

Consensus Report

Tissue augmentation and esthetics (Working Group 3)

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Abstract

Introduction: The remit of this working group was to update the existing knowledge base regarding bone augmentation for implant site development and soft-tissue grafting for esthetic outcomes. Four reviews from the working group formed the basis of this update. Moreover, clinical applications as well as suggestions for further research have been formulated.

Materials and methods: The papers in the working group critically reviewed the literature. Four manuscripts were produced assessing (a) the outcomes of correcting dehiscence and fenestration defects at implant sites using various graft materials, (b) the outcomes of sinus floor augmentation at maxillary posterior sites with 6 mm or less residual bone height using various graft materials, (c) the association of the horizontal dimensions of buccal and interproximal bone with esthetic outcomes of implant-supported restorations, and (d) the outcomes of soft-tissue augmentations.

Results: The results and conclusions of the review process are presented in the following papers. The group's consensus statements, clinical implications, and directions for future research are presented in this article.

- Chiapasco, M. & Zaniboni, M. Clinical outcomes of GBR procedures to correct peri-implant dehiscences and fenestrations using bone or bone substitutes.
- Nkenke, E. & Stelzle, F. Clinical outcomes of sinus floor augmentation for implant placement using autogenous bone or bone substitutes.
- Teughels, W., Merheb, J. & Quirynen, M. Critical dimensions of buccal and interproximal bone around implants for optimal esthetic outcomes.
- Thoma, D.S., Benic, G.I., Zwahlen, M., Hämmerle, C.H.F. & Jung, R.E. A systematic review assessing soft-tissue augmentation techniques.

The remit of this working group was to compile and analyze the current knowledge in the areas of graft materials for bone augmentation and soft-tissue conditions for optimal esthetics of implant-supported restorations. The group acknowledged the results of previous workshops and systematic reviews regarding the choice of grafting material and focused on the information provided by the following position papers:

- Chiapasco, M. & Zaniboni, M. Clinical outcomes of GBR procedures to correct peri-implant dehiscences and fenestrations using bone or bone substitutes.

- Nkenke, E. & Stelzle, F. Clinical outcomes of sinus floor augmentation for implant placement using autogenous bone or bone substitutes.

With respect to soft-tissue conditions for esthetics, the group acknowledged the complexity of reproducing the esthetics of a natural tooth with an implant-supported restoration and based its deliberations on the following position papers covering different aspects of hard- and soft-tissue esthetics:

- Teughels, W., Merheb, J. & Quirynen, M. Critical dimensions of buccal and interproximal bone around implants for optimal esthetic outcomes.
- Thoma, D.S., Benic, G.I., Zwahlen, M., Hämmerle, C.H.F. & Jung, R.E. A systematic review assessing soft-tissue augmentation techniques.

A systematic approach was conducted when searching and retrieving the literature.

It was also intended to conduct systematic reviews when possible. The paucity and heterogeneity of the available clinical results, however, prevented doing so in three of the four position papers. The group recognized the limitations of the data and in general, felt that there was a need to encourage adequately designed and reported clinical trials in areas of tissue augmentation and esthetics in oral implants.

Clinical outcomes of GBR procedures to correct peri-implant dehiscences and fenestrations using bone or bone substitutes

Chiapasco, M., Zaniboni, M.

Placement of oral implants into alveolar ridges with insufficient dimension may result in dehiscence or fenestration defects exposing parts of the implant body. As the dehiscence or fenestration may impair implant success or increase the risk of implant failure, various surgical procedures have been used to generate bone over the exposed implant surface following implant placement. In the present narrative review, the clinical outcomes of guided bone regeneration (GBR) using various barrier membranes alone or in combination with different types of grafts in the treatment

of dehiscence or fenestration defects was assessed.

Aim

The objectives of the review were to compile the results of publications related to GBR procedures used in the presence of fenestration or dehiscence defects associated with screw-shaped titanium implants and to assess the clinical outcomes of these procedures performed with autogenous bone or bone substitutes in combination with resorbable or non-resorbable membranes.

Major conclusions from the paper

Because of lack of negative controls in the available studies, the clinical need to correct dehiscence or fenestration defects remains unclear. Both resorbable and non-resorbable membranes either with or without graft material were able to promote bone generation over exposed implant surfaces (seven studies, 238 patients, 374 implants). However, non-resorbable membranes showed a greater frequency of complications than resorbable membranes (20% and 5%, respectively; six studies, 163 patients, 221 implants). Resorbable membranes were used in combination with graft materials to maintain the space for bone regeneration.

Bone substitute materials and autogenous bone, alone or in combination, have been used for augmentation procedures. Implant survival and the stability of the peri-implant soft tissues over time was similar following various combinations of grafts and membranes. Limited sample of patients together with the wide variety of grafting materials and membranes used, make it difficult to draw any conclusions regarding the most effective GBR procedure. Harvesting of autogenous bone may lead to donor site morbidity with an unknown impact on the patient quality of life.

Group's consensus

- Fenestration and dehiscence defects can be successfully treated with GBR using non-resorbable membranes alone or in combination with a graft. Reported implant success rates following the correction of dehiscence or fenestration defects using GBR seem to be high (90–96%; two studies, 36 patients, 46

implants, 5 years follow-up). Nonetheless, it is unclear whether or not similar success rates would be obtained without augmentation.

- There is insufficient information regarding the outcome of the augmentation procedures using resorbable membranes because re-entry is generally not performed following the use of resorbable membranes.
- Non-resorbable membranes are more prone to early exposure or inflammatory reaction of the surrounding tissues than resorbable membranes. This does not appear to have a detectable impact on the outcome of the augmentation procedure.
- There is no evidence to support or refute the superiority of a specific membrane or graft material in the treatment of dehiscence or fenestration defects at implant sites.

Clinical implications

- For the correction of dehiscence or fenestration defects, GBR procedures with or without grafts may be considered.
- Space maintaining membranes may be used alone or in combination with a graft.
- Non-space maintaining membranes should be used in combination with grafting materials.

Implications for research

- The need for augmentation procedures in dehiscence and fenestration defects of various dimensions should be determined.
- Studies of high level of evidence are needed to identify the most appropriate materials and techniques for the treatment of dehiscence or fenestration defects.
- Long-term stability of the augmentation, patient reported outcomes, and cost effectiveness of various procedures need to be assessed.
- There is a need to develop an effective method to measure the outcome of augmentation repair in fenestration and dehiscence defects.

Clinical outcomes of sinus floor augmentation for implant placement using autogenous bone or bone substitutes

Nkenke, E., Stelzle, F.

In the posterior maxilla, insufficient vertical height of the alveolar ridge may preclude oral implant placement or compromise implant survival. Sinus floor augmentation procedures have been used to increase the height of the available bone.

Aim

The objective of this review was to determine the outcomes of sinus floor augmentation in partially dentate or edentulous patients using autogenous bone or bone substitutes. As outcomes variables, implant survival, patient morbidity, sinusitis, and graft loss were assessed. The analysis was limited to titanium implants with a modified surface placed in sites with 6 mm or less of residual bone height treated with sinus floor augmentation procedures using a lateral wall approach.

Major conclusions from the paper

A descriptive analysis of the constructed evidence tables did not show any major differences in the success of the augmentation procedure, complications, or implant survival rates for the assessed grafts. This finding was irrespective of different heights of the residual alveolar crest, implant placement protocol (immediate vs. staged), lengths of healing periods, sinusitis, or graft loss.

Harvesting of autogenous bone was associated with donor site morbidity, the impact of which on overall patient morbidity and quality of life is unclear. The cost-effectiveness of using autogenous bone or bone substitutes has not been analyzed sufficiently.

Group's consensus

- While there appears to be a high survival rate of implants following sinus floor augmentation regardless of the graft material used, the invasive nature of this technique-sensitive procedure should not be overlooked.
- Complications, while infrequent, can be significant and if not managed ap-

propriately will adversely affect outcomes and patient morbidity.

- The evidence neither supports nor refutes the superiority of any specific graft material for sinus augmentation with regard to implant survival or complications at the recipient site. Implant survival may be confounded by additional factors other than the graft material used for sinus floor augmentation.

Clinical implications

- The group emphasizes the necessity for adequate training when undertaking sinus floor augmentation surgery. This is essential to ensure both the correct performance of the surgical procedure as well as to enable the effective management of any resulting complications.
- Autogenous bone or bone substitutes may be used for sinus floor augmentation surgery.
- It is important to acknowledge that any use of autogenous bone implies donor site morbidity. The severity of this and the implications for the patient depend on the site. This should be taken into consideration when using autogenous bone as a graft material.
- While some bone substitute materials may carry a minimal risk of disease transmission, it is generally accepted that adequate screening, processing, and testing ensures safety for the recipient.

Implications for research

- Long-term randomized-controlled trials assessing the outcomes following the use of various graft materials in sinus floor augmentation are needed.
- Guidelines need to be established to aid clinical decision making regarding
 - residual height of the alveolar ridge,
 - surgical approach,
 - simultaneous vs. staged implant placement,
 - healing times,
 - graft material,
 - volume of material.
- The use of growth factors and tissue-engineered bone in sinus floor augmentation needs to be further evaluated.

- Incremental cost-effectiveness analyses should be performed.
- Patient-reported outcome measures of donor site surgery need to be assessed.

Critical dimensions of buccal and interproximal bone around implants for optimal esthetic outcomes

Teughels, W., Merheb, J., Quirynen, M.

To achieve optimal esthetic outcomes for implant-supported restorations, natural and stable peri-implant soft-tissue architecture is important. It has been suggested that the width of the buccal plate of the osteotomy and the positioning of oral implants in relation to the natural dentition or neighboring implants may have an influence on the esthetic outcome. The present systematic review assessed the available evidence regarding any association of vestibular–lingual width of the buccal alveolar plate during implant placement and the distance between implants and adjacent teeth as well as between adjacent implants with the esthetic outcome of implant-supported restorations.

Aims

This review was initiated to identify critical horizontal interproximal and buccal bone dimensions around implants to ensure optimal esthetic results.

Major conclusions from the paper

Horizontal dimensions of interproximal bone
Based on four articles (two prospective case series, one cross sectional, and one cohort study (191 patients, 463 interelement sites, observation period 1–6 years following restoration) in immediate and delayed implant placement procedures, there appears to be an association between the horizontal dimension of interproximal bone and the extent to which the interproximal area is filled with a papilla under the contact point of the restoration (papillary fill).

Tooth-implant distance. Based on one cross-sectional and two prospective case series (142 patients, 196 tooth-implant sites), partial ($\geq 50\%$) complete papillary fill was found in 75–86.9% of the interproximal sites with tooth to implant distances of 3–4 mm. For tooth to implant

distances of <3 mm or >4 mm, partial ($\geq 50\%$) to complete papillary fill of the interproximal site was less frequently found (0–35.7% and 56–70% of the interproximal sites, respectively).

Interimplant distance. Based on one cross sectional and one cohort study (97 patients, 195 implant–implant sites), interproximal sites showing partial ($\geq 50\%$) to complete papillary fill were found in 71–88.5% of the interproximal sites with an interimplant distances of 2.5–4 mm. For interimplant distances of <2.5 mm or >4 mm, partial ($\geq 50\%$) to complete papillary fill of the interproximal site was less likely to occur (0–80.6% and 48.0–72.7% of the interproximal sites, respectively). Several other factors have been suggested to influence the papillary fill of interproximal sites including, distance between the crest of the interproximal bone and the restoration's contact area, gingival biotype, periodontal health, time delay following extraction and implant placement, and patient age.

Horizontal dimensions of buccal bone
There is no information available determining the influence of the horizontal dimension of buccal bone at implant sites on esthetic outcomes. The vertical dimension of buccal bone after healing was correlated with the horizontal dimension of buccal bone at implant placement. Three clinical case series (2699 implants, healing period of 3–8 months) did not reveal conclusive information regarding an association between the horizontal dimension of buccal bone at the time of implant placement and vertical buccal bone height following healing.

Group's consensus

- Limited information regarding the association of horizontal interproximal and buccal bone dimensions with soft-tissue esthetics was available.
- In relation to horizontal interproximal dimensions, papillary fill was frequently reported and used as a surrogate for esthetics.
- While the systematic review by Teughels et al. (2009) advocated an optimal interproximal distance, additional factors such as the vertical distance between the crestal bone and the restoration contact area, multiple vs.

single-tooth replacements, soft-tissue biotype, and time delay between extraction and implant placement together with the anatomical location of the placed implant determine the esthetic soft-tissue outcomes. Thus, the advocated dimension may have questionable application in many anatomical situations.

- There is no evidence that supports or refutes an effect of horizontal buccal bone dimensions on the esthetic outcome (including peri-implant soft-tissue marginal recession) of implant therapy.

Clinical implications

- Care needs to be taken when applying isolated data to a clinical situation.
- The horizontal interproximal and buccal bone widths at implants alone are insufficient to determine the esthetic outcomes of implant-supported restorations and need to be considered in conjunction with other factors mentioned above.

Need for further research

- Prospective clinical trials assessing potential factors influencing esthetic outcomes are needed. In these studies, validated measurements of esthetic outcomes should be employed to assess aspects related to the soft tissue and restoration and including patient-reported outcomes.

A systematic review assessing soft-tissue augmentation techniques

Thoma, D. S., Benic, G. I., Zwahlen, M., Hämmerle, C. H. F., Jung, R.E.

Aim

The aim was to systematically assess the dental literature regarding the outcomes of soft-tissue grafting procedures. The focused question for the review was whether there is superiority of one method over others for increasing and maintaining the width of keratinized and/or attached gingiva and gaining soft-tissue volume. The literature search for this systematic review

included soft-tissue augmentation techniques around implants, teeth, and partially edentulous ridges. An inclusive literature search strategy did not identify any studies reporting procedures to increase the width of keratinized tissue around dental implants.

Major conclusions from the paper

Augmentation of keratinized tissue
Apically positioned flap or vestibuloplasty procedures were shown to increase the width of attached gingiva (two CCT, three RCT, 191 patients, 394 sites) or keratinized tissue (one CCT, three RCT, 179 patients, 370 sites) at teeth. The use of autogenous tissue (free gingival grafts, subepithelial connective tissue grafts) in addition to the apically positioned flap or vestibuloplasty significantly increased the width of attached gingiva (two CCT, 15 patients, 32 sites). Autogenous grafts resulted in less shrinkage of the graft (two RCT, 34 patients, 56 sites) as well as greater increase in the width of keratinized tissue (three RCT, 92 patients, 139 sites) and attached gingiva than allogenic grafts (one RCT, nine patients, 18 sites). Allogenic grafts showed better color and texture match with the surrounding tissues compared with free gingival grafts (two RCT, 47 patients, 94 sites). Patient-reported outcomes did not reveal a superiority of any of the treatment methods regarding post-operative morbidity (one CCT, three RCT).

Augmentation of soft-tissue volume

Only a limited number of studies provided data on soft-tissue volume augmentation (one CCT, one case series, one cohort study, 59 patients, 74 sites). Retrieved evidence showed that autogenous grafts resulted in an increase in soft-tissue volume, though this was after an observation period of only 3.5 months (one CCT, 30 patients, 30 sites). In localized alveolar ridge defects, subepithelial connective tissue grafts provided greater volume gain than free full-thickness gingival grafts.

Consensus statements

- In some cases, there is a clinical need for soft-tissue augmentation at implants in order to improve esthetics and patient comfort.

- Periodontal plastic surgery has developed techniques to improve soft tissue width and volume at teeth. With appropriate modifications to existing surgical techniques it may be possible to apply these to implant sites.
- Timing of soft-tissue augmentation at implant sites and the proper sequence of the various interventions (e.g. bone augmentation, implant placement, temporization, reconstruction) that contribute to esthetic outcomes have not been systematically assessed.
- Limited long-term data are available for stability of soft-tissue augmentation at teeth. No evidence is currently available at implants.
- To increase tissue width and volume, different graft materials have been used.

The evidence from the review, supported by the consensus participants, indicated that no ideal material is currently available. The group strongly encourages the development and clinical testing of soft-tissue augmentation materials.

Clinical implications

- The need for augmenting keratinized or attached tissue at implants is unclear. However, it may be beneficial for the esthetics, restoration design, and oral hygiene.
- Owing to the technique sensitive nature of many of these surgical procedures together with frequent need to

use them in esthetic areas, adequate surgical training of the clinician is necessary.

Implications for research

- Techniques aimed at increasing soft-tissue volume at implant sites need to be evaluated and the long-term stability of the augmented areas assessed.
- The clinical outcomes of substitute and tissue-engineered grafts that avoid donor site morbidity should be evaluated.
- Non-invasive measurements to quantify soft-tissue volume and esthetic outcomes should be validated and used in clinical trials.

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