Is A Soft Tissue Graft Harvested from The Maxillary Tuberosity the Approach of Choice in An Isolated Site?

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INTRODUCTION

The connective tissue graft (CTG) is considered the material of choice in treating gingival/mucosal recessions around teeth and implants because it provides an increased marginal soft tissue thickness, protects post-surgical healing by first intention, and maintains the innate tissue texture as of adjacent teeth/implants [1-4]. Initially, soft tissue graft was introduced for re-establishing an adequate width of keratinized tissue/mucosa (KT/KM) [5], and since then, the free gingival graft (FGG) has also been advocated for increasing the vestibular depth [6], root coverage [7] and for augmenting the KT/KM prior to crown placement [8]. Nowadays, a FGG is mainly used to re-create/augment KT width [9, 10], which is most important for dental implants. Indeed, in the 2017 World Workshop, the beneficial role of KM around implants for patient comfort and plaque control was confirmed [11].

The introduction of the CTG [12, 13] and the progressive changeover from the FGG to CTG was identified by Zuhr and colleagues as the catalyst for the transition from traditional mucogingival surgery (focused to a greater extent on increasing the tissue thickness and KT width) to periodontal plastic surgery (more esthetic- and patient- centered) [1]. CTG acts a biological scaffold that improves the stabilization of the flap to the root surface, promoting a greater soft tissue thickness and KT width at the same time [14]. Indeed, it has been shown that CTG is able to induce the keratinization of the overlying epithelium [15], especially if mainly composed by lamina propria and collagen fibers. On the contrary, a CTG from the deep palate seems not to have the same potential of inducing keratinization as superficial CTG [16] , which may be due to the large amount of adipose and glandular tissue that may act as barriers to the plasmatic diffusion and vascularization during the first phase of healing [17].

With this in mind, it remains controversial in determining the best location for obtaining a graft and the ideal harvesting technique that minimizes a patient's morbidity. Indeed, patient opinions and

preferences have slowly influenced decision making in the daily practice and clinical oriented considerations [18]. While graft substitutes seem to provide less stable long-term outcomes when compared to the autologous soft tissue graft [19-21], efforts have been made for developing techniques for harvesting a soft tissue graft that minimizes patient discomfort as well as one that allows healing by first intention [22-24]. Despite that first intention healing is one of the main goals of these approaches, over-thinning of the palatal flap is often encountered, leading to wound sloughing and increased patient morbidity [22, 23, 25]. Zucchelli et al. showed that a CTG can also be obtained by de-epithelialization of a FGG with similar post-operative morbidity compared to the traditional harvesting approach [25].

Nevertheless, the choice of harvesting technique is usually dictated by the anatomy of the site (such as the palatine artery, shape of the palatal vault, palatal thickness), the required graft thickness, and the clinician's preference [1, 26].

It has been suggested that the location of the donor site (whether anterior-, lateral-, superficial-, deep-palate or the maxillary tuberosity) can affect the graft shape and its composition [1]. In particular, concerns have been raised regarding the presence and amount of adipose tissue in the CTG that may act as a barrier to plasmatic circulation and impair the revascularization during the early healing phase [17]. The importance of these consequences has led some clinicians to prefer harvesting from the superficial palate or from the maxillary tuberosity due to the high amount of lamina propria and minimal submucosal tissue (adipose and glandular tissue) [9, 27].

Soft tissue grafts from the tuberosity are increasingly gaining popularity because of their ease in harvesting, the presence of low fatty/glandular tissue, and the richness in connective tissue fibers [1, 28, 29]. Additionally, harvesting from the tuberosity present minimal risk of intra- or post-operative

complications, resulting in reduced patient morbidity [1, 30-32]. The aim of this commentary is therefore to discuss the advantages and disadvantages of harvesting soft tissue grafts from the tuberosity and compare it to the traditional palatal grafts, while highlighting functional-, esthetic- and patient-related outcomes.

Harvesting approaches from maxillary tuberosity

While a FGG from the maxillary tuberosity (tFGG) can only be harvested by performing a gingivectomy, a CTG from the tuberosity (tCTG) can be obtained with a distal wedge procedure [1, 33] or by removing a gingival cuff and performing the de-epithelialization extra-orally [28, 31].

The distal wedge technique allows for approximating the mesial and distal flap margins post-harvesting, achieving healing of the donor site by first intention. However, there is no doubt that performing a gingivectomy is a faster and simpler procedure [31]. Several authors have described the harvesting of a gingival cuff from the tuberosity followed by extraoral de-epithelialization and trimming to perfectly adapt to the recipient site [28, 31]. In addition, tCTG can be split and "opened like a book" in order to increase the graft width for the treatment of multiple defect areas [32].

However, there are situations in which the amount of tCTG that can be harvested from maxillary tuberosity is limited, such as in the presence of a third molar or following a past periodontal surgery, therefore, harvesting from the lateral palate may be a better choice in this condition.

It may be concluded that the healing of the tuberosity donor site, whether by first or second intention, is not crucial to patients' post-operative morbidity since the maxillary tuberosity is less exposed to friction during eating and does not come in direct contact with the tongue compared to the palate [30]. Moreover, it should be mentioned that greater consumption of analgesics was found to be related to a lower residual soft tissue thickness from the donor site [25]. This may also explain

the reduced post-operative pain after harvesting from the maxillary tuberosity, which is the thickest area of the oral masticatory mucosa [34].

Soft tissue graft from the tuberosity around natural teeth

The simplicity of the procedure, the limited risk of complications and the minimal graft shrinkage during the healing [1, 31] are main advantages that have contributed to the popularity of tCTG among clinicians. In addition, a tCTG can also be obtained during a distal wedge procedure from the posterior maxillary region for the purpose of treating gingival recessions in other areas as well [32]. When compared to a palatal CTG in the bilaminar technique, the tCTG has shown similar mean root coverage outcomes and a greater gain in tissue thickness[30]. This tendency was also observed for the FGG [30]. Moreover, given the increasing attention to patient perception and their subjective reported outcomes in clinical practice and clinical trials [18, 35], it is important to highlight that the tuberosity donor site may have heal faster than the palatal donor site and lead to much less morbidity (based on visual analogue scales and painkiller consumption) [30]. This may be due to a greater thickness remaining over the bone after the harvesting procedure on the tuberosity sites compared to the palatal donor sites, which is associated with better tolerance of post-operative pain [25]. In addition, the tuberosity area is also less exposed to masticatory friction and does not come in direct contact with the tongue[30].

While a greater tissue thickness provided by a tCTG can be considered beneficial in soft tissue augmentation [36], a tendency for a fibrotic response that can lead to unaesthetic outcomes (requiring an additional plastic surgery) has also often been observed following the tCTG [31, 36]. Table 1 summarizes the outcomes of the studies that compared a soft tissue graft from palate and from the maxillary tuberosity.

Tuberosity soft tissue graft for dental implants

The treatment of soft tissue dehiscences around implants poses more challenges and often results in lower outcomes than root coverage in natural teeth [37, 38]. It has been suggested that the graft quality and composition may play a crucial role [4, 27, 28]. Indeed, outcomes of 96.3% and 89.6% in mean dehiscence coverage were obtained with a CTG from the superficial palate [27] and tCTG [28], respectively (both mainly composed of lamina propria), as opposed to clinical trials that used a subepithelial connective tissue graft (SCTG) from the deep palate (rich in fatty and glandular tissue) that reported a tendency of graft shrinkage over time, as well as less percentage of mean dehiscence coverage[37, 38]. Additionally, the quality of the graft has also been shown to play a role in the long-term stability of the results [4, 39].

In addition, when soft tissue augmentation is performed for correcting peri-implant volume deficiencies, tCTG was shown to provide a greater KT width gain than the SCTG (and a greater tissue thickness apically) [33] (Table 1). Once again, this result may be explained by the composition of the graft with tCTG being more stable and collagen-rich than the SCTG [33], which better enables inducing keratinization of the overlying epithelium [15, 40]. In particular, having an adequate amount of keratinized mucosa has been shown to be crucial for maintaining implant health [9, 41].

To increase tissue thickness, using tCTG can also be successfully applied during an immediate implant placement in the esthetic area, where thickening marginal soft tissue can prevent recession of the mid-facial mucosa [42, 43]. tCTG has demonstrated a mean gain of 0.1 mm in the mid-buccal mucosal tissue versus a loss of 0.5mm in the no graft site during immediate implant placement [43]. Nevertheless, no differences in the pink esthetic score and patient satisfaction were found [43].

Histological and molecular analysis of tuberosity soft tissue graft

The reason for the different clinical performance between the SCTG and tCTG has also been investigated in histological studies and at the molecular level [29, 36]. Compared to the SCTG, the tCTG was found to have a denser but less vascularized lamina propria (72.79% for the tCTG vs 51.08% for the SCTG) while the SCTG showed to be richer in submucosal tissue including glandular and adipose components (25.75% vs. 4.89%) [29, 36]. Given the evidence suggesting that high amounts of submucosa tissue in the graft may result in more graft shrinkage, less volume gain, and no or minimal effect on epithelium keratinization induction [1, 33, 40], these findings further support the rational to consider tCTG as a viable (or of higher quality) alternative to palatal CTG, especially when comparing to grafts harvested from the deep palate [16].

On a molecular level, a tendency for decrease in mRNA levels of collagen type I and III (COL-I and COL-III) was observed in tCTG compared to SCTG and the overall long lysyl hydroxylase 2 (LH2b) mRNA levels was up-regulated [36]. In addition, a four-fold increase in LH2b/COL-1 ratio has been reported in tCTG, suggesting that tuberosity-derived collagen is less subject to degradation by metalloproteinases (MMPs) [36]. This may be the mechanism responsible for collagen accumulation in sites augmented with tCTG. In addition, tCTG was found to exhibit a higher expression of LLH2 antibodies, which are over-expressed in fibrotic tissues. Lastly, the tendency for higher cytokeratin formation at the epithelia in tCTGs has been speculated that it is related to the potential of inducing keratinization of the peri-implant mucosa. [29]

Therefore, it can be summarized that tCTG and SCTG illustrate not only different percentages of lamina propria and submucosa, but also gene expression that may explain the variability in clinical outcomes (KT width gain, volume gain and hyperplastic healing). In particular, tCTG resembles a

more a fibrotic tissue with a tendency for a hyperplastic response and therefore, as suggested by Dellavia et al. [36], its thickness should be limited to < 3 mm.

CONCLUSION

Within its limitation, the present article highlights the advantages and disadvantages of a soft tissue graft from the maxillary tuberosity, describing its application around natural teeth and dental implants. Clinical, histological and molecular analyses have shown a different behavior and composition compared to the palatal soft tissue graft, especially from the deep palate. Therefore, clinicians should bear in mind that the maxillary tuberosity is a valid donor site for harvesting a soft tissue graft and it may provide advantages compared to the palate, particularly when increased KT width, gain in soft tissue thickness and reduced patient morbidity are primary aims. Nevertheless, this procedure may result in an unaesthetic hyperplastic response and in cases with a thick phenotype or when esthetic concerns are of primary concern, a CTG harvested from the palate may provide superior outcomes.

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TABLES

Table 1. Outcomes of the studies comparing soft tissue graft from palate and from maxillary tuberosity

Treatment groups	mRC (mean ± SD) (%)	KT gain (mean ± SD) (mm)	Thickness (mean ± SD) (mm)	Final PES (mean ± SD)	Pain (mean ± SD) during the first 2 weeks (VAS)	Pain (mean ± SD) at 4 and 8 weeks (VAS)	Reference
tCTG vs SCTG	NA	NA	6.8 ± 1.1 vs 4.9 ± 0.6 (at 1 year)	NA	NA	NA	Dellavia et al. (2014)
tCTG vs SCTG	NA	0.83 ± 0.61 vs 0.22 ± 0.48*	Comparable from 1 to 5 mm apical to the healing abutment. Significantly higher in favor of tCTG at 6-7 mm apical to the healing abutment	9.15 ± 2.34 vs 10.07 ± 2.19	NA	NA	Rojo et al. (2018)
tCTG vs DGG	67 ± 12 vs 62 ± 13	NA	1. 2.9 ± 0.5 vs 2.3 ± 0.6 (at 8 weeks) †	NA	2.6 ± 2.2 vs 5.9 ± 2.7‡	0 ± 0 vs 0 ± 0	Amin et al. (2018)
tFGG vs pFGG	NA	NA	2.7 ± 0.7 vs 2.1 ± 0.7 (at 8 weeks) †	NA			Amin et al. (2018)

Note. tCTG: connective tissue graft from tuberosity. SCTG: sub-epithelial connective tissue graft (from palate). DGG: de-epithelialized gingival graft (from the palate). tFGG: free gingival graft from tuberosity. pFGG: free gingival graft from palate. mRC: mean Root Coverage. PES: Pink Esthetic Score. VAS: visual analogue scale. *: P value < 0.01. †: P value < 0.05. ‡: P value <0.001.