



Guided Bone Regeneration Versus Connective Tissue Graft to Increase Volume in the Aesthetic Sector

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Abstract

Objectives: Compare the volumetric changes and its long - term stability generated by guided bone regeneration techniques versus connective tissue grafts in the second phase of integrated implants, as well as to compare the aesthetic results obtained with them.

Materials and Methods: A bibliographic review is carried out in relation to articles published in the last 10 years in various languages, including several not included in this range given their interest, being grouped according to year and similarity.

Results: The data show volume gain in the aesthetic sector with both procedures: guided bone regeneration and connective tissue grafting; obtaining a percentage of unit recession over implants and volume increase of up to 89,6 % by the second procedure [14].

In terms of dimensional stability with one-year results, vestibular volume was stable, not showing statistically significant results between both procedures, although in terms of contraction it is less for the connective tissue graft [11].

Conclusion: Within the limitations of the present review, it can be concluded that volume increase is possible with both procedures, being two highly predictable procedures with one-year results, obtaining stable values.

More long-term studies are needed to continue assessing this dimensional stability over time [11].

Satisfactory aesthetic results are produced with both techniques because they are related, although ITC is considered the gold standard for soft tissue augmentation in a second surgical phase, obtaining more satisfactory values [1,5-7].

Keywords: Guided Bone Regeneration; Connective Tissue Graft; Aesthetic Sector

Introduction

Aesthetics is a concept that has revolutionized dentistry in the last decade; And it is that when we have to replace a lost tooth in the anterior sector, maintaining the volume of the tissues is going to become a real challenge for the operator.

When we apply this concept to the field of implantology and apply it to aesthetics, our primary objective will be to preserve or recover the gingival margin so that it is as similar to that of its contralateral tooth [1].

When rehabilitating a tooth that is absent in the anterior sector, be it maxillary or mandibular, we must bear in mind that the residual bone table will undergo a series of alterations in terms of its size after the extraction. There is going to be a bone remodeling with a consequent reabsorption, which will take place during the 12 months after extraction and being more accentuated during the first 3 months; This remodeling is more pronounced in the vestibular wall, which will be reduced by 50% and the concavity will be increased in the central area. In terms of height, only slight changes of less than 1 mm will occur during these 12 months of healing [2-4].

Knowing these dimensional changes, we can act in various ways. One option is to try to preserve this alveolar ridge at the time of extraction. We can also address the defect using regenerative augmentation techniques before or at the time of implant placement. Or, deferred, in a second surgery or reentry. We can add that the immediate placement of implants in post-extraction sites is a successful method when it comes to preserving bone structures [3,4].

Various oral soft and hard tissue bulking techniques and materials have been proposed. For soft tissue augmentation procedures we have the use of autogenous materials, such as free gingival grafts (Sullivan and Atkins, 1969), subepithelial connective tissue grafts; or allogenic materials (acellular dermal matrix) or xenogeneic (collagen matrix or Mucograft®), being the connective tissue graft the gold standard [1,5-7].

We could affirm that there is no consensus as to a minimum amount of keratinized gingiva necessary around implants to achieve good gingival health, but it would be necessary if we want to achieve an adequate volume to achieve ideal aesthetics [1,6].

Referring to the increase in hard tissues, the main highlight is the bone regeneration guided by xenografts, which have good osteoconductive characteristics and limited reabsorption, as well as the use of resorbable collagen membranes [1].

To all this, we must add the importance of the patient's type of smile. Unlike natural teeth, in which we can even accept 1 or 2 mm of recession as normal, in an implant treatment we could consider aesthetic failure when this migration of the soft tissues occurs, due to the exposure of the titanium; or even a horizontal collapse of the tissue can be responsible for an aesthetic failure [8].

If we think about avoiding long-term exposure of the implant placed in post-extraction sockets with thin cortices as a result of remodeling, a good time to act would be the second phase or reentry.

We must emphasize that it has not been analyzed whether the increase, stability and long-term aesthetics are better with an in-

crease in soft or hard tissue in implants, and therefore we will try to compare the technique considered as the gold standard of both augmentation options: connective tissue graft (CTG) versus guided bone regeneration (GBR) with xenograft and membrane.

Objectives of the Study

Next, we go on to detail the main objective and the secondary objectives.

Primary objective

- To compare the volumetric changes and their long-term stability generated by techniques of guided bone regeneration versus connective tissue grafts in the second stage of osseointegrated implants.

Secondary objectives:

- Compare the aesthetic results obtained by the two techniques.
- Analyze which of them have greater associated surgical complications.

The type of study shown is a descriptive bibliographic review with a search methodology that favors its reproducibility.

PICO question (Patient - Intervention - Comparison - Results):

- Patient: Osseointegrated implant with a horizontal bone defect that requires an increase in volume.
- Intervention: Bone regeneration guided by bone xenograft and collagen membrane (GBR).
- Comparison: Autologous connective tissue graft (CTG).
- Results: Which of the two best maintains volume and aesthetics within a period of at least 1 year.

Search procedure

This review has been carried out by searching various sources of information (See table 1).

The information has been obtained through different scientific articles, as well as various reviews, which have also been used to create ideas and acquire knowledge prior to carrying out this bibliographic review.

Databases	Electronic journal	Websites
Medline (Pubmed)	<i>International Journal of Periodontics and Restorative Dentistry</i> <i>Journal of clinical periodontology</i> <i>Periodontics</i> <i>Clin Oral Implants Research</i> <i>Clinical Oral Investigations</i> <i>Journal of Dental Research</i>	

Table 1: Sources of information.

For this search, the following variables have been used in the form of parameters: KEYWORDS: "soft tissue aumentation", "guided bone regeneration", "graft", "free gingival graft", "soft tissue volume", "guided tissue regeneration", "bone substitutes", "soft tissue defect", "connective tissue graft", "single implant".

1st search: (guided tissue regeneration) OR guided bone regeneration.

Search parameters:

- Type of articles: Comparative articles, systematic reviews.
- Publication date: last 10 years.
- Species: humans.
 - Total articles: 366 articles.
 - Selected articles: 0 articles.

2nd search: (connective tissue graft) OR guided bone regeneration.

Search parameters:

- Type of articles: Comparative articles, systematic reviews.
- Publication date: 10 years.
- Species: humans.
 - Total articles: 2 articles.
 - Selected articles: 1 article.

D'Elia C, Baldini N, Cagidiaco EF, Nofri G, Goracci C, de Sanctis M. Peri-implant Soft Tissue Stability After Single Implant Restora-

tions Using Either Guided Bone Regeneration or a Connective Tissue Graft: A Randomized Clinical Trial. *Int J Periodontics Restorative Dent.* 2017 May/Jun;37(3):413-421. doi: 10.11607/prd.2747. PubMed PMID: 28402353.

3rd search: (connective tissue graft) AND guided bone regeneration.

Search parameters:

- Type of articles: Comparative articles, systematic reviews.
- Publication date: 10 years.
- Species: humans.
 - Total articles: 20 articles.
 - Selected articles: 1 article (1). (Appears in search above).

4th search: (guided tissue regeneration) AND guided bone regeneration.

Search parameters:

- Type of articles: Comparative articles, systematic reviews.
- Publication date: 10 years.
- Species: humans.
 - Total articles: 257 articles.
 - Selected articles: 2 articles.

De Bruyckere T, Eeckhout C, Eghbali A, Younes F, Vandekerckhove P, Cleymaet R, Cosyn J. A randomized controlled study comparing guided bone regeneration with connective tissue graft to re-establish convexity at the buccal aspect of single implants: A one-year CBCT analysis. *J Clin Periodontol.* 2018 Nov;45(11):1375-1387. doi: 10.1111/jcpe.13006. PubMed PMID: 30133718.

Yen CC, Tu YK, Chen TH, Lu HK. Comparison of treatment effects of guided tissue regeneration on infrabony lesions between animal and human studies: a systematic review and meta-analysis. *J Periodontal Res.* 2014 Aug;49(4):415-24. doi: 10.1111/jre.12130. Epub 2013 Sep 24. Review. PubMed PMID: 24111550.

5th search (guided bone regeneration) AND single dental implant.

Search parameters:

- Type of articles: Clinical trial, systematic reviews.
- Publication date: 10 years.
- Species: humans.
 - Total articles: 40 articles.
 - Selected articles: 0 articles.

All the data that were selected for subsequent analysis and contained in this study were documents comprised in a specific period of time: from 2010 to 2020 (present).

This bibliographic search began in July 2019 and ended in March 2020, with a certain procedure that we will detail later.

To search for these documents, the aforementioned databases (PubMed) were used in which an advanced search was carried out by combining the keywords and using “or” and “and”, in addition to when it was allowed in “Mesh Term” terms.

The search was limited as there is very little literature comparing connective tissue graft versus guided bone regeneration for bulking. This bibliography usually appears separately, but there are no articles in which the two terms are mentioned and also follow our inclusion and exclusion criteria.

Database	Keywords	Total Articles	Pre-Selected Articles
Medline (Pubmed)	Guided tissue regeneration OR Guided bone regeneration	366 articles	0 articles
Medline (Pubmed)	Connective tissue graft OR Guided bone regeneration	2 articles	1 article
Medline (Pubmed)	Connective tissue graft AND Guided bone regeneration.	20 articles	1 article (Appears in second search)
Medline (Pubmed)	Guided tissue regeneration AND guided bone regeneration	257 articles	2 articles
Medline (Pubmed)	Guided bone regeneration AND single dental implant.	40 articles	0 articles

Table 2: Databases consulted and results of said search.

In addition to the articles selected in the bibliographic searches through the Pubmed database, other articles included in the previous bibliography that were considered relevant for our review were also selected.

After entering the limiters with which the search was carried out, we proceeded to read all the documents found and the following inclusion and exclusion criteria were applied to refine the information previously obtained (See table 3).

In a first overview of the documents mentioned above, their selection was based on methodological quality. After this step, the objectives and results were analyzed, in order to see if they agreed with the objectives of this review.

Finally, the documents included were read, grouping and classifying the information in various Excel tables, based on: Author and year, journal, study design, objective, treatment/procedure group, sample size, inclusion criteria, exclusion criteria, examiners, primary variable and measurement method, other variables, follow-up, results and conclusions.

As limitations that we found in this study were the lack of bibliography referring to the comparison between the two regenerative techniques together, being found separately; in addition to finding almost all the information contained in non-osseointegrated implants.

Inclusion Criteria	Exclusion Criteria
Content referring to: guided tissue regeneration (soft and hard tissues) in single implants.	Articles whose title covered some keyword but did not focus on the main objective.
Period of publications (years): 2010 - 2020 (present).	Articles published in years prior to 2010.
Scientific articles in full text (full text), which after reading the abstract we consider of interest.	Articles not written in any of the languages mentioned above.
<i>In vivo</i> articles. Human studies.	Clinical trials.
Articles in English, Portuguese, Italian and Spanish.	Multiple implants.
Doctoral theses.	Procedure performed simultaneously with implant placement.
Osseointegrated implant.	Implant placed in the posterior sector or in the lower arch.
Procedure performed during the second stage on implants/ Reentry.	Second phase performed with GBR with another material different from xenograft + resorbable collagen membrane.
Implant in aesthetic zone.	Second phase in which CTG substitute material was used.
Second phase performed with GBR with xenograft + reabsorbable collagen membrane.	
Second stage carried out with CTG.	

Table 3: Inclusion and exclusion criteria.

Results and Discussion

Description of the techniques for increasing hard and soft tissues

A bone thickness of at least 2 mm on the buccal side is considered an ideal situation. Although normally it is impossible to achieve due to atrophied ridges or traumatic extractions, so we will need soft and hard tissue augmentation therapies [9,10].

Various techniques of bone augmentation with materials have been proposed (Aghaloo and May, 2007) (Chiapasco, *et al.* 2009) (Jensen and Terheyden, 2009) (Milinkovic and Cordaro, 2014) [11].

Guided bone regeneration (GBR): it is a technique that has evidence and is widely used today; its results are widely predictable (Buser, *et al.* 2017).

It is often used to treat wide or horizontal bone defects that remain after implant placement (Benia, *et al.* 2017).

Its main objective is the formation of the buccal bone wall, which is very important to serve as support and achieve stability of the soft tissues and avoid future dehiscence of these [1,3,10].

GBR advantages [1]

- Morbidity: causes less morbidity due to the fewer number of surgical sites.
- Stability: maintains the soft tissue around the implant.
- Contraction: prevents the contraction of the marginal soft tissue.

GBR disadvantages

- Complications.

As disadvantages of this technique we could mention a high prevalence in terms of post-operative complications due to the sur-

gical technique and factors inherent to the patient, in addition to the fact that it is a procedure that involves several stages and that has an impact on the papillae [1,3,10].

Among the techniques proposed for soft tissue augmentation (Espósito, *et al.* 2012) (Eyhbali, *et al.* 2016) (Bruyckere, *et al.* 2015) or a combination of both (Schneider, *et al.* 2011, Cosyn, *et al.* 2015) [11].

Subepithelial connective tissue graft (CTG): It can be obtained either from the maxillary tuberosity or from the palate and it is considered the gold standard for soft tissue augmentation [7,11].

If we mention the techniques with autogenous material, we can divide them into roll - flap, palatal CTG and subepithelial CT [1].

CTG advantages

- Autogenous.
- Minimally invasive process and requires a single intervention [3,11].

CTG disadvantages

- Morbidity: higher morbidity than GBR.
- Long-term stability: it has a drawback in terms of maintaining horizontal stability and that is that we do not have long-term studies (Hauser and Khoury, 2016).
- Inherent limitations of the donor site in terms of thickness and length due to anatomical structures, palatal nerves and blood vessels.

Volumetric changes according to the technique used (GBR versus CTG)

Hard tissues

After the extraction of a tooth, a series of biological processes take place that involve bone remodeling, as well as a subsequent reabsorption of the edentulous ridge.

The alveolar process is a structure that depends entirely on the tooth and that it is inevitable that it will suffer alterations after the dental absence [3,11,12].

Several authors agree that, although we apply alveolar preservation therapies (Vignoletti, *et al.* 2012), dimensional changes will occur that will be less accentuated in the apical and middle portion and are more increased in the coronal portion; as well as the loss of said volume is more pronounced in the buccal aspect than in the lingual/palatal aspect [3,11,12].

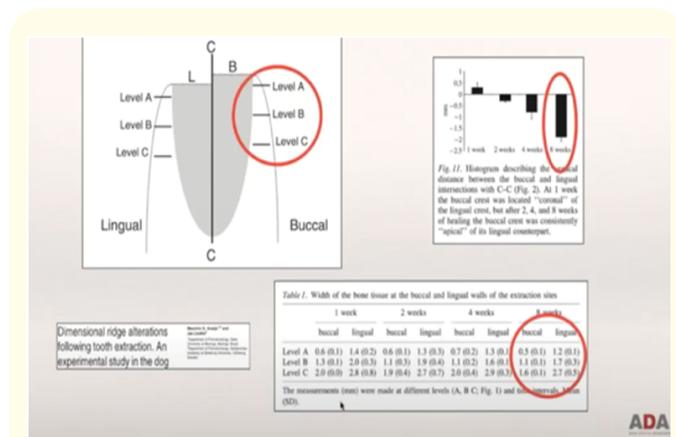


Figure 1: Dimensional changes in the post-extraction socket [12].

In a systematic review in which dimensional changes in post-extraction alveoli are analyzed, they reached a conclusion; At the sixth month after extraction, there is a horizontal loss of 3.79 (± 0.23) mm, as well as a vertical bone loss of 1.24 (± 0.11) mm [12].

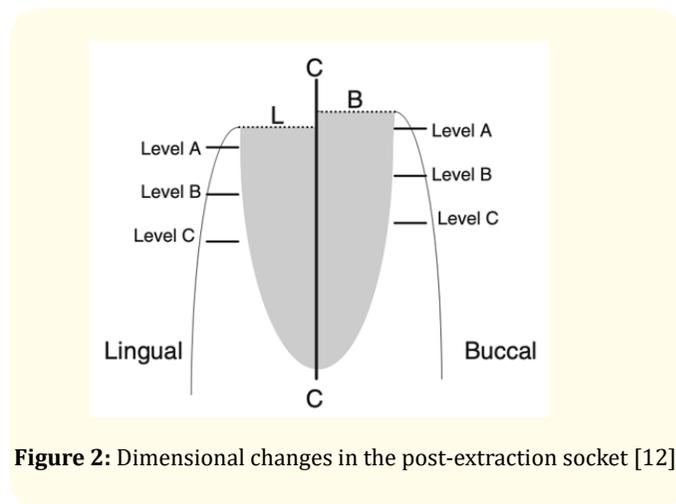


Figure 2: Dimensional changes in the post-extraction socket [12].

Soft tissues

Focusing on soft tissues, the literature agrees that changes also occur in these, such as a loss of soft tissue thickness of between 0.4 - 0.5 mm, as well as a displacement of the mucogingival line towards the coronal [13,14].

In a systematic review conducted by Bassetti, 2016, he compares different augmentation methods for keratinized gingiva around osseointegrated or covered implants with insufficient tissue around them such as:

- Vestibuloplasty.
- An apically positioned partial-thickness flap (APPTF) in combination with autogenous graft: free gingival graft (FGG) and subepithelial connective tissue graft.
- An apically positioned flap + allogenic materials (AMDA) or xenogenic collagen matrices (XCM).

It gives us evidence that the coverage of these can be achieved for volume increase with subepithelial connective tissue grafts combining it with an apical replacement of the partial thickness flap [14].

In another systematic review carried out by Bassetti, 2016, the same year assesses the efficacy of different methods for increasing the volume of keratinized mucosa around implants, in a second surgical stage. The methods used are:

- An apically positioned flap.
- Partial thickness vestibuloplasty adding a free gingival graft.
- Xenogenic collagen matrices (XCM/Mucograft).
- Mucosal epithelium.
- Partial thickness vestibuloplasty adding a subepithelial connective tissue graft (CTG): 2.30 mm are gained and the surgery time is estimated at 46.25 minutes.

It concludes that a good gingiva width added to a good volume of soft tissue has a positive impact on long-term stability, and that a good method to achieve this in the upper jaw can be the combination of a partial thickness apical repositioning flap (APPTF) adding a subepithelial connective tissue graft of the palate, but suggested that in aesthetic regions to achieve a good texture and improve color, an XCM collagen matrix is better [15].

After analyzing the two studies carried out by Bassetti in 2016, we have to assess the importance of these in our review, since, due to the limited literature that specifically talks about coating in a second-stage around implants, we demonstrate that CTG combined with a replacement technique is an effective method of augmentation of soft tissues around implants in osseointegrated implants, although as mentioned above they are studies with a follow-up of 6 - 12 months [14,15].

There is no bibliography in the literature that compares the long-term stability of the tissues of GBR versus CTG performed in a second surgical or reentry phase, although we have found two studies that do carry out the comparison, but we have to note that the entire treatment in a surgical phase at the time of implant placement.

In a recent study (Thoma, 2016) in which the efficacy of bulking was evaluated by comparing the use of collagen matrix versus connective tissue graft and its long-term stability; thickening results only date back to three months.

The ideal characteristics that a graft should have are specified, since it is important that it maintains long-term dimensional stability, as well as having a favorable biological behavior allowing a good remodeling process. It concludes that both are totally predictable procedures for the increase of these, although the CTG is considered as the gold standard and that long-term studies are needed [11].

When we talk about the stability of soft tissue around an implant using GBR versus CTG, the authors referred to the fact that there was only one controlled clinical trial (D'Elia, 2017) that compares these for the restoration of vestibular convexity in implants individual.

In this study, the test group (GBR) used xenograft plus membrane and the control group (CTG) used a de-epithelialized CTG of the palate.

Evaluates the stability of the soft tissue thickness at two moments, t1 (6 months later) and t2 (one year after the surgical procedure): for the test group (GBR) similar results are obtained 3.56 ± 1.23 (t1) and 3.7 ± 1.1 (t2); for the control group (CTG), 3.6 ± 1.5 (t1) and 3.73 ± 1.13 (t2) were obtained.

Procedure	Follow-up time	Stability results (mm)
Test group (GBR)	T0 (implant placement: 0 months)	3.56 +- 1.23
	T1 (crown placement: 6 months) T2 (1 year)	3.7 +- 1.1
Control group (CTG)	T0 (implant placement: 0 months)	3.6 +- 1.5
	T1 (crown placement: 6 months) T2 (1 year)	3.73 +- 1.13

Table 4: One-year stability ROG versus ITC [1].

Within the limitations of the trial by D 'Elia, 2017, the authors conclude that GBR is an effective method in maintaining vestibular gingival volume when performed together with implant placement, and does not show significant differences in gingiva contraction with CTG, although if observed at one year, CTG offered less contraction; on the other hand, regeneration causes less morbidity due to the fewer number of surgical sites [1].

Coincides with Debruyckere, 2018; which compared in another trial the GBR with CTG to restore the vestibular aspect of individual implants and reached the conclusion in agreement with D 'Elia, 2017, that both the GBR and the CTG were effective and reproducible methods for wall restoration in long-term single implants [3].

We must also add that these are studies carried out on non-osteointegrated implants, so we can deduce that they are predictable methods over time, although they have not been carried out following our inclusion criteria.

Aesthetic results according to the technique (GBR versus CTG) Hard tissues

Although scientific evidence is lacking, several authors agree that soft tissue augmentation should be considered in places where aesthetics predominate and we want to improve comfort and reduce discomfort for the patient [3,8,16].

In recent years, aesthetic demands and patient dissatisfaction have increased when we want to replace a tooth with an implant in a maxillary or mandibular anterior sextant, so that to achieve the success of the treatment it is a priority to achieve the patient's satisfaction [1,8].

Minimum amount of gingiva around implants: We do not have enough evidence and it remains a controversial issue whether a keratinized gingiva width is necessary to achieve peri - implant health, although there is evidence that a width less than 2 mm will develop plaque accumulation with the consequent inflammation, retraction and subsequent loss of attachment [8,14].

Just as width is important, a certain thickness is also necessary to achieve long-term stability of the peri-implant tissues; There is evidence that thin dental tissue is usually associated with bone loss around the osseointegrated implant when compared with a wide thickness [14].

We must add that there are several factors that are influential in terms of maintaining the soft tissue level [10]:

- Keratinized gingiva versus non-keratinized or alveolar gingiva.
- Mobile versus non-mobile mucosa.
- Thickness of the mucosa.
- Vestibular bone level and thickness (three-dimensional placement).
- Implant angulation.
- Interproximal bone crest level: a minimum separation between implants of 3 mm is necessary if we want to achieve papilla formation between implants [9].
- Surgical technique.
- Abutment and connection of the prosthesis.

Regarding the coverage of recessions in individual implants in the aesthetic sector, we have several studies that evaluate the coverage of soft tissues using various materials and techniques.

Due to the limited bibliography found that specifically evaluates our main objective, three studies were found, which were included in the Bassetti review, 2016 and focused on evaluating the increase in volume to cover recessions [14].

In the case of Roccuzzo, 2014, using a CTG in an envelope without incisions, he obtained a final coverage of 89.6 ± 12.1%. It con-

cludes that soft tissue dehiscences around implants can be treated successfully [8].

Zucchelli, 2013, which uses a coronal replacement flap, also adding a connective tissue graft, obtains a final coverage of the recession of $96.3\% \pm 2.62\%$ and concludes that the bilaminar technique was effective for the coverage of a single tooth, resembling it to its contralateral tooth and that in order to achieve greater aesthetics, the replacement of the crown on the implant was recommended [10].

We could conclude, based on the results obtained in the two previous studies (Rocuzzo., *et al.* 2014) (Zucchelli, 2013), that an CTG obtained from both the palatal region and the tuberosity region are predictable coating methods and thus, increase in volume in single implants, and that, depending on the surgical technique used, we will achieve a higher percentage of coverage [8,10].

However, Burkhart, 2008 uses the coronal replacement flap and a connective tissue graft and obtains 66% as a result. He adds that there is a significant improvement but there is no complete coverage [14].

The first two studies are the basis of our results, since they are carried out on osseointegrated unit implants [8,10].

Author	Technique	Results of volume increase and recession coverage (%)
Burkhart., <i>et al.</i> 2008	CAF + CTG	66% (Improvement, but not full coverage)
Zucchelli., <i>et al.</i> 2013	STF + CTG	96.3% (Effective for coverage)
Rocuzzo., <i>et al.</i> 2014	STF + CTG	89.6% (Dehiscences can be treated successfully)

Table 5: CTG volume increase combined with different techniques [14].

We must add according to the other systematic review carried out by Bassetti, 2016, in which it compares different covering techniques such as CTG or Mucograft®, as well as apical replacement flaps adding free grafts, considers that CTG is the gold standard for

volume increase in aesthetic regions, and this or the XCM or Mucograft® could be recommended in aesthetic regions to improve tissue color and soft tissue texture [17].

Regarding the stability of the soft tissues, we only have results at one year, which confirm predictability, but more research is needed on this topic [8,10].

Hard tissues

GBR has been shown to keep soft tissue volume stable with results after one year, so the gingival level of the gingiva is linked to the long-term stability of the bone graft [1,3].

Conclusion

1. Within the limitations of this review, both guided bone regeneration (GBR) and connective tissue graft (CTG) are effective methods of horizontally increasing hard and soft tissues in a second surgical phase.

Data on volume increase (%) are obtained, as well as recession coverage by soft tissue graft (TCI) [14].

2. Stable oral soft tissue thickness values are obtained within a year for the GBR of: 3.56 ± 1.23 mm (6 months) 3.7 ± 1.1 mm (1 year) and for the CTG of 3.6 ± 1.5 mm (6 months) 3.73 ± 1.13 mm (1 year), not obtaining statistically significant differences in terms of dimensional stability.

It is observed that the CTG offers less contraction compared to the GBR within a year.

3. Aesthetics and dimensional stability of the volume of hard tissues in the anterior sector are related, so we can conclude that favorable aesthetic results are produced with both techniques, although CTG is considered the gold standard to achieve greater aesthetics in aesthetic regions for volume increase vestibular in a second surgical phase.
4. GBR presents less morbidity due to the smaller number of surgical sites. As limitations of the CTG we have the scarcity of donor tissue.

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