Bibliographic review

Peri-Implant Soft Tissue Augmentation. Proper Timing and Surgical Procedure for Predictable Surgical Outcomes. A Bibliographic Review

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Date of receipt: 11 May 2018.
Date of acceptance for publication: November 29, 2018.

coem
Ilustre Colegio Oficial de Odontólogos y Estomatólogos de la I^{a} Región

Published in spanish Científica Dental Vol. 15. Nº 3. 2018
www.cientificadental.es

ABSTRACT

The role that the width of keratinized mucosa (KM) surrounding dental implants plays in the long-term stability of peri-implant tissues remains a topic for debate.

The aim of this review is to evaluate and describe the outcomes of available surgical procedures and the proper timing for augmenting peri-implant soft tissue.

A bibliographic search was conducted on the online PubMed and Medline databases, as well as a manual search for relevant articles comprising the period between 2012 and 2017, selecting for articles dealing with the various surgical procedures performed starting at time B (implant placement).

A total of 10 articles was selected, contrasting them in terms of the moment in time at which the surgical procedure was performed while analyzing the following study variables: keratinized mucosa width, keratinized mucosa thickness, postoperative contraction, surgical timing, and aesthetic outcome and postoperative discomfort.

The conclusion may be drawn that free gingival grafting has been shown to result in the greatest widths of keratinized mucosa. However, there are other materials available that reduce patient morbidity and eliminate the need for a second surgical site, such as a xenogeneic collagen matrix, which can be equally effective and predictable in outcome. Both a xenogeneic collagen matrix and connective tissue grafting offer superior aesthetic results to those achieved with free gingival grafting.

KEYWORDS

Dental implants; Connective tissue graft; Mucograft; Peri-implant keratinized mucosa; Peri-implant soft tissue volume; Increased soft tissue.

INTRODUCTION

Long-term successful outcomes in dental implants depend not only on osseointegration of the implants in the surrounding bone tissue, but also on preserving the health and integrity of the surrounding soft tissues.

The soft tissue surrounding the teeth is subdivided into keratinized mucosa (KM) and immobile keratinized mucosa (attached mucosa, (AM)) separated by the mucogingival junction. However, in implantology, peri-implant soft tissues are unevenly dealt with[1,2]. The structure and composition of the peri-implant mucosa are organized into a well-keratinized oral sulcus followed by a long binding epithelium and an insertion of connective tissue (Figure).

Despite many similarities, peri-implant tissues differ from the tissue surrounding the teeth in a number of ways, such as the amount of blood supply, the directionality of connective tissue fibers, the amount of fibroblasts and collagen fibers present, the permeability of the binding epithelium, and the presence of a minimum width of keratinized soft tissue attached to the teeth[1-3].

The role that the width of keratinized mucosa (KM) surrounding dental implants plays in the long-term stability of peri-implant tissues remains a topic for debate[4].

Recent systematic reviews conclude that inadequate KM peri-implant width is associated with increased plaque buildup, the presence of inflammation, soft tissue loss and insertion loss[1-7].

Also important for long-term success is the sealing of the circumferential tissues around the implants; namely, the early formation of an effective barrier capable of biologically protecting peri-implant structures, thus preventing bacterial penetration and the progression of marginal bone loss[8].

In line with this view, scientific data and clinical reports seem to indicate that an adequate width of the attached mucosa can facilitate oral hygiene procedures, thus preventing peri-implant inflammation and tissue degradation. Consequently, in order to prevent biological complications and improve long-term prognosis, the condition of soft tissues should be carefully evaluated when planning implant therapy. Knowledge of the appropriate surgical procedure and the most suitable timing for carrying it out appears to be of the utmost clinical significance when considering implant therapy[9].

Two methods for augmenting peri-implant soft tissue can be distinguished[1,2]:

1. Augmented KM *width*: apical replacement flaps (in combination with free gingival (FGG), allogeneic, or xenogeneic grafts).
2. Augmented KM *thickness*: subepithelial connective grafts, other soft tissue replacement grafts (xenogeneic, allogeneic).

In terms of optimal timing, four different loading protocols for carrying out an augment in the width or thickness of the soft tissues around implants can be distinguished[1,2]:

a. Prior to implant placement.

b. During implant placement.

c. During second surgery (2nd phase).

d. After the implant is osseointegrated, uncovered, and definitively loaded.

The aim of this study is to review the literature on the available surgical procedures and the proper moment in time at which to carry out an augment of peri-implant soft tissues in order to make the outcome predictable.

A total of 10 articles, listed in Table 1, were included.

Our review centered on describing the various augmentation procedures in use only once the implant has been placed; namely, procedures b, c, and d.

KERATINIZED MUCOSA (KM)

Whether or not there is a need for surgical intervention to augment the keratinized tissue surrounding implants in patients with reduced or insufficient tissue width remains controversial in the literature[10].

On the one hand, several studies suggest that the absence of KM in implants may favor peri-implant inflammation and recession. However, others find that there is insufficient evidence regarding the influence of KM width on the survival rate of KM implants and future recession[4].

Regardless of medical opinion, although the absence of KM tissue may not justify surgery, in situations where there is discomfort during brushing, poor control of bacterial plaque, or persistent inflammation or aesthetic alteration, the performance of soft tissue augmentation procedures around the implants may be advisable for restoring health and peri-implant aesthetics.

Various surgical procedures and materials have been proposed to increase the amount of soft tissue around dental implants[11].

Surgical procedures for increasing the width of keratinized tissue can be divided into free grafting procedures, bilamellar procedures, use of an autograft, xenograft, or allograft along with a replacement flap, or flap/vestibuloplasty (VP) procedures. The results of the studies included are listed in Table 2.

Time b: During the placement of implants.

Bruschi et al.[12] describe an apically repositioned partial-thickness flap (APPTF) procedure performed on patients who were to be treated with implants with the aim of increasing KM width. They reported a gain of 5.03 mm at one year and 5.14 mm at four years.

Time c: Coinciding with second surgery (2nd phase)

In the study comparing the use of a xenogeneic collagen matrix (XCM) with a free gingival graft (FGG), a gain of 7.76 mm was observed with the FGG. Higher gains were obtained with FGG (7.76 mm) when compared to the XCM group (6.51 mm)[13].

In the case of connective tissue grafting (CTG), gains of 0.90 mm were observed. No statistically significant differences were found between the use of XCM (1.2 mm) and CTG (0.9 mm) procedures in the Cairo et al. study[14].

Time d: After the implant has been osseointegrated, uncovered, and definitively loaded.

In the articles reviewed, KM gains between 2.36 and 4.05 mm were seen to be obtained using the FGG protocol. (15-16) Statistically significant differences were obtained in favor of FGG (2.36 mm) with respect to VP (1.15 mm). (15) With respect to the CTG protocol, KM width gain values ranging from 1.7 to 2.33 mm were observed[1,17].

The data obtained by Zucchelli et al.[18] resulted in a gain of 0.57 mm when using coronal flap repositioning (CFR+CTG).

Lorenzo et al.[11] observed KM width gains of 2.3 mm with the use of XCM. Comparing the outcome with the CTG and XCM procedure shows that there are no statistically significant differences between the two[11,19].

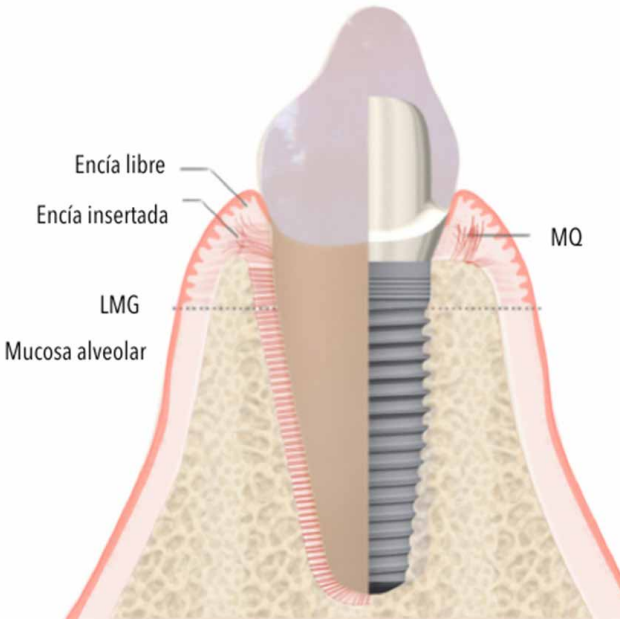

Figure. Cutaway view of the soft tissues around teeth and implants.

Table 1. Articles covered by the review.

Author /Year	Surgical Timing	n (number of implants) / Study group	Aim of Treatment	Surgical Procedure
Zucchelli et al. 2013[18]	D	20	Width - Thickness	CFR+CTG
Bruschi et al. 2014[12]	B	131	Width	APPTF
Lorenzo et al. 2012C[11]	D	24 Grupo control: CRA (EP)+ ITC (12) Grupo test: CRA (EP)+ MCX (12)	Width	APPTF+CTG APPTF+XCM
Schmitt et al. 2015[13]	C	176 Grupo control: VP+IGL (74) Grupo2: VP+MCX (102)	Width	VP+FGG VP+XCM
Roccuzzo et al. 2014[17]	D	16	Treat recession (width)	CTG
Baseman et al. 2012[15]	D	64 Grupo 1: CRA+IGL (32) Grupo 2: VP (32)	Width	APPTF+FGG VP
Puisys et al. 2015[21]	B	40	Thickness	ADM
Cairo et al. 2017[14]	C	60 Grupo control: ITC (30) Grupo test: MCX (30)	Width - Thickness	CTG XCM
Buyukozdemir et al. 2015[16]	D	60 Grupo1: Cantidad insuf de MQ —> IGL (20) Grupo2:Cantidad insuf de MQ —> mant. periodontal (20) Grupo 3:Cantidad suficiente de MQ	Width	FGG
Zeltner et al. 2017[19]	C	20 Grupo control: ITC (10) Grupo test: MCX (10)	Thickness	CTG XCM

LEGEND: *B: During implant placement; C: during second surgery phase; D: after the implant is osseointegrated, uncovered, and definitively loaded; CFR: Coronal flap replacement; CTG: Connective tissue graft; APPTF: Apically positioned partial thickness flap; XCM: Xenogeneic collagen matrix; VP: Vestibuloplasty; FGG: Free gingival graft; ADM: Acellular dermal matrix; KM: Keratinized mucosa.*

SOFT TISSUE THICKNESS (VOLUME)

To date, there exists no broad consensus regarding the amount of soft tissue volume functionally required on the vestibular face of dental implants. However, it can fairly be said that the amount of soft tissue volume will influence the aesthetic outcome and may even partially compensate for the lack of bone in the vestibular area.

The critical thickness for soft tissue on the oral side of dental implants has been shown to be <2 mm. However, as of today this parameter has not yet been evaluated three-dimensionally nor in a long-term clinical study.)

In the case of volume deficiency on the oral side of dental implants, soft tissue augmentation surgery has been considered an integral part of implant therapy. Assessment of the need for soft tissue augmentation is based on mucosal biotype and aesthetic expectations[3].

Fine peri-implant tissues are more prone to recession and are associated with increased marginal bone loss, suggesting the advantage of having a minimum of oral soft tissue thickness to prevent peri-implant tissue discoloration and bone loss[19].

Table 2. KM gain outcomes (in mm), and follow-up time of the studies included in the review.

Author/Year	KM Width Gain		Follow-up time
Zucchelli et al. 2013[18]	CRC+CTG: 0.57 mm		1 year
Bruschi et al. 2014[12]	APPTF: 5.03 mm	5.14 mm	1-4 years
Lorenzo et al. 2012[11]	CTG: 2.33 mm	XCM: 2.3 mm	6 months
Schmitt et al. 2015[13]	FGG: 7.76 mm	XCM: 6.51 mm	1 year
Roccuzzo et al. 2014[17]	CTG: 1.7 mm		1 year
Basegmez et al. 2012[15]	FGG: 2.36	VP: 1.15 mm	1 year
Cairo et al. 2017[14]	CTG: 0.9 mm	XCM: 1.2 mm	6 months
Buyukozdemir et al. 2015[16]	FGG: 4.05 mm		6 months

LEGEND: *KM: Keratinized mucosa; CRC: Coronal replacement flap; CTG: Connective tissue graft; APPTF: Partial thickness apical replenishment flap; XCM: Xenogeneic collagen matrix; FGG: Free gingival graft; VP: Vestibuloplasty.*

Soft tissue grafting contributes to over 40% of final peri-implant volume, results in better aesthetics, more stable oral soft tissue dimensions in combination with immediate implants and may favor more stable marginal bone levels around implants[19, 20].

Autogenous soft tissue grafts taken from the palate (free gingival and subepithelial connective tissue grafts) remain the gold standard for achieving an increase in soft tissue volume around implants. However, this type of procedure involves the need for a second surgical wound, as well as requiring longer healing time, and therefore exhibits greater patient morbidity. This, in addition to the limited availability of tissue, is one of the principal drawbacks to this type of procedure. Hence, alternative materials have emerged, such as the acellular dermal matrix (ADM) or the xenogeneic collagen matrix[21]. The study results are listed in Table 3.

Time b: During implant placement

Puisys et al.[21] observed a soft tissue volume gain of 2.21 mm when using ADM at 3 months.

Time c: At time of second surgery (phase 2)

In the case of CTG procedures, average volume gain ranged from 0.79 to 1.2 mm. As for XCM, the values obtained were between 0.77-0.9 mm[14.19].

While in the Cairo et al. study (14) statistically significant differences were found in favor of the CTG (1.2 mm) compared to XCM (0.9 mm), Zeltner et al. (19) found no differences in volume gain between the two groups (CTG 0.79 mm; XCM 0.77 mm).

Time d: After the implant is osseointegrated, discovered, and finally loaded

Zucchelli et al.[18] achieved a soft tissue volume gain of 1.54 mm at one year by using CRC+CTG.

OTHER FACTORS

Postoperative Contraction

The results of the studies included are listed in Table 4. A reduction in tissue volume of 0.33 mm was observed

Table 3. KM gain outcomes (in mm), and follow-up time of the studies included in the review.

Author/Year	KM Thickness Gain		Follow-up Time
Zucchelli et al. 2013[18]	CRC+CTG: 1.54 mm		1 year
Cairo et al. 2017[14]	CTG: 1.2 mm	XCM: 0.9 mm S	6 months
Puisys et al. 2015[21]	ADM: 2.21 ± 0.85 mm		3 months
Zeltner et al. 2017[19]	CTG: 0.79 mm	XCM: 0.77 mm NS	3 months

LEGEND: *KM: Keratinized mucosa; CRC: Coronal replacement flap; CTG: Connective tissue graft; XCM: Xenogeneic collagen matrix; ADM: Acellular dermal matrix; S: Statistically significant; NS: Not significant.*

Table 4. Postoperative contraction results expressed in mm%, time and statistical significance.

Author/Year	Postoperative Contraction		Follow-up Time	Statistical significance
Zucchelli et al. 2013[18]	3.07%		1 year	S
Lorenzo et al. 2012[11]	CTG: 0.33 mm.	XCM: 0.2 mm	6 months	NS
Basegmez et al. 2012[15]	FGG: 2 mm.	VP: 3.06 mm	1 year	S

LEGEND: *CTG: Connective tissue grafting; XCM: Xenogeneic collagen matrix; VP: Vestibuloplasty; FGG: Free gingival graft; S: Statistically significant; NS: Not significant.*

Table 5. Duration of surgery (in min) and statistical significance.

Author/Year	Duration of Surgery		Statistical significance
Lorenzo et al. 2012[11]	CTG: 46.25 min	XCM: 32.50 min	S
Schmitt et al. 2015[13]	FGG: 84.33 min	XCM: 65.11 min	S
Cairo et al. 2017[14]	CTG: 51.7 min	XCM: 35.5 min	S

LEGEND: *CTG: Connective tissue grafting; XCM: Xenogeneic collagen matrix; FGG: Free gingival graft. S: Statistically significant; NS: Not significant.*

Table 6. Aesthetic appearance results and postoperative pain and discomfort.

Author/Year	Group	Aesthetics		Pain and discomfort	
Zucchelli et al. 2013[18]	CRC+CTG	Patient	Clinical	-	
		VAS (0-10) S Initial: 3.80 Final: 8.00	-		
Lorenzo et al. 2012[11]	CTG XCM	-	Comparative photographs	VAS (0-10) 10 days: <3 CTG/<3 XCM 30 days: <1 CTG/0 XCM	Anti-inflammatory medication: CTG: 8 tablets XCM: 5 tablets
Schmitt et al. 2015[13]	FGG XCM	-	FGG < XCM in texture and color	-	
Roccuzzo et al. 2014[17]	CTG	VAS (0-10) S Initial: 3.60 Final: 8.50	-	-	
Cairo et al. 2017[14]	CTG XCM	-		VAS (0-100) S CTG: 37 XCM: 13	Anti-inflammatory medication: S CTG: 3.9 tablets XCM: 2.2 tablets

LEGEND: *CRC: Coronal replacement flap; CTG: Connective tissue graft; VAS: Visual analog scale; APPTF: Partial thickness apical replenishment flap; XCM: Xenogeneic collagen matrix; FGG: Free gingival graft; VP: Vestibuloplasty; ADM: Acellular dermal matrix; -: not measured in the study; S: Statistically significant.*

at 6 months using CTG as compared to 0.2 mm using XCM, the results not being statistically significant[11].

Zucchelli et al. (18) report a contraction of 3.07% at one year using the CRC+CTG procedure. For their part, Basegmez et al. (15) report a statistically significant difference between contraction when using FGG compared to VP, FGG being lower (2 mm) with respect to VP (3.06 mm).

Duration of Surgery

The results from the studies under review are listed in Table 5. The revised studies describe a surgical duration ranging from highest to lowest of: FGG (84.33 min), CTG (46.25-51.7 min) and XCM (32.50-65.11 min), the latter being lower in a statistically significant manner when compared to the first two. (11,13,18)

Aesthetics

The results from the studies under review are listed in Table 6. Two of the studies report patient aesthetic perception using the visual analog scale of 0-10 (VAS), obtaining values between 8 and 8.5 for CTG (17,18). Lorenzo et al. do not find statistically significant differences in terms of coloration and aesthetics between CTG and XCM[11].

Significant differences in both coloration and texture were detected when comparing FGG to XCM, which showed no differences with respect to adjacent areas[13].

Pain and Discomfort

In contrast, no statistically significant differences in pain and the amount of anti-inflammatory medication needed were found when comparing CTG with

XCM[11].Cairo et al.[14] did report statistically significant differences, both in the amount of pain and anti-inflammatory medication required.

CONCLUSIONS

Bearing in mind the limitations of any bibliographic review and the heterogeneity of the data, we may conclude that:

1. Optimal soft tissue sealing protects and preserves the underlying bone and is necessary to creating the emergency profile and biological peri-implant width.
2. The performance of soft tissue augmentation procedures around implants is recommended in cases of discomfort when brushing, poor bacterial plaque control, persistent inflammation, or aesthetic alterations.
3. Fine biotypes are more prone to recession and are associated with increased marginal bone loss; consequently, it is advisable to have a minimum thickness of oral soft tissue to prevent tissue discoloration and peri-implant bone loss.
4. Free gingival grafting has been shown to obtain the widest widths in keratinized mucosa when performed both during the second surgical phase and after osseointegration and functional loading of the implant.
5. CM as an alternative to the use of connective tissue grafts could be equally effective and predictable for increasing the width and thickness of keratinized mucosa, is associated with less patient morbidity, and yields similar results in terms of postoperative contraction.
6. Connective tissue grafts and use of a xenogeneic collagen matrix offer aesthetic results equal to or better than a free gingival graft.

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