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ORIGINAL PAPERS

Current Orientations in Proimplant Alveolar Bone Addition

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Abstract
In the context of the increased prevalence of dental caries and periodontal disease reported in our country, the extensive partial edentation is a common pathology, which requires complex treatment solutions. Implant-prosthetic therapy is the optimal treatment solution from a biological, functional and biomechanical point of view. Interdisciplinary management of implant-prosthetic therapy frequently involves the reconstruction of alveolar ridges in the pro-implant stage. The specialists in implantology and dento-alveolar surgery face the issue of the selection of grafting materials and techniques in relation to systemic, loco-regional, local factors and the planned prosthetic solution. In this context, a practical guide for the use of grafting materials and techniques may be useful to practitioners in order to optimize the aesthetic and functional results in the implant-prosthetic therapy of edentulous patients.

Keywords: edentation, alveolar resorption, implant-prosthetic therapy, alveolar bone addition

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Introduction

In the context of the increased prevalence of dental caries and periodontal disease in our country, extensive partial edentation is a common pathology, which requires complex treatment solutions. (Forna N, 2008). The implant-prosthetic therapy is the optimal treatment solution from a biological, functional and biomechanical point of view. The alveolar bone addition techniques used in the pro-implant stage are required to facilitate the correct positioning of the dental implants,

given that the insertion axis of dental implants guides the distribution of the stress in the peri-implant bone tissue and allows the implant osseointegration (Bhat et al., 2014; Dundar et al. 2016). Although the literature presents a wide range of results, conclusions and recommendations of the research groups, there are big differences between them in terms of optimizing the selection of the addition materials to take into account the local and loco-regional conditions, in relation to the implant-prosthetic solution.

Materials and techniques of alveolar bone addition

Based on the personal experience of the authors and considering the literature review, we present in tables' I-III the categories of graft materials and techniques frequently used in the reconstruction of the alveolar bone ridges in the pro-implant stage. An important factor that influences the selection of the bone addition materials and techniques is the shape and extension of the bone defect (Tables I.1-3). In low and medium bone defects, all categories of bone addition materials can be used in inlay / onlay, "sandwich" or interposition grafting techniques. In severe bone defects, guided bone regeneration is recommended either classic (Miyamoto et al., 2012; Liu et al., 2014; Elgali et al., 2017) or screw-guided bone regeneration (Toeroek et al., 2013), the interposition graft (Campos et al., 2019), osteodistraction / directed elongation (Yamauchi et al, 2013).

The studies focused on the success rate of implant-prosthetic therapy in the implant sites grafted with different addition materials recommend the selection of the graft materials used as single materials or in combination with autogenous bone in relation to the severity of bone defects (Tables II.1-II. 4). Autogenous bone as the only graft material has been used in both reduced alveolar and severe alveolar defects, but reconstruction in the latter case is recommended by combining autogenic bone with xenograft materials (Proussaefs et al., 2006; Miyamoto et al. 2012; Alluden & col, 2017; Bae & col, 2019). Xenografts (bone of bovine or porcine origin) are recommended as addition material due to advantages represented by osteoconductivity, available volume and price (Lee & col, 2014; Liu & col, 2014; Kim & col, 2015; Cavdar & col, 2017; Pang & col, 2017). Alloplastic grafts (hydroxyapatite, tricalcium phosphate) have a wide applicability in the addition techniques due to osteoconductivity, biocompatibility and lower rate of postoperative infections (Sheikh et al., 2017; Chavda et al., 2018).

The features of the bone addition techniques and the working steps, are presented in Tables III.1-4 (Aghaloo et al, 2016; Wessing et al, 2018; Majzoub et al, 2019). In the maxillary posterior area with severe alveolar resorption, the data from the literature reported favorable results in the case of using guided bone regeneration associated with sinus lifting (Li & col, 2010; Zhu & col, 2018). The interposition grafting (Barone et al, 2017) and subperiosteal tunneling technique (Karmon et al, 2020) are minimally invasive techniques used in the pro-implant stage due to the

significant reduction in the intensity of the inflammatory reactions and the low rate of complications in the postoperative stage.

Table I.1. Selection of materials and bone addition techniques reported to the defect extension

Extension of bone defect	Graft materials	Graft technique
Low	Autogenous bone Allograft Alloplastic graft Xenograft	Inlay/onlay „Sandwich" graft Interposition graft
Medium	Autogenous bone Allograft Alloplastic graft Xenograft	Inlay/onlay „Sandwich" graft Interposition graft
Severe	Mixed graft (autogenous + xenograft/alloplastic graft)	Guided bone regeneration Interposition graft Osteodistraction/ directed elongation

Table I.2. Techniques and addition materials in severe alveolar bone resorption

Alveolar bone	Technique	Addition material
Severe resorption	- Alveolar augmentation (horisontal/vertical onlay graft, „J" onlay graft, inlay graft, „sandwich" graft) - Alveolar augmentation + lifting sinus - Bone addition - Interposition graft - Osteodistraction	-Mixed grafts (autogenous bone + xenografts) -Alloplastic grafts

Table I.3. Techniques and addition materials in sharp/unregulated alveolar ridges

Morphological features of implant sites	Tehnică	Material de adiţie
Sharp Unregulated	- Bone remodelling techniques - Alveolar augmentation (horisontal/verticală onlay graft, „J" onlay graft, inlay graft, „sandwich" graft) - Alveolar augmentation + lifting sinus - Bone addition - Interposition graft - Osteodistraction	-Autogenous bone -Allografts -Xenografts -Alloplastic grafts -Mixed grafts (autogenous bone + xenografts)

II.1. Autogenous bone in alveolar addition

Materials	Origins	Indications	Contraindications	Advantages	Limits
Autogenous bone	-menton and mandibular bone (cortical bone) -iliac bone (spongious bone)	-implant sites with reduced/medium resorption (<5cm) -combined with xenograft -severe resorptions	-implant sites with severe resorptions	-cortical bone has low rate of resorption -spongious/ cortical bone combines strenght of osteogenic and osteoconductive properties	-one more session -low volume autogen bone -donor site compli-cations

Table II.2. Allograft in proimplant procedures

Materials	Origins	Indications	Contraindications	Advantages	Limits
Allografts	3 sources: -Fresh bone -FDBA -DFDBA	-implant sites with low/medium resorption (<5cm) -combined with xenograft -severe resorptions	-implant sites with severe resorptions	-osteogenic, osteoinductive potential -lack of immune reactions	-higher rate of bone resorption

Table II.3. Xenografts use in pro-implant procedures

Materials	Origins	Indications	Contra indications	Advantages	Limits
Xenografts	bovine/pig source	-implant sites with reduced/medium or severe resorption	-	- osteogenic, osteoinductive potential -biological matrix -slow resorption	potential for immune reactions

Table II.4. Alloplastic grafts use in pro-implant procedures

Materials	Origins	Indications	Contra indications	Advantages	Limits
Alloplast	-synthesis hydroxiapatite -calcium phosphate -glass polymers -calcium carbonat	-implant sites with low/medium resorption	-	-osteogenic cells adherence -high mechanical strenght -stable volume -absent immune reactions	-lower rate of new bone tissues -graft resorption higher than autogenous bone resorption

Table III.1. Alveolar augmentation

Implant sites features	Technique	Advantages
-Postextractional implant site -Postcystectomy	Note: insertion and maintaining of the addition material inside to the bone cavity Stages: 1. radiographic exam and CBCT 2. trapezoidal flap 3. periosteum desinsertion using periostal elevator 4. gingival fibers desinsertion from buccal and occlusal ridges walls 5. holes creation in cortical bone 6. addition material insertion in the bone cavity 7. membrane insertion (guided bone regeneration technique) 8. hemostasis 9. suture	- increase of integration graft rate

Table III.2. Guided bone regeneration technique + sinus lifting

Implants sites resorption	Technique	Advantages
Medium/severe bone resorption	loco-regional anaesthesia trapesoidal flap release sinusal bone windows preparation Schneider membrane release implant sites preparation bone addition insertion membrane insertion dental implants threading insertion of addition material in excess cavities bonding insertion of abutments flap repositioning suture	sufficient bone volume graft stability strenght minimal exposure of the dental implants postoperatory complications reduction implants stability

Table III.3. Interposition graft

Implants sites resorption	Technique	Advantages
Medium/severe horisontal and vertical bone resorption	Note: bone cut inside of the bone deffect to create space for addition material insertion (between two receptor areas for vascular and osteogenic cells supply) Stages: 1. radiographic exam and CBCT	-gingival tissue preservation and avoidance of the gingival recession -sufficient bone volume -graft stability -graft strenght

	2. trapezoidal flap 3. periosteum desinsertion using periostal elevator 4. gingival fibers desinsertion from buccal and occlusal ridges walls 5. holes creation in cortical bone 6. addition material insertion in the bone cavity 7. membrane insertion (guided bone regeneration technique) 8.hemostasis 10.suture	-minimal exposure for dental implants -the decrease of the postoperatory complications rate especially for smokers and patients with diabetes stability of dental implants

Table III.4. Bone addition by subperiostal tunellisation

Implant sites anatomy	Technique	Advantages
Implants sites with absent walls: -horisontal bone defects -vertical bone defects	Note: graft is fixed on bone defect Stages: 1. limited incision; 2. desinsertion of the gingival fibers from ridge walls 3. holes creation to medular bone 4. addition materials insertion 5. suture	increased confort; postoperatory decrease of the inflammatory processess; acceleration of the healing processess; intraoperatory and postoperatory complications

Discussions

In the context of the increased prevalence of dental caries and periodontal disease recorded in our country, the extensive partial edentation is a common pathology, which requires complex treatment solutions. The interdisciplinary management of the implant-prosthetic therapy frequently involves the reconstruction of the alveolar ridges in the pro-implant stage. In the reconstruction of the implant sites in patients affected by severe alveolar resorption (Misch class C or D), specialists in implantology and dento-alveolar surgery face the issue of the selection of grafting materials and techniques in relation to systemic, loco-regional, local and with the planned prosthetic implant-supported solution. For a maximum long-term success rate it is necessary to understand the predictive factors and to adopt adequate informed decisions regarding the planning of the pro-implant stage, surgical implantation stage and the choice of the implant-prosthetic therapeutic solution (Forna N.2011).

A significant advantage of modern alveolar graft materials and techniques is the possibility of applying minimally invasive surgical techniques associated with the reduction of pain, edema and postoperative discomfort (Krauser et al. 2011; Torok et al., 2019). Regarding the success rate of the alveolar bone addition techniques, many factors must be considered that can affect the healing of grafted bone areas: the type of graft material; local biological factors (quality of vascularization); local infectious factors; local mechanical factors (stability and biomechanical load); systemic factors (medication, systemic disorders, smoking) (Plonka et al, 2018).

In this context, a practical guide for an optimized use of the grafting materials and techniques may be useful to practitioners in order to optimize the aesthetic and functional results in the implant-prosthetic therapy of the edentulous patients.

Conclusions

The topic of the alveolar bone addition techniques and materials raises interest in the field of specialists in implantology and dento-alveolar surgery. The current trends in the implant site reconstruction techniques focus on the use of xenografts, alloplast materials or combinations of xenograft and autogenous bone in severe alveolar resorptions.

The guided bone regeneration are techniques of choice in the pro-implant stage, with excellent results in the medium and long term. Minimally invasive addition techniques, such as subperiosteal bone addition or interposition grafts, with low rates of postoperative complications, are promoted in medium / severe vertically and horizontally alveolar resorptions.

The practitioner must take into account in the pro-implant stage many factors that may affect the post-graft healing stage: graft type; local biological factors (quality of vascularization); local infectious factors; local mechanical factors (stability and biomechanical load); systemic factors (medication, systemic disorders, smoking).

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