

Soft tissue behavior around dental implants placed in fresh extraction sockets and immediately restored in esthetic area: a preliminary short-term evaluation

Comportamento dos tecidos moles ao redor de implantes instalados em alvéolos frescos e imediatamente restaurados em área estética: uma avaliação preliminar a curto-prazo

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Resumo

Objetivo: Avaliar o comportamento do tecido gengival após a instalação de implantes imediatos em função imediata, por meio de (1) medidas clínicas diretas de altura e espessura da margem de tecido mole peri-implantar, (2) medidas de altura gengival em fotografias, e (3) percepção de profissionais da área de odontologia em relação a parâmetros estéticos. **Material e método:** O estudo incluiu 8 pacientes com incisivo central ou lateral indicados para extração. Medidas diretas de altura e espessura da margem de tecido mole peri-implantar foram realizadas imediatamente antes da extração (T0) e 1 (T1), 4 (T2), 8 (T3) e 12 (T4) meses após a instalação de implante sem abertura de retalho. Fotografias foram tiradas nos mesmos tempos. Um questionário foi respondido por Implantodontistas em relação à percepção visual dos mesmos sobre coloração, arquitetura da margem de tecido mole peri-implantar e harmonia na região do implante usando fotografias obtidas no T4. **Resultado:** Os resultados clínicos mostraram alterações significativas na altura da margem de tecido mole peri-implantar, mas nas fotografias não foi observada diferença estatisticamente significativa para essa mesma medida. A espessura da gengiva inserida se manteve durante todo o período de observação. Dos profissionais entrevistados, 35,2% observaram coloração alterada na região do implante, 39,8% identificaram alteração na arquitetura da margem de tecido mole peri-implantar e 12,5% alteração na harmonia da margem de tecido mole peri-implantar. **Conclusão:** Os tecidos moles ao redor de implantes imediatos sofreram alterações durante o período estudado, mas não afetaram o resultado estético e na opinião dos profissionais os resultados foram satisfatórios.

Descritores: Implantes dentários; maxila; estética.

Abstract

Objective: To assess the behavior of the peri-implant soft margin after immediate implant placement with immediate function, by (1) direct clinical measurements of peri-implant soft margin height and thickness, (2) measurements of peri-implant soft margin height on photographs and (3) the perception of dental professionals regarding the results considering esthetic parameters. **Material and method:** The study included 8 patients with central or lateral incisors indicated to be extracted. Direct measurements of peri-implant soft margin height and thickness were done immediately before extraction (T0) and 1 (T1), 4 (T2), 8 (T3) and 12 (T4) months after the flapless insertion of the implant. Photographs were taken at the same time intervals. A questionnaire was filled in by implantology professionals regarding their visual perception of color and peri-implant soft margin architecture and harmony in the implant region using the photographs obtained at T4. **Result:** The clinical results showed significant changes to the height of the peri-implant soft margin, but the photographic results did not show significant changes for this measurement. The thickness of the attached gingiva was maintained during all the observation period. Of the professionals interviewed, 35.2% noticed an altered peri-implant soft margin color of the implant region, 39.8% noticed a change in the peri-implant soft margin architecture and 12.5% noticed a change in the peri-implant soft margin harmony. **Conclusion:** The soft tissues around immediate implants changed during this period, but did not affect the aesthetic outcome and in the opinion of professionals, the aesthetic results were satisfactory for these cases.

Descriptors: Dental implants; maxilla; esthetics.

INTRODUCTION

Over the last two decades there have been significant developments in implantology, with a revolution in the concepts of rehabilitative treatment. Thus, patients previously considered “mutilated” can now have an improved quality of life through the use of osseointegrated dental implants to resolve edentulism, in an effective and promising manner¹. During this period, the success of rehabilitations was based on peri-implant health and masticatory function, but did not take peri-implant aesthetics into account. The initial treatment protocol proposed by Brånemark was divided into a surgical phase (during which the implants were installed), an osseointegration phase of 3 to 6 months, followed by a prosthetic phase^{1,2}.

With the advancement of research, implantology has gained credibility and acceptance by the scientific community and dental implants can now be used for partial and single rehabilitations³. Currently, a less-invasive⁴ approach is practiced in implantology due to the better understanding of bone biology and the development of new implants with surfaces that produce a better and quicker bone and peri-implant soft margin response, accelerating the rehabilitation. Thus, implants with immediate loading can be used in the majority of total, partial and even single rehabilitations³⁻⁶.

Studies have focused on immediate rehabilitations in the anterior region, to help surgeons find the best approach when restoring single teeth, in order to produce a good aesthetic result for patients with gingival smile^{3,5-8}. The aesthetics of peri-implant tissues have improved with new implant designs, such as Morse type prosthetic connections, biomaterial grafting techniques, subepithelial connective tissue grafting⁷, pre-surgical CT scans⁹ and surgical techniques developed for better bone and peri-implant soft margin biological responses¹⁰. Among these techniques, flapless surgery to install the implant in the correct three-dimensional position combined with initial stability and the placement of a temporary crown with a suitable contour, are factors that are required for clinical success^{8,11}.

One important factor in this type of therapy is the preservation of bone tissue after tooth removal and implant installation. Some studies have reported an absence of bone preservation¹² and loss of the peri-implant soft margin architecture with implant placement in fresh alveoli, but other studies have contradicted this¹³.

Because the immediate replacement of compromised anterior teeth using the fresh alveolus is increasingly practiced, this technique requires that the surgeon and prosthodontist have a certain degree of experience and technical-scientific knowledge. In addition to installing the implant with effective anchoring, the professionals must use customized pillars¹⁴ and place a provisional restoration with adequate anatomy and an emergence profile that favors and improves the aesthetics of the peri-implant soft tissues^{8,15}. Often there is also the need for both a biomaterial graft and a connective tissue graft in the buccal aspect of the alveolus with the purpose of maintaining the volume of buccal tissue¹⁶. A Morse taper implant and *switch* platform prosthetic connection must be used to promote the increase of soft tissue, improve tissue stability and, thus, optimize the peri-implant aesthetic result⁸.

Therefore, the aim of this prospective preliminary study was to assess the behavior of peri-implant soft margin tissue after immediate implant placement with immediate function. Two clear evaluations

were proposed: (1) clinical measurements of peri-implant soft margin height and thickness and (2) measurements of peri-implant soft margin height using photographs. A subjective evaluation, the perception of dental professionals regarding the results considering esthetic parameters (color, architecture and harmony), was also proposed.

MATERIAL AND METHOD

This prospective study was approved by the College Dom Bosco Ethical Committee (Number 734.782). It pertains to eight consecutive patients with one maxillary anterior tooth indicated for extraction and the adjacent teeth in good periodontal health. Inclusion criteria were good oral hygiene and adequate bone volume for immediate implant placement. Patients were excluded from the study if they had: an active infectious process in the future implant region; a medical history that might interfere with the results of the study (alcoholism, smoking and illicit drug use); bruxism or parafunctional habit; undergone additional trauma during extraction; and low bone quality that could compromise the primary stability of the implant.

Eight Morse taper implants (Drive Acqua Morse taper - Neodent-Curitiba/PR, Brazil) were installed (1 central incisor and 7 lateral incisors). The extractions were carried out in a minimally traumatic manner using an extractor device. The implants were installed in the lingual alveolar wall in order to obtain initial stability. Afterwards, the intermediate was selected and installed. The interim restoration was made and before cementation, a biomaterial (Beta Tricalcium Phosphate) was inserted in the vestibular gap. The implants were selected according to the tooth involved, and the local bone availability. For the central incisor, the implant used was 3.5 x 13 mm and for the lateral incisors the diameter was 3.5 mm and the lengths varied from 11 mm (1), 13 mm (5) and 16 mm (1), considering the need to obtain initial stability.

Clinical Measurements of Attached Gingiva Thickness and Height

The attached gingiva line was determined by applying pressure to the tissue from the mucosa towards the cervical area of the tooth to locate the start of the ischemic area. Peri-implant soft margin thickness was measured by using an endodontic file with a cursor and the height of the attached gingiva was measured using a periodontal probe with cursor, both with the aid of a millimeter ruler (Figures 1A and B). The thickness was measured at the mid-point between the cervical limit of the free peri-implant margin and the apical limit of the attached peri-implant margin. The patients were clinically evaluated immediately before tooth extraction (T0) and 1 month (T1), 4 months (T2), 8 months (T3) and 12 months after implant insertion (T4). The same calibrated researcher did all the measurements.

Operator Error

The measurements of height and thickness of the tissue were carried out at five observation periods, on a monthly basis, by the same operator. Data were recorded, tabulated and received statistical

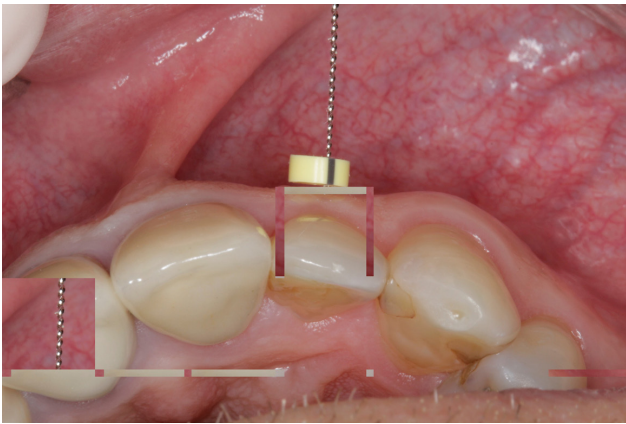


Figure 1A. Peri-implant soft margin thickness was measured by using an endodontic file with a cursor.

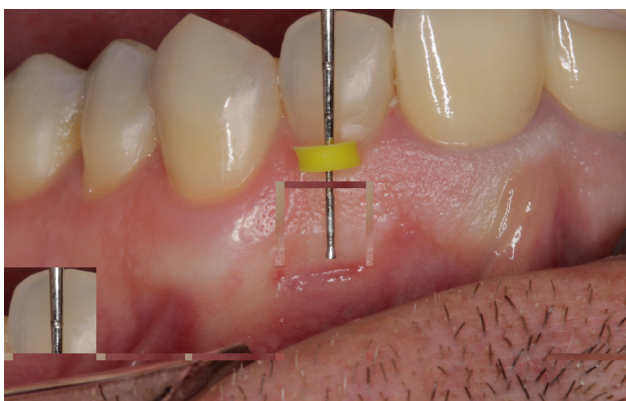


Figure 1B. Peri-implant soft margin height of the attached gingiva was measured using a periodontal probe with cursor.

treatment. For the photographs the operator was calibrated to mark the points the measurements were statistically treated to check the operator error. The operator error was not statistically significant.

Photograph Measurements of Peri-implant Soft Margin Height

A device was used to position the patients' heads and the position was standardized in all the photographs, which were taken by a single operator (Figure 2). A Canon digital camera, with a 100mm Canon, macro, f 2.8 lens was used. The position of the camera was also standardized using the device mentioned above, since it has space for attaching the tripod, to establish the height and focal length of the camera. The photos were carried out at the same observation periods described above.

In order to do the measurements, the photos taken at T0 were used to register the deepest portion of the gingival curvature (zenith) of the canine teeth (C), and the tip of the cusps in the canines. Lines that united the following were drawn: the two points that correspond to the deepest portion of the gingival curvature of the canine teeth (L1); point corresponding to the deepest portion of the gingival curvature of the C tooth to the point corresponding to the cusp of the right tooth C (L2); point corresponding to the deepest portion of the gingival curvature of tooth C to the cusp the left tooth C (L3) (Figure 3). These lines were drawn on a computer in Power Point, using the Shapes tool.



Figure 2. The position of the camera was also standardized using the device, since it has space for attaching the tripod, to establish the height and focal length of the camera.

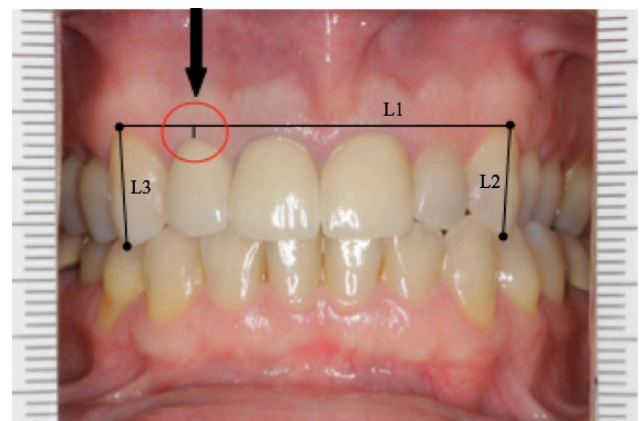


Figure 3. In order to do the measurements, lines were draw - horizontal line (L1), verticals lines (L2) and (L3).

The angle and length of each of the lines were recorded using PowerPoint software (Shapes tool) at all observation periods, to ensure the reproducibility of the reference structures.

Perception of Dental Professionals

Eleven professionals of implantology were invited to participate on the study.

Photographs of patients (T0 - before surgery and T1 - 12 months after implant insertion) were transferred to a Tablet and the evaluators analyzed each photo before answering a questionnaire containing 3 questions regarding the results considering esthetic parameters (color, architecture and harmony).

Statistical methods

The results were described as means, medians, minimum and maximum values, and standard deviations (quantitative variables) or as frequencies and percentages (qualitative variables). ANOVA was

used to compare the means of variables. Non-parametric Friedman test was used to compare consecutive evaluation of gingiva height and thickness. P-values <0.05 were considered statistically significant. Data were analyzed with the computer program IBM SPSS v.20.0.

RESULT

Clinical Measurements of Attached Gingiva Height and Thickness

It was tested the null hypothesis that the means were equivalent in all the observed times. The descriptive statistics according to the observed times are described in Table 1.

Considering that there was a statistically significant difference for gingiva height specific comparisons in pairs were obtained (Table 2).

Photograph Measurements of Gingiva Height

The null hypothesis of equal means at all observation periods was tested. Table 3 shows the mean peri-implant soft margin height according to the observation period.

Perception of Dental Professionals

Table 4 presents, for each case, the frequencies and percentages of evaluators regarding their perception of changes in color, architecture and harmony.

Table 1. Descriptive and comparative analysis of clinical measurements of gingiva height and thickness

Moment of evaluation	Gingiva height						P*
	n	Mean	Median	Minimum	Maximum	SD	
T0	8	5.38	6.0	2.0	9.0	2.26	
T1	8	5.19	6.0	2.0	8.0	2.10	
T2	8	5.13	6.0	2.0	8.0	2.17	
T3	8	4.88	5.3	2.0	8.0	2.05	
T4	8	4.81	5.3	2.0	8.0	2.02	0.002
*ANOVA, p<0.05							
Moment of evaluation	Gingiva thickness						P*
	n	Mean	Median	Minimum	Maximum	SD	
T0	8	1.94	2.0	1.5	2.0	0.18	
T1	8	1.94	2.0	1.5	2.0	0.18	
T2	8	1.88	2.0	1.5	2.0	0.23	
T3	8	1.91	2.0	1.5	2.0	0.18	
T4	8	1.89	2.0	1.5	2.0	0.18	0.637

SD: standard deviation; *Non-parametric Friedman's test, p<0.05.

Table 2. p values comparing the observation periods in pairs

Comparisons	P value***
T0 x T1	0.300
T0 x T2	0.108
T0 x T3	0.001
T0 x T4	<0.001
T1 x T2	0.551
T1 x T3	0.008
T1 x T4	0.001
T2 x T3	0.031
T2 x T4	0.005
T3 x T4	0.457

***Non-parametric Friedman's test, p<0.05.

Table 3. Descriptive and comparative analysis of photograph measurements of gingiva height

Moment of evaluation	Gingiva height						p value*
	n	Mean	Median	Minimum	Maximum	SD	
T0	8	0.48	0.4	0.0	1.1	0.42	
T1	8	0.46	0.4	0.0	1.0	0.33	
T4	8	0.50	0.3	0.2	1.2	0.39	0.507

SD: standard deviation; *Non-parametric Friedman's test, $p < 0.05$.

Table 4. The frequencies and percentages of evaluators regarding perception of changes in color, peri-implant soft margin architecture and harmony

Case	Number (percent) of the evaluators that perceived and alteration		
	Color	Architecture	Harmony
1	1 (9.1%)	4 (36.4%)	1 (9.1%)
2	6 (54.5%)	5 (45.5%)	0 (0%)
3	5 (45.5%)	3 (27.3%)	0 (0%)
4	10 (90.9%)	8 (72.7%)	1 (9.1%)
5	0 (0%)	1 (9.1%)	3 (27.3%)
6	0 (0%)	1 (9.1%)	2 (18.2%)
7	1 (9.1%)	4 (36.4%)	2 (18.2%)
8	8 (72.7%)	9 (81.8%)	2 (18.2%)
Mean	35.2%	39.8%	12.5%
Median	27.3%	36.4%	13.6%
Minimum	0%	9.1%	0%
Maximum	90.9%	81.8%	27.3%
SD	35.5%	26.6%	9.6%

DISCUSSION

Some factors are crucial for successful treatment with immediate implants in the fresh alveoli of an aesthetic region, such as: the gingival biotype and the thickness of the buccal bone^{8,11,17}. Other technical features must also be prioritized, such as a minimally traumatic extraction, which can be carried out using extractor devices, for example⁴; the use of implants with Morse type connection and *switch* platform, which minimize the formation of biofilm and prevent micromovements¹⁸; and the use of smaller-diameter implants, thus maintaining maximum vascularization and nutrition in the bone bed¹⁹. Considering the position of the implant, an anchorage in the palatal wall of the alveolus, for the purpose of primary stability and creating distance between the implant and the buccal bone^{8,18,20} is generally considered for better results. When the buccal gap between the body of the implant and the remaining bone wall is greater than 2mm, grafting with a biomaterial²¹ and also soft tissue grafts, are recommended with the aim of maintaining volume and improving the buccal contour²². Finally, it can also be considered obtaining an adequate primary stability, ensuring prosthetic loading²⁰; installation of definitive transmucosal component, to avoid its replacement and consequent disruption of tissues; and the installation of the

provisional with an appropriate format and maintaining it until the maturity and stability of bone and gingival tissue¹⁹.

In light of all these technicalities, some studies show aesthetically satisfactory results regarding tissue stability²³. However, other studies differ and show just a small number of cases with excellent clinical results^{5,17}. In this study, the thickness of the surrounding soft tissues did not change significantly throughout the observation period ($p=0.637$). Nevertheless, there was a significant decrease in the peri-implant soft margin height ($P < 0.05$) when comparing T0 (5.38 ± 2.26 mm) to T3 (4.88 ± 2.05 mm) and T4 (4.81 ± 2.02 mm). Significant decrease was also observed from T1 (5.19 ± 2.10 mm) to T3 and T4, and from T2 (5.13 ± 2.17 mm) to T3 and from T2 to T4. However, the peri-implant soft margin height did not alter significantly ($p=0.507$) when evaluated using photographs before surgery for the installation of the immediate implant (T0: 0.48 ± 0.42 mm), right after surgery (T1: 0.46 ± 0.33 mm) and at the final observation period (T4: 0.50 ± 0.39 mm).

The methodological variation must be taken into account in the results of peri-implant soft margin height in this study. We understand that the photographic methodology was more accurate, both in terms of obtaining the photos and in terms of linear measurements, because it used precise software. Thus, in this

study, the peri-implant soft margin height that was evaluated from photography had no significant change ($p > 0.05$), and it can be considered more precise, which would justify the visual perception of harmony by the evaluators.

Because a good aesthetic result is important in cases of immediate replacement of anterior teeth, the volume and buccal gingival margin, position of the gingival zenith, as well as the presence of mesial and distal papillae are important anatomical factors for a harmonious smile. In this study, peri-implant soft margin areas that received Cone Morse type immediate implants were perceived to have some aesthetic variation in color (35.2%) and architecture (39.8%). However, in general, the harmony of the smile was not impacted, as only 12.5% of evaluators considered that there was some disharmony in the cases. It must be taken into consideration that the sample of patients had considerably compromised dental aesthetics at the beginning of treatment, so this percentage represents a relevant improvement in the harmony of the smile.

The stability of soft tissue is more favorable when, in addition to taking the appropriate surgical and prosthetic steps, patients present a thick gingival biotype¹¹ and the remaining buccal bone is also thick⁹. The gingival biotype is often difficult to qualify visually, with little clinical reliability, so measuring the thickness of the mucosa during surgery is the most reliable method²⁴.

The final aesthetic result is highly important, along with the satisfaction of the patient regarding the outcome of treatment. In a survey of patient satisfaction with the aesthetic results of immediate implants, patients reported that they were fully satisfied with the treatment and the dental evaluators who were also questioned, approved of the results²⁵.

Many dental professionals are capable of installing implants in fresh alveoli¹⁸, however, the maintenance of the soft tissue is unpredictable, because the bone tissue undergoes remodeling after tooth extraction, and the changes in the gingival margin will occur regardless of the installation¹⁵, compromising the outcome of pink aesthetics. The gingival biotype in these cases is also relevant, because it contributes to maintaining the gingival thickness and architecture, even when there are changes in the buccal bone, according to some studies⁶. Clinical change in gingival height can be attributed to the decrease in height and thickness of the buccal bone, as can the perception of gingival color change.

In this study, the soft tissues around the immediate implants that were placed in an aesthetic region of the mouth changed in height but not in thickness during the study period. However, the change to the soft tissues were not significant in terms of perception of gingival color, architecture and harmony, according to the opinion of the professional evaluators.

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CONFLICTS OF INTERESTS

The authors declare no conflicts of interest.

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