Preservation of Socket Volume through Xenografting, Immediate Implant Placement and Restoration: A 1- Year Case Series.

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Abstract

## Objective

The purpose of this study was to prospectively evaluate the dimensional thickness changes of peri-implant buccal tissues following extraction combined with immediate implant placement, bone and soft tissue augmentation, and immediate provisionalization, at 1 year post-op using a new, non-invasive method for thickness measurement.

## Method and Materials

Five patients were selected and treated with the forementioned purpose in mind. In each of the 5 patients a premolar tooth was extracted and immediately replaced surgically with an implant and a screw retained provisional crown. The gap between the implant and the buccal bone was filled with Bio-Oss Collagen®, and an extra-cellular biologic membrane was grafted with a pouch technique, without raising a flap, as an alternative to an autogenous connective tissue graft. An impression was taken prior to tooth extraction and at 1 year post-surgery. The 2 sets of stone casts were registered with a digital optical scanner, and then digitally superimposed using CAD-software technology to compare the soft tissue thickness variation in 6 fixed points.

Results

The 5 patients in this report were re-evaluated at 1 year post-surgery. A small average reduction of vestibular tissue thickness, with a mean value of -0,595 mm was found when measuring all points.

Conclusions

The average measurements were almost ~~a~~ll negative, demonstrating a minimal variation in the tissue thickness in all of the six marked points. Despite this finding the quality of the soft tissue was pleasant with a well-keratinized mucosa and a very natural and healthy appearance.

Key words: Dental Implants, Esthetics, Esthetic Surgery, Immediate Dental Implant Restoration, Membranes, Socket Volume.

Introduction

Modern osseointegrated implant dentistry was conceived to rehabilitate totally edentulous arches through the use of implants. Historically, its only purpose was to restore a correct masticatory function with fixed hybrid prostheses in areas where there was a sufficient amount of bone, and without fully taking into consideration the esthetic needs of the patient.(1)

More recently, the dental patient’s requests and esthetic expectations have considerably increased especially with regards to conventional and implant prostheses. In implant prostheses the peri-implant soft tissue quality and thickness is one of the most important factors influencing the esthetic result. Peri-implant mucosa if treated with an adept technique and correct materials is capable of maintaining a truly natural looking final appearance.(2)

The structure and the function of the peri-implant tissue has been studied in several investigations.(3-6) When compared with the gingiva surrounding natural teeth, it is possible to determine several affinities both anatomical and histological in nature. In fact, both gingiva and the peri-implant mucosa, in ideal conditions of health, have a pink color, a good consistency and are both well keratinized showing an anatomical continuity between the epithelial tissue and the supra-alveolar connective tissue. The main difference reported relates to the distribution of the collagen fibers, which in the peri-implant tissue run almost parallel to the implant without any real anchorage but only with a smooth adhesion. Nevertheless, connective tissue is esteemed to be very important for the support of the epithelial tissue and to limit its apical migration, thus avoiding possible peri-implant pockets from forming and/or tissue recession.(7)

It is essential for the clinician to improve and maintain the quality and stability of peri-implant soft tissues, not only for aesthetics but also for the long-term prognosis of the implant.

In order to assess the aesthetic result the profile of the peri-implant soft tissue has to be taken into consideration. Various parameters are considered when rating aesthetics of implant-supported single crowns and adjacent soft tissues, including and not limited to: the peri-implant papilla, the buccal parabola position and contour, and the texture and thickness of the buccal mucosa.(8,9)

The maintenance of the papilla is relatively easy in immediate post-extraction implants, provided that the proximal bone peaks are well preserved. On the other hand, in cases where the tooth was previously extracted, one may perceive a flattening of the ridge with consequent impairment of an ideal papillary anatomy. In fact, over the years various techniques have been proposed to correct the problem of the lack of peri-implant papillae, but to date methods are difficult and not very predictable.(10)

Another challenge lies in obtaining a peri-implant parabola identical to that of the natural adjacent elements especially with respect to the prominence. Unfortunately, the vestibular bone is very often resorbed following tooth extraction irrespectively of the placement of an immediate or delayed implant. Thus, in order to obtain true aesthetic success, in addition to placing an implant in a correct position, it is important to preserve the buccal bone plate as much as possible or to regenerate it if needed. In addition, an increase in the thickness of the overlying soft tissue with a connective tissue grafting techniques can contribute in obtaining ideal esthetics.

The modification of the peri-implant soft tissue~~s~~ resulting from the insertion of an implant has been examined by several studies. Many of these came to the conclusion that just following prosthetic restoration the peri-implant parabola may recede from 0.6 mm to 1.5 mm. Small and Tarnow showed that 50% of the recession is seen as early as one month following restoration and 90% is reached within the first three months, with stabilization at nine months. (11) Kan et al. (12) in a more recent research confirmed the same results.

Soft tissue augmentation using autogenous grafts is a widely used procedure to increase soft tissue volume around dental implants predominantly for esthetic reasons. Unfortunately, using autogenous tissue does have some disadvantages due to the second surgical donor site. In order to overcome this difficulty research activities have focused on the development of alternative techniques and materials. Thoma et al. tested soft tissue augmentation with a collagen matrix in comparison to conventional autogenous subepithelial connective tissue grafts.(13)

Aim

The aim of this study was to evaluate the stability of the buccal root bump (root bump preservation, RBP) around post-extractive, immediately restored implants, connected with a concave design abutment and in combination with deproteinized bovine bone substitute to fill the implant socket void, in combination with an extra-cellular biologic membrane (DynaMatrix, Keystone Dental, Burlington, MA, USA) positioned between the buccal bone plate and the soft tissue. According to the manufacturer the DynaMatrix membrane is ideal for tissue regeneration procedures, with a regenerated tissue similar to the one obtained with autologous grafting.(14)

Methods and Materials

Study group

Between September 2011 and January 2012 five patients were treated to rehabilitate single edentulous areas using 3 Xive® implants (Dentsply Implants, Mannheim, Germany) and 2 Nobel Active implants (Nobel Biocare AG, Sweden). The implant choice was based on the authors’ preferences particularly in relation to the internal connections and the flaring of the collar, that allows to move the implant-abutment connection away from the bone.

The study population, which was comprised of 5 patients (2 males and 3 females), was selected from consecutive patients seeking treatment in the authors’ office (M.R.). The female and male patients were on average 54,3 (range, 43-62 years) and 76,5 (range, 71-82 years) years of age respectively.

For each of the 5 patients, treatment involved the maxillary premolar segments of the dental arch. The distribution of the restored teeth is shown in Table 1.

Patients with severe parafunction, periodontitis, severe gingival inflammation, infection and presence of a vestibular fistula, poor oral hygiene, or a high caries rates were excluded from this study.

Each patient was given an oral hygiene recall regimen based on his/her periodontal condition.

The study was conducted in accordance with the Helsinki declaration of 1975 as revised in 2000.

Surgical procedure

The first step included the extraction of a compromised tooth, using a syndesmotome with a very gentle technique, to preserve the anatomic site as much as possible and paying attention not to crack the alveolar walls. (Figs 1,2)

After having extracted the tooth, the alveolar bone was explored by a periodontal probe to assess its integrity and to establish which implant diameter to use.

An implant was inserted 2-3 mm apical to the free gingival margin with a proper 3-D placement. (15)

Immediately after provisional crown relining the gap between the implant and the buccal bone was filled with Bio-Oss collagen® (Geistlich Pharma AG, Wolhusen, Switzerland) to prevent possible resorption and esthetic damage.

To improve and maintain stability in the tone and thickness of the surrounding soft tissue, an extra-cellular biologic threefold layered membrane was grafted without raising a large flap, by designing a small envelope close to the parabola. (Figs 3)

Provisional procedure

An individual screw retained provisional crown was relined with acrylic resin (Yates & Bird / Motloid, Chicago, IL, USA) onto the provisional abutment. After resin polymerization the provisional crown was removed and some resin was added to fill the gap between the crown and the abutment. The provisional crown was then finished and the transmucosal portion was shaped with a concave design, more pronounced on the buccal than on the palatal or interproximal sides, to avoid any undesired soft tissue compression. (Fig 4)

The provisional was screwed by hand, maintaining stability with two fingers, so as to limit the transmission of forces to the implant.

Finally, the access screw hole was filled with Teflon and covered with Telio CS Onlay temporary filling (Ivoclar-Vivadent AG, Schaan, Liechtenstein). The occlusion was checked and the contacts in both centric relation and in protrusive/lateral movements were removed.

Patients kept the provisional for 6 months and then an impression according to the Hinds’ method was taken.(16)

A titanium custom made abutment was then manufactured and screwed to the implant followed by definitive crowncementation. (Figs 5, 6)

Evaluation

Photographs, data forms, and alginate impressions (initial pre-extraction and one year after surgery) were used as documentation tools in the analysis to compare the changes in the soft tissue thickness. Master casts were made out of dental stone (Elite ortho thixotropic white, Zhermack, DE) utilizing the pre-operative and follow-up impressions. A digital optical scanner (COS, 3M, USA) was used to register and then compare the initial and the one-year post-op casts. This method made it possible to obtain objective data for the final evaluation.

To have six comparable measurements or reference points on the digital replicas of the casts, a line tangential to the parabola more apical point of the final restoration and perpendicular to its long axis was first drawn; then three other lines perpendicular to the first tangent were designed, one at the center of the mesial and distal papilla and one at the center of the tooth. Two additional lines were also drown parallel to the first tangential line at a distance of 1,5 mm from each others so that six specific reference points were determined by the intersection of these lines as illustrated in the picture. (Fig 7)

Every impression cast was scanned and then through the use of CAD-software (DWOS Lava Edition, Dental Wings Inc. Montreal, Canada) the 3D virtual images were precisely superimposed utilizing the surfaces of the adjacent teeth as a guide in the superimposition. (Fig 8)

Following this method it was possible to compare the vestibular tissue thickness variation by just viewing the two superimposed images in a cross section as if they were tomographic images.

In all the cases the patients were re-examined by the authors at intervals of 15 days for the first 3 months, and every 3 months thereafter, by means of a mirror and a sharp explorer, radiographs and clinical photos.

Results

At 1 year all the implants maintained stability without any signs or symptoms of inflammation or pain. The soft tissue aspect was excellent with the presence of a thick amount of keratinized pink mucosa with the characteristic orange peel effect around the definitive crowns. After detailed observation, the authors assessed the stability of the soft tissue, noticing only minor changes from the beginning of therapy to the end of the follow-up period. Radiographs detected minimal bone resorption with the mesial and distal bone peaks showing only minor physiologic remodeling. No prosthetic complications were recorded and all patients had pleasant final esthetic outcomes. All the patients were very satisfied with the treatment received.

A small decrease in vestibular tissue thickness, on average -0,595 mm (range of +0,125 mm to -1,228 mm), was measured by calculating the mean of all the measurement points at the end of the observation period. The single results atthe six measured points are reported in Table 2.

Discussion

The obtainment of natural looking implant supported restorations is one of the objectives of every implant treatment. During therapy the creation and maintenance of ideal peri-implant soft tissue, both from a functional and aesthetic point of view, represents a major challenge that we face.

By performing planned and accurately executed surgeries and designing provisional restorations that properly influence soft tissues during their maturation, it is possible to obtain initial excellent results that can be easily replicated in the definitive restorations.

Today, an implant-supported restoration should respond to very precise requirements especially when replacing a single tooth in the aesthetic area.

Obtaining stable good results over time essentially depends on various factors such as the presence of an adequate amount of keratinized mucosa, a proper thickness and height of the buccal and interproximal hard and soft tissues, a correct three-dimensional positioning of the implants, proper management of the augmented peri-implant hard and soft tissues and finally transmucosal prosthetic components accurately shaped to guide an ideal final mucosal outline. (2, 7, 15)

The immediate loading method presents a significant advantage due to the fact that the alveolar-gingiva and inter-papillary fibers seem to better preserve the interproximal osseous peaks, provided that the interdental and peri-implant tissues are immediately supported by means of a healing screw or a provisional crown.(17)

In addition, it is preferable to design the transmucosal portion of the immediately placed implant-provisional restoration so that it is concave and not compressive to better stabilize the peri-implant mucosa over time.

Following the described technical approach the tissues appear quite natural with a pinkish color and often with a characteristic orange peel aspect similar to natural teeth. In addition in the treated cases the prominence of the root bump could be maintained almost ideally.

A concave abutment, in fact, ensures more space for the surrounding connective tissue creating a “soft tissue O-ring” that functions as a stabilizing barrier near the bone-implant interface.(2, 17, 18)

In the literature, cases of immediate post-extraction implant insertion associated with an immediate temporary restoration have been reported and this approach has been regarded as an effective method to preserve the papilla. On the contrary, when considering the stability of the buccal bone plate and the overlying mucosa, the performance of the same approach has been questioned.(19, 20)

With delayed implant placement as an alternative method, a better control of the buccal tissues may be obtained, while the papilla might contract more than what is desired.(17, 21, 22)

In any case, filling the buccal gap between the implant and the alveolar bone with biomaterial and placing an autologous connective tissue graft between the vestibular bone wall and the overlying mucosa, also in association with a concave abutment, seems to better maintain the stability of the root bump. This also allows for a greater thickness of connective tissue around the implant components and less buccal tissue recession.(2)

Finally, the possibility of using a membrane instead of a connective tissue graft, harvested from the palate, facilitates the surgery for the clinician and reduces the morbidity for the patient.

Nevins in 2010 compared the efficacy and feasibility of this extracellular matrix membrane (DynaMatrix), with that of an autogenous gingival graft, in increasing the width of attached keratinized tissue. The biopsy specimens of both test and control sites appeared to be similar histologically with mature connective tissue covered by keratinized epithelium. The results of both clinical and histologic evaluations have suggested a potential application of an extracellular matrix membrane in achieving gingival augmentation.(14)

Nevins in 2011 demonstrated, in a prospective study, that a bilayer collagen matrix is also a viable alternative to an autogenous connective tissue graft in augmenting areas deficient in keratinized gingiva.(23)

Lorenzo in 2011 published a similar study using a xenogenic collagen matrix to augment the keratinized tissue around implant-supported prosthesis in comparison with the connective tissue auto-graft. The reported results revealed that this xenogenic collagen matrix could be considered an effective and predictable alternative to the connective tissue graft.(24) Several other studies have been conducted, either on humans or on animals, evaluating the possibility of using a collagen matrix instead of a connective tissue graft and all of them concluded that these new membranes could be a viable substitute to the conventional autologous graft.(25,26,27,28,29)

The lack of evidence with respect to similar biomaterials, for soft tissue volume augmentation, makes it difficult to compare the outcomes of the DynaMatrix with other studies. The missing evidence may in part depend on the number of techniques suitable for the measurement of thickness changes.(13)

Several non-invasive methods have been described to measure soft tissue thickness changes in the oral cavity. The techniques ranged from simple clinical evaluation and two-dimensional measurements, using periodontal probes, to complicated volumetric assessments using the Moiré projection method. The use of different techniques impairs any comparison of thickness outcomes between studies.(13)

In the present study a three-dimensional optical method has been used to detect thickness changes over time. The applied technique showed a high reproducibility and an excellent accuracy for measuring thickness changes in a methodological study. A variety of studies have shown that this method offers great advantages because it is easy to apply, non-invasive and precise.(13)

In the present report, apart from the limited number of observations, there is one shortcoming of the technique since the optical scans were performed on study casts. The accuracy of the method is, therefore, highly influenced by the accuracy of the impressions and casts. It is likely that future developments of this technique will allow for the optical scan to be done directly in the oral cavity thus avoiding the taking of an impression.

The results obtained utilizing this method for the Root Bump Preservation (RBP) were diverse with minor variations depending, according to our observation, on the initial condition of soft tissue health, thickness and presence of an adequate amount of keratinized mucosa. This probably confirms how the initial biotype may be one of the main factors responsible in determining the quality and quantity of the final result.(30)

Conclusions

The average measurements were almost all negative demonstrating a minimal decrease in variation of the root bump prominence in almost all the six marked points. This suggests, within the limitations of the current case series, that filling the gap between the implant and the buccal bone with a bone substitute and using an extracellular biological membrane, instead of a conventional connective tissue graft, does not completely maintain the stability of the root bump morphology. However, the quality of the soft tissue at 1-year post-surgery was pleasant with well-keratinized mucosa and with a natural and healthy appearance.

Further long-term, prospective, randomized, multicenter studies with more patients, are needed to verify the reported findings and to determine if this membrane will be able to effectively replace connective tissue grafts.

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Table 1 Distribution of the restored teeth

|  |  |
| --- | --- |
| Patient | Tooth |
| 1 | First left premolar |
| 2 | Second right premolar |
| 3 | First right premolar |
| 4 | First right premolar |
| 5 | Second right premolar |

Table 1 represents the position of the treated teeth

Table 2

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Patient | # 1 | # 2 | # 3 | # 4 | # 5 | # 6 |
| Pt 1 | -1.228 | -0.711 | -0.477 | -1.08 | -0.342 | -0.351 |
| Pt 2 | -0.711 | -0.335 | -0.753 | -1.122 | -0.458 | -0.753 |
| Pt 3 | -0.406 | -0.103 | -0.098 | -0.422 | -0.081 | -0.086 |
| Pt 4 | -0.62 | -0.902 | -0.562 | -0.982 | +0.101 | -0.255 |
| Pt 5 | -0.483 | +0.125 | -0.442 | -0.195 | -0.442 | -0.719 |
|  |  |  |  |  |  |  |
| Average | -0.689 | -0.385 | -0.466 | -0.76 | -0.244 | -0.432 |

For each patient measurement results at the six marked points. A negative number is an expression of tissue thickness contraction. At the bottom of the table there is the average measurement for all points combined.

Legends:

1. Upper right second premolar with hopeless crown fracture.
2. Initial x-ray
3. The biological extracellular membrane, folded back on itself three times during its insertion in the envelope created by the use of a periosteal.
4. The provisional screw retained restoration with a concave transmucosal profile.
5. The definitive crown (second premolar) at one year post-surgery. The soft tissue is adequate for contour, shape, and its aspect is absolutely natural, as is that of the keratinized gingiva.
6. One year after: radiographic outcome showing successful osseointegration of the implant (Xive, Dentsply).
7. The six marked points used for the tissue thickness comparison between pre- and post-op
8. 3D-virtual image superimposition showing the soft tissue contraction between pre- (blue image) and post-op (yellow image) in one of the six marked points.