported restoration [4,6,20].

As few patients have thick biotypes, sub-epithelial grafts are performed more and more frequently [6,20] and the main source of tissue donor is the palatal mucosa [6-8,20].

Despite presenting good clinical results, this technique has a high morbidity in the donor region, which often makes patients not accept or have restrictions on this treatment option [7,8,10].

The conjunctive matrix of porcine origin (Mucograf) presents itself as an alternative to the use of the conjunctive graft, avoiding the need to remove tissue from the palate which would decrease the morbidity of the treatment, increasing the patient acceptance index [11-14].

Histopathological evaluations after six months showed a safe interaction of the matrix with the surrounding tissue, without any signs of inflammation and the achievement of a significant increase in the thickness and width of the keratin tissue [11,15].

Randomized clinical studies have indicated that the collagen matrix can result in a significant band of keratinized gingiva, both in teeth and in implants after 6 months of healing when compared to the conjunctive graft. In addition to the short time required for the surgical procedure in the group treated with the matrix, patients who received the conjunctive graft reported significantly higher postoperative morbidity [11,15,19].

Some authors claim that in order to obtain the desired keratinized mucosa, the entire matrix must be surrounded by keratinized tissue [17,21]. For this reason, more recently, some authors have associated the porcine collagen matrix with autogenous gingiva for tissue repositioning in major bone reconstructions [17].

Few studies are available to increase peri-implant tissues, mainly with the objective of increasing the volume of peri-implant tissues for aesthetic purposes, which justifies the accomplishment of this research.

The improvement of imaging exams allows a fairly accurate assessment of peri-implant soft tissue measurements. The change in exposure and the removal of the upper lip allow the measurement to be quite real [22-24].

The decision to take measurements at two fixed points had the objective of evaluating in a more aesthetic area (2 mm) and an area where gain is normally easier (5 mm) but which has less implication in the aesthetic result.

The case selection criteria sought to minimize the influence of factors to achieve more accurate results. The option for implants already rehabilitated with temporary prostheses is that the peri-implant tissues already had dimensional stability, thus there is no interference in the grafts performed [1,2].

Despite strict criteria, some factors could have directly influenced the behavior of the grafts. Cemented prostheses are usually the result of implants positioned more towards the vestibular, which would limit tissue augmentation [5]. Cases 1 and 3 in the test group and 2 in the control group were performed on cemented prostheses. Case 3 of the test group was the case that presented the lowest augmentation in this group, whereas in case 1 of the same group, the augmentation was the second largest obtained in the measure of 2 mm. In case 2 of the control group, the augmentation was the second smallest treated with conjunctive. Despite the small augmentation, we must consider that the initial thickness was the largest in the group and the final thickness was the second largest obtained also in 2 mm. In the measurements made in 5 mm, there was also no difference between the types of prosthesis. These results do not allow to confirm the expectation that the type of prosthesis influences the increase in the thickness of the mucosa. This interpretation must be carried out with caution since it was not the main objective of the study and the number of cemented prostheses was much lower than screwed prostheses.

Another factor is the diameter of the implants. Small diameter fixations have a greater amount of tissue or greater need for vestibular reconstruction [25]. In this study, only 3 implants were of regular diameter, while all the others were of reduced diameter. In the control group, contrary to expectations, the two implants (cases 6 and 7) showed the greatest augmentations in 2 mm, while the case of the test group (case 6) showed an increase in thickness within the group average also by 2mm. In the measurements made in 5mm there is also no difference in thickness augmentation.

Despite presenting an increase in the thickness of the mucosa, the augmentation obtained by the porcine collagen matrix, the amount obtained was small and significantly less than the autogenous grafts, which would make its use unfeasible in most cases. A next evaluation can be performed with the use of two overlapping matrices in an attempt to increase the thickness gain.

Even though this was not the objective of the study, an average increase of 4 to 5 mm in the range of keratinized mucosa was observed, confirmed by the increase in tomographic density in postoperative images.

Despite presenting a lower morbidity, the use of Mucograft does not seem to be indicated for the treatment of large peri-implant defects, but it can be used as an alternative to increase the range of keratinized mucosa and the quality of peri-implant mucosa.

Conclusion

Within the limitations of this study, that both techniques were effective in promoting the augmentation in thickness of the peri-implant mucosa, however, the conjunctive graft promoted a significantly greater augmentation.

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