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Review

EVALUATION OF MARGINAL BONE LOSS IN HYBRID AND NOT-HYBRID SURFACES: A NARRATIVE REVIEW

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ABSTRACT

The surface of an implant should have specific features that influence osseointegration. Many different surfaces were used and studied in the literature, especially rough surfaces. Hybrid surface implants could be better than traditional rough implants in marginal bone loss (MBL), peri-implantitis and bone-to-implant contact. This retrospective review analyses different studies which compare implants with and without hybrid surfaces. Usually, the MBL is measured with digital radiographs. Standard radiographs are also helpful in the evaluation of osseointegration. An electronic search was performed in the PubMed database. The keywords allowed us to find studies concerning hybrid surfaces. Thereafter, a selection of the studies had to be made by reading the full text. Six articles were found in PubMed and formed the basis of the study. In this review, MBL was the subject of the research. Hybrid surface with different roughness seems to have better results concerning survival rate, MBL and presence of peri-implantitis. However, further investigations are needed.

KEYWORDS: *hybrid surface, dental implants, osseointegration, marginal bone loss*

INTRODUCTION

Nowadays, dental implants play an important role in dentistry thanks to the possibility of replacing lost and extracted teeth with titanium implants able to support the dental crown of different materials. This success depends mainly on the fulfillment of integration, its maintenance, and the preservation of adequate bone support. Albrektsson et al. (1) proposed that changes in marginal bone level should be <1 mm for the first year and an annual bone loss of<0.2 mm from the second year. These values identify the survival and the success rate of the implant.

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The surface's roughness is one of implantology's most studied and constantly evolving topics. Rough titanium implants are the most commonly used in clinical practice; they increase the survival rate and support the osseointegration process but simultaneously, there is a higher risk of developing peri-implantitis. Osteoblasts' growth is better on a rough surface than a smooth one, but similarly, bacteria adhere better to the first type. So, unfortunately, high roughness causes plaque accumulation and, as a consequence, considerable alveolar bone loss.

A smooth surface is less favourable: this type of implant has fewer biological complications such as peri-implantitis, but the process of osseointegration is slowed down and hindered. Osseointegration is an essential process to ensure the stability of the implants and it is strictly related to the roughness of the implant: the greater the roughness, the greater the osseointegration. In 2009, Albrektsson and Wennerberg classified implants surfaces as smooth surface (Sa<0.5 mm), minimally rough surface (0.5 mm<Sa<1 mm), moderately rough surface (1 mm<Sa<2 mm) and rough surface (Sa>2 mm). Therefore, it seems reasonable to use implants with a "moderate rough" surface, which have less chance of peri-implantitis than rough surface implants (such as TPS or HA implants) and a better survival rate than implants with a machined surface. However, peri-implantitis still represents a problem, so the concept of the hybrid surface was introduced (1). In this case, initially, the implant has a machined surface in the coronal area and a rough surface in the remaining area. The target was to create a surface with resistance to plaque accumulation of smooth surfaces in the coronal area meanwhile to maintain osteointegration properties in the apical area.

Some clinical studies (2, 3) showed no difference between the hybrid surface and a moderately rough surface implant. So, a new design was developed with a moderately rough surface in the coronal area and the rougher surface in the apical surface. The target of this new surface is to reduce marginal bone loss thanks to the introduction of a minimally rough surface in the coronal area of the implant (3). The aim of this study is to evaluate the bone-implant contact (BIC) changes in hybrid surface implants and non-hybrid surface implants.

BIC is a term that refers to "how much of the implant surface adheres to bone on a microscopic level", and it is graded as a percentage. A lot of other different factors can impact implant-bone contact. In periodontally healthy patients, marginal bone loss depends mainly on the implants' surface and position; moreover, in vivo, the loading (i.e., immediate, early or delayed) can influence the results. Implants had to be placed with the correct surgical procedures and loaded with ideal prosthetic restoration. However, even if all these procedures are perfectly executed, there is still a tiny possibility of fixture failure.

MATERIALS AND METHODS

An electronic search was performed until 2018 and the database used was PubMed. In this review, we included studies *in vivo* on animals and humans and compared implants with different types of surfaces. The research was developed using keywords like "hybrid rough surface implants", "hybrid surface implant and marginal bone loss", and "machined collar and crestal bone changes". The principal inclusion criteria in studies on human patients were age (older than 18 years). In addition, all the implants had to be placed in native bone: bone augmentation procedures could significantly modify the results.

In the search, all the articles concerning mini-screw and not-titanium implants were excluded, as well as studies that do not evaluate marginal bone loss or only evaluate not-hybrid surfaces. Only six were included in this review after an accurate selection and reading of the same.

RESULTS

Hermann et al. (4) placed 60 unloaded implants (30 with machined collars and 30 sandblasted – large grit – acid etched, SLA) at different heights in the alveolar bone. The authors did a histometric quantification using a light microscope and measured the distance between the micro gap implant abutment and the higher attachment of peri-implant bone.

The results of this study revealed that, depending on the corono-apical position of the implant, the SLA surface has better results in terms of reducing crestal bone loss than implants with machined collars. Therefore, in this histometric study, the authors stated that the machined collar negatively influences marginal bone loss.

The authors noticed a bone gain in the implant with machined collars placed above 3 mm to the crestal bone level (CBL):

probably, the distance between the microgap implant-abutment and the CBL was enough to recreate the biologic width and also to increase the bone level. Therefore, this factor has to be evaluated: the authors in this study create six groups (every group has 10 implants). The implants of every group were placed at different heights: two groups were placed above 2 mm to the CBL, two above 1 mm to CBL, one above 3 mm to CBL and the last one at the CBL. The groups with the exact distance between the microgap and the CBL highlighted a greater crestal bone loss in implants with machined collars.

Lee et al. (5) studied marginal bone loss (MBL) in three different types of implants. They evaluated rough-surface implants, hybrid (smooth and rough) implants and rough-surface with micro thread implants. Clinical and radiographic evaluations were conducted at the time of prosthetic loading, after one and three years. A total of 120 implants were included in the statistical analysis. The MBL for each type of implant is illustrated in Table I.

The authors highlighted that hybrid-surface implants show more MBL than rough-surface with and without microthreads. In addition, the microthreads seem to permit a more favourable bone response during the first year of loading.

Spinato et al. (6) did a comparative retrospective study in vivo, where the survival rate and the MBL of two different implants' surfaces were compared: sandblasted and double etched surface (DES) and the hybrid one, with an apical DES surface and a coronal machined surface. The authors waited about 3-4 months between implant placement and exposure and took digital radiographs (using a long-cone paralleling technique) at the time of implant placement, after the prosthetic restoration delivery and after 12 months of loading.

At the end of the study, there was no difference concerning survival rate between DES and hybrid surfaces (100%), and the amount of MBL was minimal and very similar. In particular, there were:

0.35±0.24 of mesial-MBL in DES surfaces;

0.41±0.35 of distal-MBL in DES surfaces;

0.29±0.23 of mesial-MBL in hybrid surfaces;

0.35±0.27 of distal-MBL in hybrid surfaces.

The authors concluded that in periodontally healthy patients, there was no difference between hybrid plus DES and MBL implants in terms of survival rate. Moreover, it was noticed that the abutment height could influence the MBL: if the abutment height increase, there will be less MBL. Finally, the authors identify some differences between the different surfaces. In hybrid surfaces, MBL is reduced when abutments are lower than 2 mm and, in DES implants, the MBL is reduced when abutments are higher than 2 mm.

In a preliminary clinical and radiographic study (7), the same authors placed 54 hybrid implants in 45 healthy patients and 56 hybrid implants in 48 periodontally compromised patients. No statistically significant differences were recorded in the evaluation of MBL in each group. The non-surgical and surgical therapy before implant placement and the high level of oral hygiene probably influenced these. They also demonstrated that the machined surface area in hybrid implants was less susceptible to peri-implantitis than a rough surface.

In the retrospective review by Lee et al. (8) performed on 141 patients with 460 hybrid surfaces implants, survival rate, MBL and incidence of peri-implantitis were evaluated. The survival rate at 5 years was 94.8%. Only 182 implants were included in the analysis: MBL between the date of implant placement and crown delivery was 0.20±0.64 mm and 0.26±0.66 at the mesial and distal sites, respectively. The MBL changed over time (at the last visit, mesial MBL was 0.31 ± 0.68 and distal MBL was 0.34±0.77 mm). Most implants (79%) lost 1 mm between implant placement and the last visit.

A randomised controlled clinical trial was published by van Eekeren et al (9). The purpose was to compare a moderately rough surface (Sa= 1.3 mm) with a hybrid surface (Sa=1.3 mm in the apical area and Sa=0.9 mm at the neck of implants). An overdenture bar was used in every patient. The authors evaluated 42 implants placed in 21 patients and their initial

Table I. *Marginal bone loss after 1 year and 3 years of loading.*

	Rough surface	Hybrid-surface	Rough surface with microthreads
After 1 year of loading	0.81 ± 0.27 mm	0.89 ± 0.41 mm	0.42 ± 0.27 mm
After 3 years of loading	0.95 ± 0.27 mm	1.05 ± 0.34 mm	0.59 ± 0.30 mm

MBL at 3 and 12 months of follow-up. The hybrid surfaces denoted 0.39 mm and 0.37 mm of MBL at 3 and 12 months, respectively; instead, moderately rough surfaces highlighted 0.42 mm and 0.32 mm of MBL, respectively. The authors reported no significant difference between these two surfaces in MBL up to 1 year of function.

DISCUSSION

MBL, the key variable to study implant surface, can be influenced by factors like smoke, history of periodontitis, implant site, and the clinician that inserts the implant. For example, implants placed by a non-expert clinician in the anterior area of the upper jaw have the most significant MBL. The low bone density in this area makes implants' positioning a tricky and complex procedure. Another problem is the high bone density that could lead to elevated torque insertion and, consequently, bone resorption.

Periodontal bacteria could colonize peri-implant soft tissue: there is a higher risk of developing peri-implantitis in patients with a history of periodontitis than in patients without periodontitis. For this reason, many authors do periodontal therapy before the implant's surgery (10). Non-surgical and surgical periodontal therapy can considerably reduce the bacteria percentage, increase the survival rate of implants and reduce the risk of peri-implantitis (11).

Smoking must be avoided in patients submitted to implant therapy: it is well known that smoke makes it difficult to heal. MBL is also influenced by technical factors such as the distance between the microgap of abutment-implant, and crestal bone, and the presence of a smooth collar at the neck of the implants. Many studies demonstrate that the distance of the crestal bone to this microgap can significantly modify the MBL: the type of implant's connection and the platform-switching can partially reduce this problem (12). In case of a history of periodontitis, the smooth collar is a good way to outdistance the oral bacteria to implant critical surface.

As previously reported, the osseointegration is worse if there is a smooth collar: it could fail or take much time before the osteointegration process is completed. However roughness can increase the risk of peri-implantitis, even in periodontally healthy patients (13).

Oral hygiene plays an essential role in plaque accumulation and bone loss: excellent hygiene reduces this possibility. Therefore, both periodontally healthy and compromised patients must be included in a severe "recall appointments' scheme". From the analysis of the studies, hybrid surfaces with machined collars did not have better results than other surfaces. The presence of the smooth neck area is the reason for a superior MBL in hybrid surfaces (14).

The last observation is about the biological width. The biological width is a peri-implant variable that must be considered. As in periodontal tissue, biological width recreates itself: small bone reabsorption must always be contemplated; when the soft tissues are thin and the implant is placed crestally, this biological width is not respected, and crestal bone loss occurs. Moreover, after the placement of an implant, initial bone remodelling occurs and becomes stable after 6 months.

CONCLUSION

Hybrid surfaces do not have any advantages compared to rough implants in terms of MBL. However, hybrid rough surfaces have similar results to rough ones and are better than hybrid ones. Furthermore, the results are the same regarding survival rate, MBL and BIC; peri-implantitis seems to be less frequent. Hence, hybrid rough surface implants may be a possible alternative to common implants. Furthermore, the minimally rough coronal area seems to have better results in periodontally compromised patients, which are more susceptible to peri-implantitis. However, further studies are necessary.

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Review

MECHANICAL ANALYSIS OF THE CONE MORSE ABUTMENT IMPLANT

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ABSTRACT

After implant insertion and loading, crestal bone usually undergoes a process of remodelling and resorption. In order to reduce crestal bone loss, the "platform switching" technique has been proposed, in which the horizontal relationship between the outer edge of the implant and a smaller-diameter component is increased. The aim of the present work was to evaluate *in vitro* a fixture-abutment connection with cone morse and screw. Mechanical tests were carried out using a Lloyd 30K universal testing machine (Lloyd Instruments Ltd, Segensworth, UK). The load was applied on the coronal portion of the abutment with a crosshead speed of 5 mm/min, and the fracture load data were automatically recorded using Nexigen software (Nexigen, Batch Version 4.0, Issue 23, Lloyd Instruments Ltd, Segensworth, UK). The results indicated that the force necessary to induce a fracture when using the new fixture-abutment connection with cone morse and screw joint systems reached 1250±60 N. In conclusion, the fixture-abutment connection with the cone morse tested in this study presents a very high resistance.

KEYWORDS: *bone resorption, microgap, platform switching, vertical bone loss, abutment-fixture connection*

INTRODUCTION

Successful results regarding the stability and continuity of dental implants and prosthetic structure within the oral cavity depend on multiple biological and mechanical factors; several *in vitro* and *in vivo* studies aimed to investigate the biochemist and cellular mechanisms that gather the process of osseointegration, integrating new biomaterials and clinical methods to obtain satisfactory results with standardized protocols.

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Osseointegrated implants are a valuable technique for solving partial or total edentulism in clinical practice. However, numerous issues should be further approached, such as obtaining an optimal implant-abutment connection in terms of mechanical and microbiological properties. Indeed, the aim is to minimize crestal bone loss, obtaining better and long-lasting results with advantages from the mechanical, biological and esthetical points of view (1).

In agreement with previous research (2, 3), applying the cone-morse connection or a joint screw system determine the level of intrusiveness within the biological space by non-biocompatible materials. This event is mainly characterized by an apical migration implying biological concerns, occurring when the cone morse is connected or when the screw is placed (4). Once the biphasic implants are placed, and the abutment connection is established, the apical migration of the soft tissues opens a new scenario. The migration is influenced by the creation of micro-gaps, the implant design in the coronal part, and the distance between the implants (5). After the initial remodelling of the crestal bone of around 1-2 mm, the loss remains constant or limited to 0.1-0.2 mm per year (6).

Pathogenic bacteria for the periodontal tissues can penetrate the junctions within the complex implant-prothesis, colonizing the spaces created by the mechanical connections (2, 7, 8). As stated in previous research, the biocompatibility of the materials implied in the abutments and prosthetic structures will be deleted due to bacterial contamination within the junctions and the internal spaces (9). Even though the abutments and screws confirm biocompatibility, the bacterial colonization induces the retreats of the epithelium to the apical part, compromising the biological stability of the implant but not of the abutment. Elimination or minimization of gaps created during the connection between implants and abutment has been proposed to solve this problem (10). This option could partially solve this issue since the abutment is exposed to contaminating agents during implantation.

Another potential solution could be re-locating the implant and positioning the implant-abutment junction as coronally as possible, although this solution is not always feasible due to functional or esthetic reasons (11, 12). Lazzara and Porter (13) evidenced how the sub-resizing of the cone morse determines a lower bone remodelling, as demonstrated by histological analysis (14). The concept of "platform switching" has been used for the last 15 years (15). Clinical results from the histological analysis have demonstrated the bone's adaptation to the implant's back face, avoiding crestal bone resorption (16). Crestal bone stability carries multiple advantages from a biological and esthetical point of view. However, concerns have been raised regarding the mechanical resistance of the implant-abutment connections obtained after using a sub-dimensional cone morse.

Thus, in the present study, we analyzed the mechanical resistance of an implant-abutment connection using the cone morse technique and guided by a hexagon screw joint, combining the advantages of the conical coupling and the screw joint.

MATERIALS AND METHODS

Implant-abutment connection

The implant-abutment connection analyzed in this study consists of a cone morse and a screw joint (Fig. 1). Twenty Close BL implants 4 x 13 mm and 20 abutments with a screw-retained conical abutment connection (Isomed, DUE CARRARE (PD), Italy) were used. A static resistance test was used to test the resistance of the new connection, where the samples were fixed to the support and subjected to an increasing force until the sample fractured. Different approaches were considered to recreate the work conditions of the implant within the oral cave. For instance, resin supports containing the implant-abutment complex were realized while 1 mm of the implant base remained uncovered to reproduce the worst situation in which a prosthetic implant could work in case of bone loss in the coronal part.

After polymerizing, the acrylic resin presents a resistance above 100 MPa (the minimum value stated by the ISO normative 5833/1 is 70MPa) and an elasticity of 2750 MPa (the minimum value stated by the same organization is 1800 MPa). In addition, samples in resin were moulded to obtain an inclining implant-abutment complex of 30 degrees; thus, the applied force can be directed in a non-parallel manner to the major implant axis, creating traction and compression forces for a greater load. During the experiment, the samples were submerged in an artificial saliva solution.

Mechanical test

The sample was inserted into a clamping system to carry out the static load resistance test, where it was subjected to

Fig. 1. *Implant with positioned abutment embedded in a resin block.*

compression with a lowering speed of 5 mm/min, monitoring the displacement of the sample. The universal instrument Lloyd LR30K (Lloyd Instruments Ltd, Segensworth, UK) was used for this analysis to examine biomedical devices' functioning under pressure conditions. The equipment used allowed the application of a non-axial load by using a mechanical piston and a load cell, the last consisting of a balance able to absorb the load, determine the values and transmit them to the computer system. The load cell used for this test reached 2000 N, and the feed speed was 5 mm/min. The test was stopped as soon as any sign of fracture or deformation was noted.

RESULTS

The samples subjected to the mechanical test supported a load of 1250±60 N before fracturing (Table I, Fig. 2). For all samples, the deformation was represented by a folding of the coronal part of the abutment under a load of 900N, without inducing modifications in the implant neck.

DISCUSSION

The implant-abutment connection is considered of central importance for the correct functioning of long-lasting prosthetic implants due to the significant advances in implant surfaces that contribute to faster and more adequate bone healing.

Several studies have documented the complications related to the screw prosthodontics superstructures, mainly represented by a loosening and fracture of the clamping screw or by a fracture of the abutment. The loosening of the clamping screw occurs more frequently during the first year after implant positioning and in single implants (17). The introduction of accurate prosthetic systems for single implants and the use of new components (gold screws, torque wrench) has been accompanied by decreased complications and improved clinical results. However, in the posterior region, where the chewing dynamics and the functional loads are high, the problem is still present. Implants used to replace a single tooth should resist torsional forces, avoiding damage to the components. An inadequate interface with a low resistance would increase the number of potential fractures (18). For this reason, some researchers have developed the abutment system with screw coupling in the apical part and conical coupling in the coronal part, allowing the elimination of the micro-movements thanks to the friction produced by the conical coupling and thus hampering the unscrewing (19).

Other researchers focus on creating new interfaces between the implant and the screws. From the data obtained here, we can affirm that the remodelling of the abutment to obtain the platform switching does not compromise its mechanical resistance. However, the implant must not present any plastic deformation under loads below 800 N

Table. I. *Summary of the mechanical testing findings of the Cone Morse implant under the controlled compression loading*

Mechanical test summary	
Test Type	Compression to fracture
Samples	n: 20
Mean	1250 N
SD	60 N
Min-Max	(1128-1373 N)
Compression Load Speed	5 mm/min

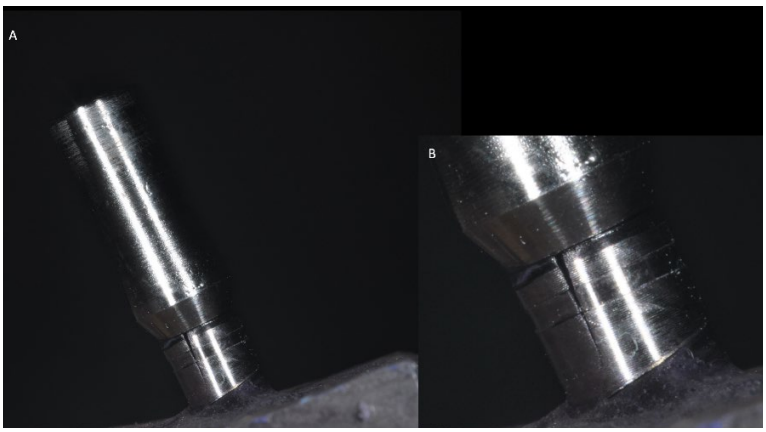

Fig. 2. *Detail of the implant at the end of the fracture test.*

(20). Furthermore, once the load is removed, the structure should be able to be back to the original conformation (elastic deformation); otherwise, the original structure could be compromised. For instance, a partial but permanent flexion of the abutment could originate a slot, which could then be colonized by microorganisms accompanied by a peri-implantation process (10).

The mechanical test is a valuable strategy to evaluate the implant-abutment connection and the probability of undergoing a fracture or damage. In the case of manufacture defects, a phenomenon of progressive propagation could be observed when applying a load, which could be due to the industrial manufacturing process more than to the potential defects within or on the surface of the material implied. If this event occurs, the effort is distributed in a non-equilibrated manner, creating small cracks able to propagate, reducing the resisting section and thus fracturing the abutment. As already stated, the samples used for this study were subjected to a load applied non-parallelly to the long axis and eccentrically, using resin-moulded blocks. Implants can be considered reliable from a biomechanical point of view when they withstand a load of 800 N. Moreover, load curves for each sample have been analyzed to determine the implant behaviour when increasing the load. In this respect, no defects were observed.

Data regarding the elasticity and resistance of the implant connection examined were obtained from the deformation diagram from material sections of appropriate form and size. While the X-axis corresponds to the deformation, the Y-axis represents the load exerted. This information allows the classification of the materials into three different groups: malleable, fragile (breakable) and plastic. Our results confirm that we can exclude fragile or malleable behaviour for our samples.

We strongly consider that the mechanical evaluation of the implant-abutment connection was a necessary step for the study of platform switching, especially considering that several studies have focused on the biological effects of this connection but not on the mechanical properties. The connection analyzed here is composed of a cone morse with an overture of 4° and a clamping screw. The close contact between the implant and the abutment reduces the micromovements of the components, considering them as a single unit and hindering the entry of biological fluids and bacteria.

In conclusion, the implant connection studied here can be considered reliable from a mechanical and biological point of view, presenting important advantages such as platform switching.

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Case Report

REHABILITATION OF DYSFUNCTIONAL PATIENT WITH SEVERE BRUXISM

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ABSTRACT

Full-mouth rehabilitation of patients with bruxism and severely worn dentition is challenging for clinicians. Several treatments and restorative materials are available, and clinicians should be able to select the most suitable treatment and materials for each patient, depending on his specific situation. A 58-year-old male affected by bruxism was referred for evaluation of a severely worn dentition. Clinical and radiographic evaluation revealed tooth abrasion in the entire dentition. Before the full mouth prosthetic rehabilitation, the patient was gnathologically treated for 8 months. The full-mouth restoration showed satisfactory functions and esthetics. No complications were observed in the restorations, supporting tissues, and temporomandibular joints during the 3-year follow-up.

KEYWORDS: *bruxism, full-mouth rehabilitation, dental abrasion, vertical occlusal dimension*

INTRODUCTION

Some loss of occlusal surface can be considered physiological over the years (1). However, severe tooth wear can be influenced by factors such as reflux disease, eating disorders, skeletal class, and parafunction (2). Dental erosions are mainly caused by parafunction of the masticatory muscle activity at night. Bruxism is characterized by teeth' occlusal surfaces rubbing on the occlusal surfaces of the opposite jaw (3). In normal conditions, the functional day contact between teeth during mastication is very short and does not lead to pathological wear. Bruxism can be divided into sleep and awake bruxism (4). The diagnosis of sleep bruxism is made by polysomnography (PSG), while the patient's self-report mainly makes the diagnosis of awake bruxism. Severe bruxism may lead to loss of function, aesthetic, and vertical dimension of occlusion (VDO).

Oral parafunctions are frequently observed in patients with high stress and anxiety (5). No specific treatment can stop sleep bruxism. In order to prevent the destructive effects of bruxism, interocclusal appliances have been proposed, such as

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occlusal splints or nightguards. The treatment plan of patients with severe erosion, loss of VDO and bruxism is the main challenge for clinicians, dental technicians, and the patients themselves. This report aims to describe the treatment of a dysfunctional patient with severe bruxism and loss of VDO employing fixed ceramic prostheses.

CLINICAL REPORT

A 58-year-old man was referred to examine abrasion of the entire dentition. The patient was concerned about tooth wear and was dissatisfied with his smile, especially for the short clinical crown length of the anterior teeth (Fig. 1, 2).

The patient had a parafunctional habit of bruxism and clenching, and the clinical history was uneventful. Intraoral and radiographic examination revealed severe attrition and dentinal exposure of the entire dentition. Abrasion determined pulp exposure in the lower frontal group, which caused pain to the patient. The maxillary left of the first premolar exhibited vertical mobility. The patient had a >20-year history of tooth erosion. The interocclusal distance at rest was 4mm. Before the prosthetic treatment, teeth with pulp exposure were endodontically treated to eliminate pain. Then a gnathological treatment started using an occlusal splint.

The case was studied on plaster models and merged with clinical measurements. The estimation of loss of vertical dimension due to abrasion was about 6 mm. A 6 mm height resin occlusal splint was provided to the patient to verify muscle response and avoid other more invasive treatments such as injections with botulinum toxin in masseter muscles. The patient was instructed to wear the occlusal splint for at least 12 hours daily. He was recalled for occlusal adjustments once a week in the first month and then once a month.

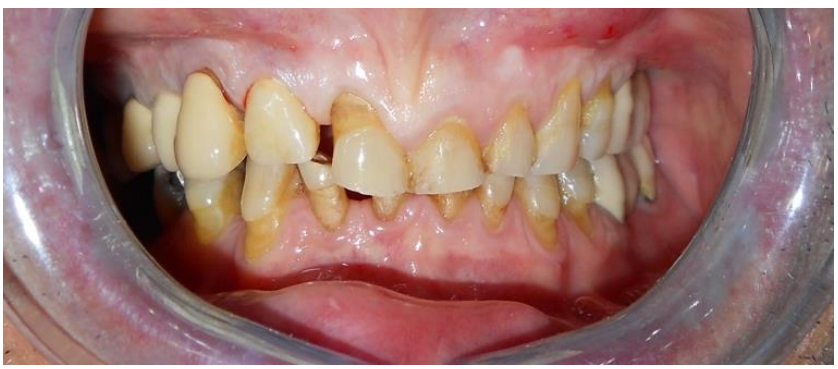

Fig. 1. *Intraoral view before rehabilitation.*

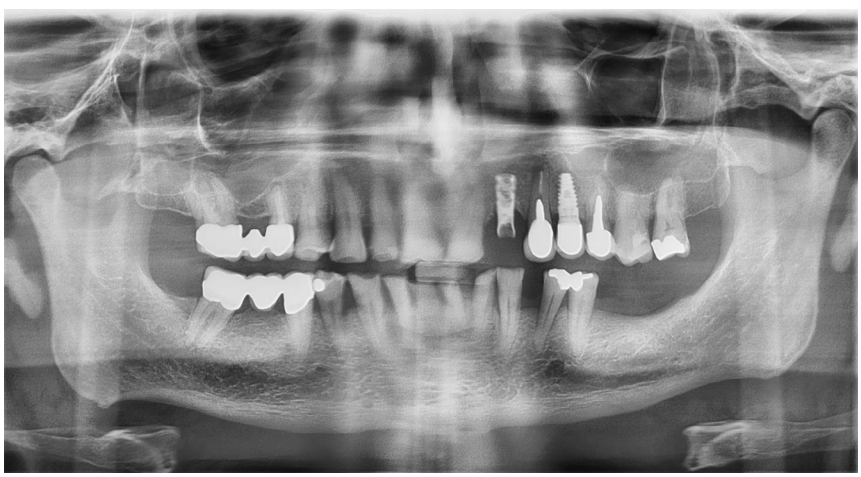

Fig. 2. *X-Ray examination before treatment.*

The patient's response was excellent during the eight months of the gnathological treatment. The patient was well adapted to the increased VDO without any muscle or joint pain complaints. A diagnostic wax-up was prepared on the casts mounted on a semi-adjustable articulator (SAM®3, SAM Dental, SAM Präzisionstechnik, Germany). After the VDO was elevated by 6 mm from the incisal guide pin of the articulator, a full-mouth diagnostic wax-up was created. The upper border of the lower lip was used as the reference line for the maxillary incisal curve to restore the smile line. Provisional full-mouth crown restorations were fabricated with acrylic resin (Jet, Lang Dental Manufacturing Co., Wheeling, IL, USA) by duplicating the diagnostic wax-up. The provisional restorations remained in function for 6 months. The shells of the interim crown restorations were relined with acrylic resin following crown preparation of the entire dentition. The goal was not to stress masticatory muscles and to continue the musculature adaptation with a not very hard restoration. Considering the patient's bruxism and abrasion history, specific restorative materials for the definitive prostheses were selected.

The definitive impressions of the maxilla and mandible were obtained using polyvinyl siloxane (PVS; Aquasil Ultra XLV; Dentsply Intl, York, PA, USA). The master casts were fabricated with Type IV dental stone (GC Fujirock EP, G.C. Europe N.V., Leuven, Belgium). Cross-mounting was performed on the semi-adjustable articulator, and the casts duplicated the intraoral provisional crowns. Definitive restorations were made by replicating the shape of the provisional crowns, which were tried and finalized in the oral cavity. Metal ceramic crowns were fabricated and cemented with resin-modified glass ionomer cement (GC FujiCEM 2, G.C., Tokyo, Japan) (Fig. 3, 4).

A night guard was made for the patient to be used during the night. During the follow-up period of 3 years, the full-mouth restorations were well maintained, and no complications were observed in the restorations, supporting tissues, or temporomandibular joints.

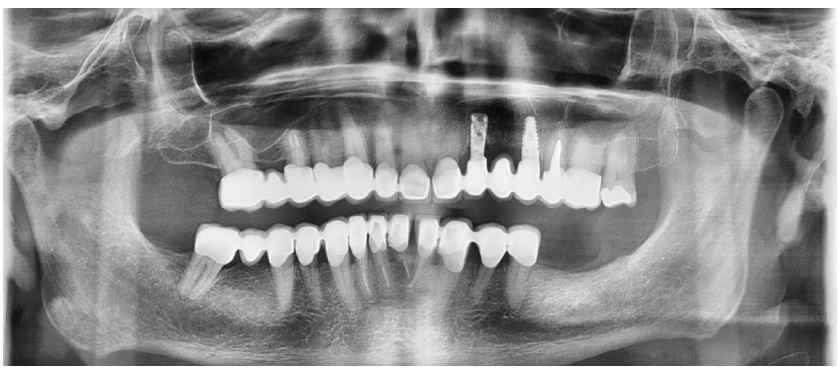

Fig. 3. *X-ray after metal-ceramic crown placement.*

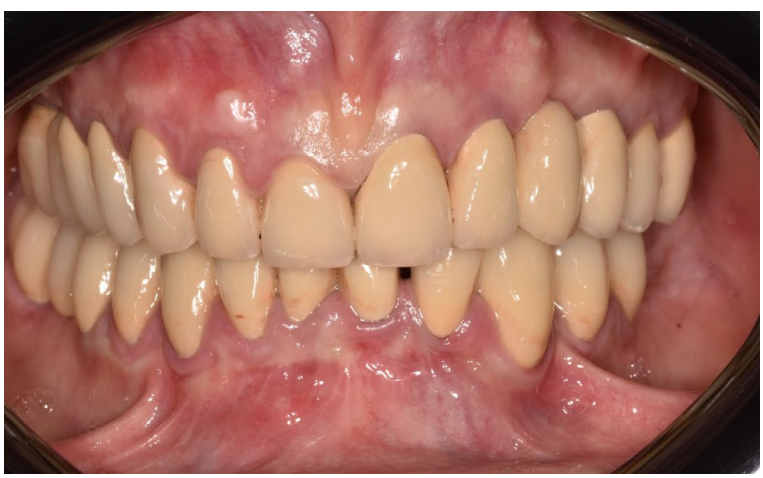

Fig. 4. *Intraoral view at last follow-up visit.*

DISCUSSION

The present clinical report performed a complete prosthetic rehabilitation of both arches. The patient lost a significant amount of teeth structures, and therefore the main challenge of the overall rehabilitation was the amount of VDO increase (6 mm). In these terms, the patient's compliance was crucial to achieving an acceptable result. The treatment methodology followed a strict protocol: the patient had to wear the occlusal splint for at least 12 hours daily (6, 7). In this way, the newly established VDO was tested with the occlusal splint. The idea was to reach comfort, bringing the mandible to a normal position without muscle or temporomandibular side effects (8, 9).

For the reconstructive material, using the same material in both jaws was suggested in several studies to avoid irregular abrasions, which can produce overloading areas (10).In addition, to prevent future technical complications with ceramic restorations, nightguards were recommended for the treated patients.

CONCLUSIONS

Treatment of severely dysfunctional patients is always a hard challenge for every clinician, especially when an increase in VDO is required. Increasing the VDO can be difficult for the patient because of the long time spent reaching functional rehabilitation. Motivation, accurate diagnosis, and individualized treatment plan are the keys to obtaining restoration with function and aesthetic results.

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Case report

L-INCISION: A SUB-EPITHELIAL CONNECTIVE TISSUE GRAFT HARVESTING TECHNIQUE

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ABSTRACT

The single horizontal incision has been widely published and extensively described in the relevant literature aiming to reduce patient discomfort from epithelial-connective tissue grafting. However, this technique implies more clinical skill from the surgeon and reduces connective tissue harvest. Therefore, modern science aims to refine minimally invasive techniques for the patient but still allow for adequate connective tissue harvesting. With this case series, a modification of the single-incision harvesting technique is being documented and described, introducing a small mesial release incision that offers multiple advantages.

KEYWORDS: *flap, surgery, pain, graft, palate*

INTRODUCTION

Periodontal surgery includes several techniques for soft tissue deficit and deformities management, often involving tissue harvested from the palate (1). The "historical" indications for tissue samples from the palate were mainly two: to deepen the buccal fornix and to cover exposed roots (1-4).

Currently, for most soft-tissue-augmentation surgeries, the connective tissue graft (CTG) is still deemed the standard gold treatment (5, 6) as it has become a reliable modality for increasing keratinised gingiva width (7) root coverage (2-4), as a membrane in the furcation treatment (8, 9), alveolar ridge deficiencies (10-13), management of peri-implant tissue abnormalities (14, 15) and papillary loss (16).

Epithelial-connective tissue graft certainly rises as one of the most documented techniques in the literature and is still used in daily clinical practice (17). However, a denuded wound area at the palate donor site is left, resulting in increased postoperative pain.

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In order to reduce patient discomfort, various surgical modified techniques have been described to harvest CTGs from the palate. Edel (7) was the first to describe a technique (trap door) to keep the palatal epithelial layer intact to obtain primary intention healing with reduced patient discomfort. A single horizontal incision parallel to the gingival margin and two vertical releasing incisions were used to achieve sufficient visual access (7). Mixed graft also deserves to be mentioned, illustrated by John Bruno in 1994 (18). As its name suggests, this technique is a mixed graft because it consists mainly of connective tissue associated with a small portion of epithelium. With a semilunar pattern, access is created to the underlying connective tissue, which, once removed, allows almost first-intention closure (18). Hürzeler and Weng, in 1999, presented a single-incision technique designed to consent to primary wound healing, thereby decreasing patient discomfort (4).

Although new techniques and modifications were proposed later as they were less invasive, some types of harvesting are also performed in clinical practice with different therapeutic goals. These include the secondary palatine flap from clinical crown lengthening or osseo-resective surgery performed in the upper maxilla (19). With the thinned and anticipated palatine flap, a secondary palatine flap is obtained, consisting mainly of connective tissue in its most apical part that can be employed on the buccal side as needed by the clinician (19).

The distal wedge, often planned to resolve a pseudo pocket distal to the most posterior molar, can also be considered an actual tissue harvest (20). Its pattern and especially the thickness of this tissue can then be divided into two parts and employed as needed. In this case, the patient's morbidity is minimal and also resolves the pseudo pocket.

The present case series aims to document and describe a modification of the single-incision harvesting technique, among many other evidence-based ones, minimally invasive to the patient but still capable of obtaining an adequate amount of connective tissue.

The goal is to describe in detail the "L" harvesting technique, which thus involves a small modification to the Hürzeler and Weng technique (4) by adding a mesial release line; this would produce multiple clinical advantages.

MATERIALS AND METHODS

Thirty patients underwent this harvesting technique. The therapeutic goal was always to obtain connective tissue graft harvested from the palate, although the purpose of surgery may have been different: in 15 patients, it was used for multiple root coverage of Miller classes I, II, and III; in 4 patients the graft was used as a barrier in a regenerative technique; in 1 patient it was used to correct an aesthetic defect caused by amalgam tattoo; in 8 patients the goal was increasing the keratinised tissue around implants during the second stage implant surgery; in 2 patients for the correction of an aesthetic defect caused by implant malposition. The patients discussed and accepted the treatment plan, including the palatal graft. Depending on the surgery, the recipient site included appropriate flap passivation, bleeding wound site bed, or root surface treatment.

"L" incision technique to harvest a connective tissue graft

The clinician always evaluates and records the periodontal parameters by circumferential probing of each tooth to

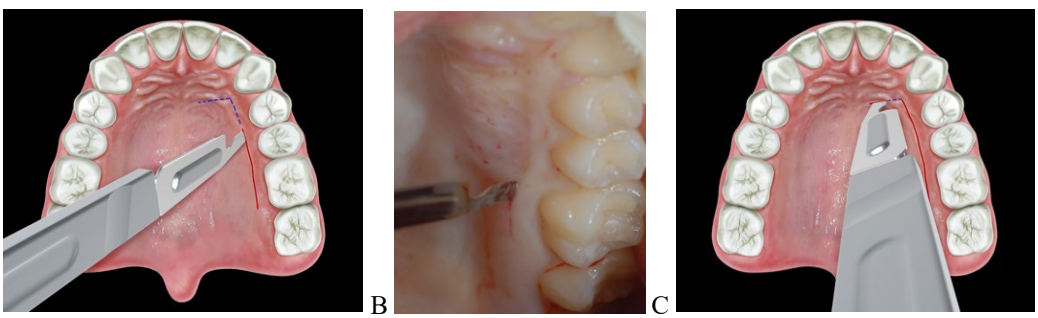

Fig. 1. ***A)*** *The flap design is drawn by the 15c blade that runs from the molar area to the distal aspect of the cuspid about 2-3 mm from the gingival margin.* ***B)*** *The surgical blade is positioned perpendicularly to the palatal bone.* ***C)*** *The blade, perpendicular to the underlying bone, draws the perpendicular, mesial releasing incision, making an "L" pattern.*

assess and respect the attachment apparatus on the palatal side. Under physiological conditions, the first incision will be made 2-3 mm from the gingival margin. The flap design starts with a single full-thickness incision, with the blade perpendicular to the underlying palatal bone. Next, the line runs from distal to mesial, 2-3 mm from the teeth (Fig. 1a-b). The length of the incision is at the clinician's discretion, always respecting certain anatomical concepts, depending on the amount of connective tissue needed at the recipient site. Finally, the flap pattern ends with a mesial release incision (Fig. 1c). The unloading incision should be made in the mesial part to avoid compromising the flap vascularity; it should be full thickness. The flap design is then reinforced with a dissector or periotome to ensure it is against the bone base (Fig. 2a-b). The thinning phase is now starting and performed by a 15c blade.

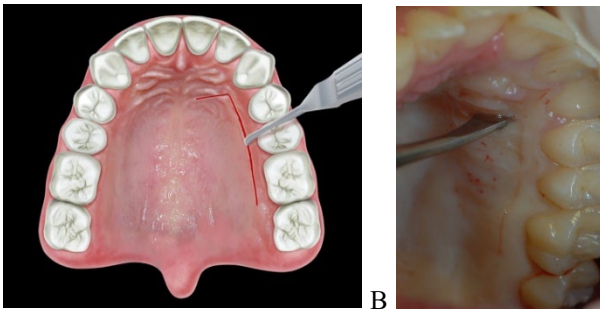

Fig. 2. ***A)*** *The dissector reinforces the horizontal and vertical incisions to ensure the full-thickness approach.* ***B)*** *Clinical image of the dissector that reinforces the previous incisions against the palatal bone.*

The first thinning is critical because it divides the flap into 2 parts, so it is important to use just the tip of the scalpel blade to begin dividing our flap in half (Fig. 3a-b). The inclination is slightly angled due to the presence of teeth. We run through the incision again from the most distal portion to the mesial aspect. Once the first thinning has been created, the clinician can already benefit from the great release incision advantage to directly visualise the thickness of our graft.

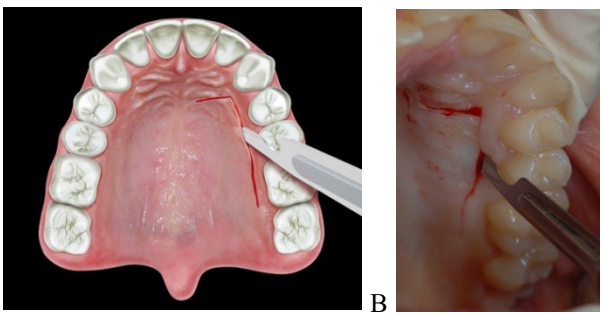

Fig. 3. ***A)*** *The first thinning, where only the tip of the blade is splitting the palatal tissue from distal to mesial.* ***B)*** *Clinical image of the fist thinning showing that only the tip of the blade is splitting the palatal flap into two parts.*

We hold an atraumatic soft-tissue tweezer to visualise the blade's position to the flap. The second thinning is always performed with the scalpel blade, in this case, provides half of the blade to get in (Fig. 4a). The objective is to increase the thickness of the primary palatal flap slowly as we move towards the most apical part to keep the thickness of our sample as uniform or homogeneous as possible, this is because the palate becomes thicker in its most apical portion. Therefore, the clinical goal must be to focus on the primary palatal flap; consequently, if we respect the thickness of the primary palatal flap, the thickness of our connective tissue graft will also be of homogeneous width; this is also essential to minimise postoperative discomfort for the patient and not to compromise the survival of the palatal flap. The third thinning, which therefore involves the complete entry of the scalpel blade, also requires that the thickness of the primary palatal flap in the apical portion be greater than in its more coronal portion (Fig. 4b-c). The drawing image shows how the operator, who can use the tweezers since the second thinning, aims to increase the thickness of the primary palatal flap to respect the anatomy of the palate.

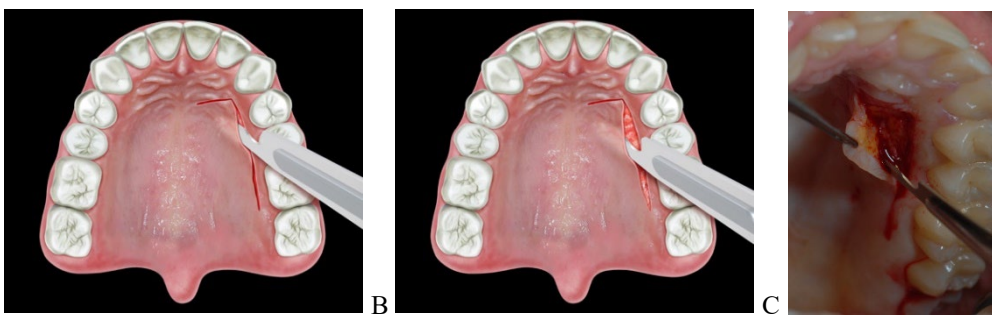

Fig. 4. ***A)*** *The second thinning is performed with half of the blade inside the flap.* ***B)*** *The third and last thinning is performed with the entire length of the blade inside the flap.* ***C)*** *The atraumatic tweezers assist the clinician in lifting the palatine flap for direct visualization of thinning and thickness of the primary palatal flap.*

Let us now move on to freeing our graft; it is recommended that

we start by releasing the angles meticulously to facilitate the removal of the graft. We take a tweezer that helps us to visualise the surgical site, and leaning with the blade against the inner flap wall; we make the apical incision against the underlying bone to join all the thinning previously performed (Fig. 5a-b).

Once the flap is free, we remove it with a K-N n°7 that is placed at the base of the bone and, with rotation and cleavage movements, removes the graft (Fig. 6a-c). The K-N n°7 is a mucogingival scalpel, useful to place it in the most apical part, and with traction movements, it helps remove the graft. It is important to try to detach it in one piece.

The suture technique is a horizontal intramural mattress crossed in the palate and tied to the buccal site. It is essential to make wide bites in the palate and apical to the graft; this is to avoid the so-called "dead space" of the primary palatal flap at the apical level of our harvesting, in addition to the fact that it is a compressive suture; therefore, it creates haemostasis and minimises the coagulum space, producing a network of threads (Fig. 7a-b).

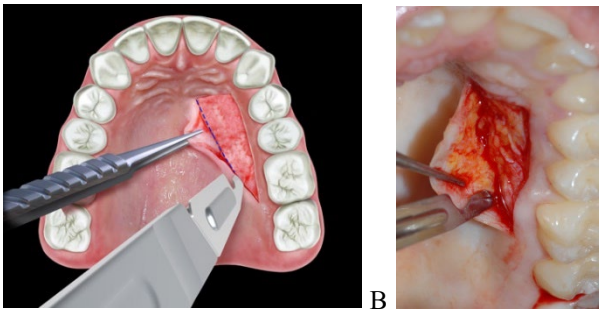

Fig. 5. ***A)*** *The apical incision against the underlying bone, with the aim of joining all the previously performed incisions.* ***B)*** *Clinical image of the apical incision with the blade perpendicular to the bony surface.*

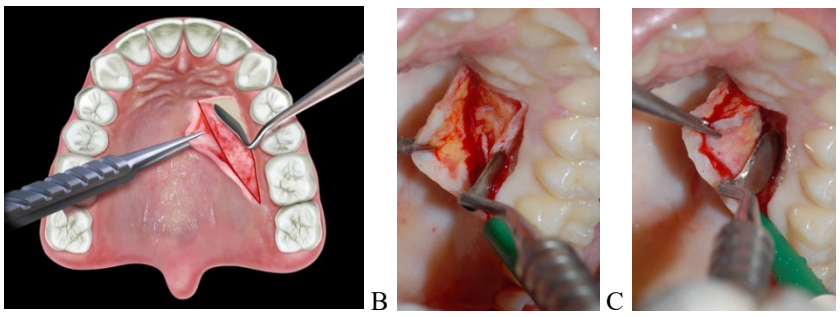

Fig. 6. ***A)*** *A K-N n°7 gingivectomy knife is positioned at the coronal incision with rotation and cleavage movements to remove the underlying connective tissue.* ***B)*** *Starting from the coronal part of the flap, the K-N n°7 begins to raise and remove the connective tissue.* ***C)*** *The K-N n°7 gingivectomy knife, placed at the base of the bone and with rotation and cleavage movements, removes the connective tissue graft.*

CASE REPORT

A 36-year-old, nonsmoking, healthy woman with Miller's class III recession following orthodontic treatment is described as follows. The patient complained of cosmetic impairment and pronounced sensitivity to cold on the mandibular left incisor (Fig. 8).

At the first visit, plaque is noted on the buccal surface of 3.1, implying the patient's difficulty in adequately cleaning the mandibular incisor area. Following initial nonsurgical preparation and patient motivation to proper home care, periodontal parameters, plaque and bleeding scores are reassessed on the day of surgery. Next, a lateral slinding pedicle flap is raised with a partial thickness approach from 3.2 to 3.1 (Fig. 9).

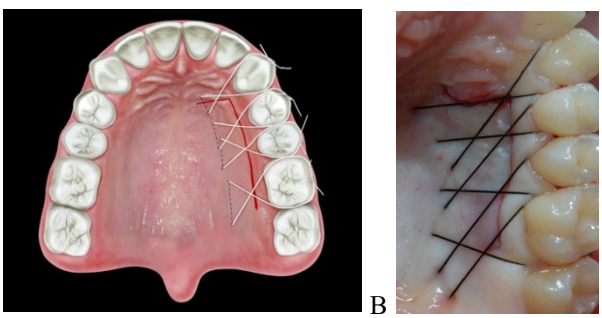

Fig. 7. ***A)*** *A horizontal intramural mattress suture technique is crossed into the palate and tied on the buccal site.* ***B)*** *Clinical image of the suturing technique.*

A mechanical and chemical root surface conditioning is then performed, where the connective tissue graft, harvested from the palate using the "L-incision" technique, will then be placed (Fig. 10-13).

The epithelial-connective graft harvested from the palate is sutured with horizontal, periosteal, stabilising mattress stitches around the teeth to ensure close contact with the root surfaces and the underlying periosteum (Fig.14). The laterally positioned flap is sutured on top of the harvested connective tissue previously adapted on the exposed root surface of the left mandibular central (tooth 3.1) (Fig. 15).

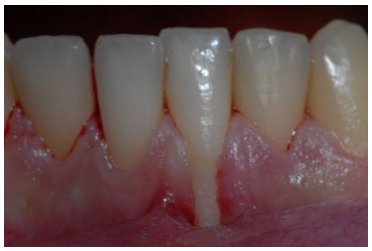

Fig. 8. *Gingival recession post-orthodontic treatment. 5mm probing depth is detected on the medial aspect of tooth 3.1.*

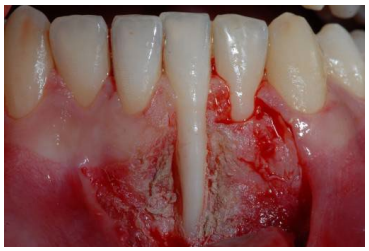

Fig. 9. *Lateral slinding pedicle flap is raised with a partial thickness approach from 3.2 to 3.1.*

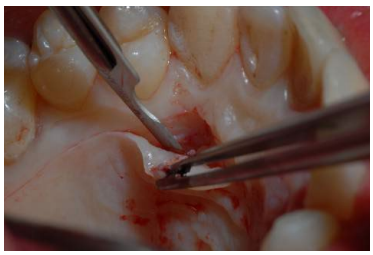

Fig. 10. *L-incision sub-epithelial connective tissue graft harvesting technique is selected.*

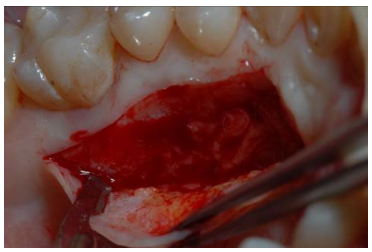

Fig. 11. *Apical incision with the 15c blade perpendicular to the palatal bony surface is performed.*

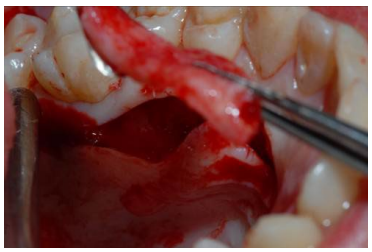

Fig. 12. *A sub-epithelial connective tissue graft is harvested.*

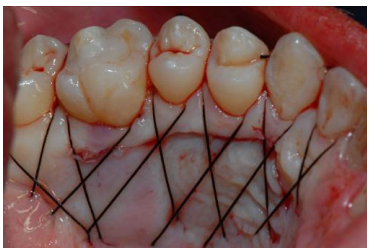

Fig. 13. *A primary closure suturing technique is performed.*

At a 6-year follow-up, a complete 3.1 root coverage and an adequate band of keratinised tissue, even in neighbouring teeth, is noted, preserved over time. Comparative clinical pictures at baseline and the 6-year follow–up check-up visit are presented (Fig. 16). On the mandibular anterior sextant at tooth 3.,1 full root coverage and increased quality and quantity of soft tissue can now be observed.

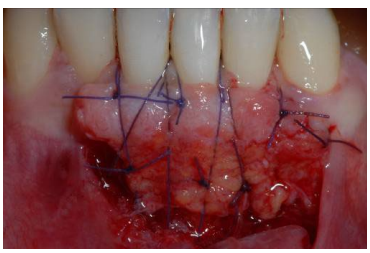

Fig. 14. *The harvested sub-epithelial connective tissue graft is stabilized to the partial thickness recipient bed to cover the gingival recession (toth 3.1) and to improve the soft tissue quantity and quality of the neighbouring teeth (3.2, 4.1 and 4.2).*

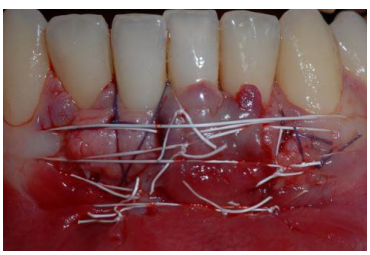

Fig. 15. *The laterally positioned flap is sutured on top of the harvested connective tissue previously adapted on the exposed root surface of the left mandibular central (tooth 3.1).*

DISCUSSION

The single incision technique was introduced to reduce the trauma and pain experienced by the patient at the donor site (4). Only by introducing a small release incision, we create a simple modification to the single incision technique providing multiple advantages. The main benefit of such a mesial incision is greatly intensifying the surgical field visibility, not increasing the patient's morbidity. During the thinning phases, this incision helps the clinician to directly visualise the thickness of the primary palatal flap and the graft. Some anatomical considerations are crucial.

The rationale for various palate thinning is to respect the thickness of the palatine flap, increasing from coronal to apical (21). As described earlier, the technique involves three thinning, during which the more the clinician extends in the apical direction, the more the clinician will have to tilt the scalpel to a position parallel to the long axis of the teeth. As a result, if the thickness of the primary palatine flap is incrementally homogeneous, the thickness of the harvested tissue will also be uniform and homogeneous along its entire length.

Many studies document the importance of sampling thickness by relating it to postoperative pain and palatine flap survival. The randomised clinical trial by Maino et al. (22) states that the thickness of the residual flap plays a critical role

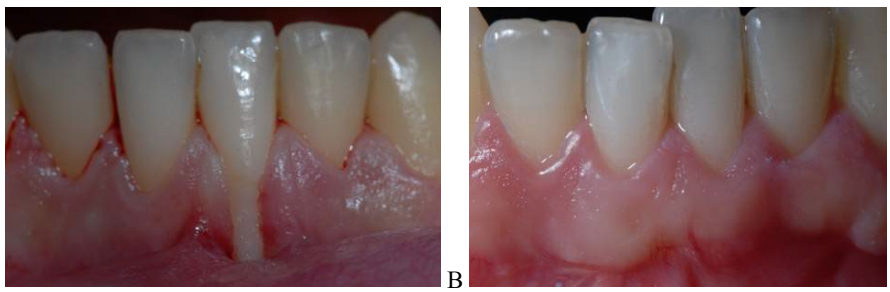

Fig. 16. ***A)*** *Baseline.* ***B)*** *6-years follow-up.*

in vascular supply to prevent necrosis and that it should gradually increase when moving from the incision line to the deeper portion of the palate. The article pointed out that with a residual flap thickness of 4 mm at a depth of 6 mm, the percentage of necrosis is 0, while with a reduced residual flap thickness (2-3 mm), the incidence of necrosis rises to 14.3%.

As suggested by Broome et al. (23), also the position of the release incision is critical, especially for the blood supply role: they observed better healing of the donor site when the incision of the Trap-door technique was located mesially. They compared the same technique with a mesial and a distal incision. A more compromised healing was assessed when the incision was located distally, resulting in a more compromised vascularisation (23). A major scientific contribution comes from Reiser et al. (21), who describe palatal anatomy and its relationship to the palatine artery and nerve complex. More recently, in the studies of Del Pizzo et al. (24), clinical wound healing at the palatal donor site was evaluated by comparing different surgical procedures to obtain CTG, resulting in less secondary healing using the single incision technique providing greater vascular supply versus the trap door approach.

Another aspect to consider and often discussed in the literature is the patient's healing process by assessing postoperative pain and suffering. As the work of Maino et al. (22) suggests, postoperative pain is closely related to the thickness of the withdrawal and not by its extent. These considerations are in accordance with Zucchelli et al. (25) and Burkhardt et al. (26), who evaluated 60 and 90 patients, respectively and agreed that the residual thickness of palatal mucosa is directly correlated to the intensity of pain perceived. The protection of the periosteum can explain the discomfort reduction by the residual connective tissue and the blood clot stabilisation by the primary residual flap (26). The study by Burkhardt et al. (26) concluded that pain is given by mechanical stimulus of the periosteum. According to these studies, an anatomical barrier is provided by the residual palatal flap, which stabilises the blood clot, protecting the underlying sensitive periosteum; this indicates how this technique can minimise postoperative discomfort to the patient, both in aiding the clinician during homogeneous thinning of the palate and in achieving a first intention closure of the wound and thus underlying periosteum covering.

CONCLUSIONS

By using the release incision, which should always result in a mesial flap that allows not to compromise the blood supply, the clinician can harvest more connective tissue than with a 'single incision. Indeed, the main advantage is to be able to directly visualise the thickness of the tissue harvested during the surgical thinning phase. At the same time, the benefit obtained with the single incision is evident: lower postoperative morbidity experienced by the patient, given the first intention of wound closure. Based on all the previously reviewed considerations, it is worth noting that such a minor adjustment can significantly improve the surgeon's performance, allowing even the neophyte to successfully approach both the technique and the thinning phase of the connective tissue graft harvesting.

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Letter to the Editor

AMYLOIDOSIS OF THE TONGUE AS-AN INSIGHT VIEW OF A SYSTEMIC DISEASE

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Amyloidosis represents a heterogeneous cluster of disorders characterized by abnormal extracellular deposition of insoluble fibrillar proteinaceous materials. Three forms of amyloidosis are defined by the presence or absence of systemic disease: primary systemic amyloidosis, secondary systemic amyloidosis, and localized amyloidosis (1).

Primary systemic amyloidosis is a condition with an unknown underlying cause, different from secondary systemic amyloidosis, which occurs associated with other known diseases, such as tuberculosis, rheumatoid arthritis, and mainly multiple myeloma (1). Localized amyloidosis consists of a nodular amyloid deposit mass without association with a systemic disease (2). Although the mean survival of patients with systemic forms is between 5 to 15 months, those with the localized form have an excellent prognosis (2).

The head and neck region is affected in about 12–90% of the cases, typically involving the larynx and tongue (2). Although oral amyloidosis involves the tongue, buccal mucosa, and gingivae, tongue amyloidosis (TA) is a rare and benign disease (3). The most reported features of TA are multiple soft nodules accompanied by yellowish, red, blue, or purple colour changes in the mucous membrane. TA may be linked to systemic disease. A complete systemic workup for amyloid is necessary in the case of TA because this can markedly change the expected morbidity and mortality. To the best of our knowledge, only 53 well-documented cases of TA have been previously described in the English-language literature (3).

TA most commonly affects individuals between 50 and 70 years of age, with a male-female predominance of 3:1 to 3:2. The mean age of the patients with TA is 57.5 years (range 10–90 years), with a female predilection (3).

TA typically results in macroglossia, manifested by increased tongue volume, tongue protrusion beyond the alveolar ridge, speech impairment, and dysphagia. In TA, yellow nodules or raised white lesions occurring predominately along the lateral border are also common; the mucosal surface is usually intact, and the underlying lesion may be nodular or flat, with a yellow, pink, or bluish colour.

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The diagnosis of TA can be easily made with a biopsy. Criteria for diagnosis of TA include eosinophilic extracellular deposits of protein fibrils that exhibit apple-green birefringence on polarized light microscopy when stained with Congo red (4). Once the diagnosis has been made, an extensive workup for systemic amyloidosis should be undertaken, including an abdominal fat or rectal biopsy. These tests are positive in 75% to 90% of patients with systemic involvement. A bone marrow biopsy may be performed to rule out plasma cell dyscrasia. Urine and serum electrophoresis is necessary to detect the presence of a monoclonal paraprotein composed of amyloid light chains. Serum or urine "Bence Jones proteins" will be found in up to 88% of patients with primary systemic amyloidosis and 100% with multiple myeloma-associated systemic amyloidoses. An echocardiogram should be done to evaluate the myocardium for signs of amyloidosis. Other tests may be useful in evaluating amyloidosis, as well as dynamic magnetic resonance imaging, Tc-99m phosphate radionuclide imaging, and 123I serum amyloid P scintigraphy.

There is a broad differential diagnosis with TA that should be considered in patients presenting with macroglossia or nodular tongue lesions. The differential diagnosis for generalized macroglossia, tuberculosis, lymphangioma, hypothyroidism, acromegaly, lingual infarction caused by giant-cell arteritis, idiopathic muscular hypertrophy, and Beckwith-Wiedemann syndrome should be considered. Furthermore, TA differential diagnosis must be considered with other nodular lesions such as fibroma, lipoma, granular cell tumor, sarcoma, and salivary gland tumors (5).

There is still no consensus regarding the management of TA, although numerous therapies have been proposed, including surgical excision and pharmacological treatment. Unfortunately, however, lesions often persist or recur. In addition, the prognosis is uncertain due to the rarity of the condition, requiring regular follow-up and monitoring (5).

In summary, TA is rare. Despite this, TA should be considered in the differential diagnosis of multiple or single yellowish nodules in the oral cavity.

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