Bone Augmentation Procedures - Review

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Abstract: Introduction: In cases of advanced horizontal or vertical bone loss, as well as insufficient bone volume to an anatomical object, bone augmentation procedures are required. Aim: The aim of this review was to assess the reliability of four augmentation procedures, including bone block grafting, ridge split technique, lateralization or transposition of inferior alveolar nerve (IAN) and guided bone regeneration (GBR). Material and methods: Articles published from 1992 to 2019 were included in the review. The search was performed using various combination of keywords such as “bone block augmentation”, “ridge split”, “split-crest”, “guided bone regeneration”, “lateralization of inferior alveolar nerve”, “transposition of inferior alveolar nerve”, “platelet-rich plasma”, “barrier membrane”, “bone grafting”. Results: The selected articles provided data about the effectiveness of the bone block grafting, ridge split technique, lateralization or transposition of IAN and guided bone regeneration. The complications, associated with the mentioned procedures were also reviewed. Conclusion: All mentioned procedures: guided bone regeneration, bone block graft augmentation, lateralization of IAN and ridge split technique seem to be reliable methods for bone augmentation. Thanks to these techniques is possible to provide implant treatment, when the existing bone is of insufficient volume.

1. Introduction

In cases of advanced horizontal or vertical bone loss, as well as insufficient bone volume to an anatomical object, bone augmentation procedures are required.

2. Aim

The aim of this review was to assess the reliability of four augmentation procedures, including bone block grafting, ridge split technique, lateralization or transposition of inferior alveolar nerve (IAN) and guided bone regeneration (GBR).

3. Material and methods

Articles published from 1992 to 2019 were included in the review. The search was performed using various combination of keywords such as “bone block augmentation”, “ridge split”, “split-crest”, “guided bone regeneration”, “lateralization of inferior alveolar nerve”, “transposition of inferior alveolar nerve”, “platelet-rich plasma”, “barrier membrane”, “bone grafting”.

Bone Block Grafting
Bone block augmentation using autogenous block graft is associated with high survival rate of the implants, placed in the augmented bone and with unstable level of the marginal bone [1].

Gultekin et al. [2] compared the results, obtained after GBR and ramus block bone grafting before implant insertion in upper jaw with horizontal bone insufficiency. The authors used cone beam computed tomography to observe the changes in the volume at the both procedures sites. Although they established that GBR leads to greater bone resorption than the other method, they also observed higher mean horizontal bone increase after the healing period for the GBR than for the ramus block grafting. The authors concluded that the both techniques are reliable, but it should be taken into account the fact that GBR leads to greater bone loss at augmented areas in upper jaw.

Thoma et al. [3] conducted a study to compare the difference in some bone characteristics of the sites, augmented via autogenous bone block and xenogeneic bone block loaded with human bone morphogenetic protein-2. The authors concluded that the both techniques are reliable for augmentation and preparation of the bone for implant placement, but histologically more mineralized tissue was establish for the autogenous bone block group 4 months after surgery.

Rocchietta et al. [4] commented on the prevalence of the bone block grafting over the particulated graft combined with guided bone regeneration with regard to bone-to-implant contact.

Synthetic blocks were also discussed as alternative way for bone regeneration in animal model studies [5]. Benic et al. [6] compared the results, obtained after GBR using bone block madeofdeproteinized bovine-derived bone mineral (DBBM) versus GBR using particulate DBBM. Authors reported better results with the block bone in regard to the amount of the augmented bone after the healing period.

In another study was concluded, that the interpositional block graft may be an adequate choice for horizontal augmentation of the alveolar bone in lower jaw [7].

Ridge split technique
Ridge split technique is a reliable method providing adequate level of stability for implant survival [8]. It is a procedure for augmentation of insufficient alveolar ridge, providing enough width for simultaneous implant placement. It was established that the performance of ridge split ostectomy could increase the bone width in the range of 1 to 4 mm [9]. Anitua et al. [10] reported 100% implant success rate for two-stage ridge split procedure, performed using ultrasonic bone surgery. The authors concluded, that the method is reliable to increase the horizontal dimensions of narrow ridges.

Piezosurgery is recommended for the ridge split technique [11, 12, 13]. Bone grafting material with large particles demonstrated advantage compared to the small particle graft in regard to the increase in bone width after ridge split procedures [14]. Agabiti and Botticelli [15] proposed two-stage
method for corticalized ridge width enlargement without using bone grafting material. Authors concluded, that this method provides option for implant placement in corticalized alveolar bone of decreased width. Fracture of the buccal bone wall and bone resorption were the most commonly observed complications after the surgery [16]. However the ridge split method is associated with high survival rate of the implants, sufficient increase of the horizontal bone width and low complication rate [16]. Even at the sites, where a fracture during the procedure was observed, the implants demonstrated favorable prognosis [17].

**Lateralization or transposition of inferior alveolar nerve (IAN)**

The lateralization of IAN is a procedure, allowing the placement of the implants into atrophic jaw [18]. If it is done accurately it could provide reliable opportunity for implant treatment with minimal transitory nerve disturbances [18]. Among the methods for inserting implants into insufficient jaw bone the lateralization of IAN is indicated when the performance of other techniques is not possible or is risky in regard to the complications [19]. According to Peev et al. (20) lateralization and transposition of IAN are very complex procedures, which should be performed from experienced surgeon. On the other hand accordingly performed procedures result in very low risk of permanent neural alterations and are associated with high survival rate. Authors didn't observe any neurosensory dysfunction, lasting more than 6 weeks.

Piezoelectric surgery is a preferred method for conducting the procedure for IAN lateralization [12, 21, 22]. Guided surgery approach for performing lateralization of IAN was introduced. According to the authors the method demonstrated the following advantages: lower risk for traumatisation of the IAN and for nerve dysfunction after surgery, as well as the surgery is less time consuming [23]. In a study was assessed the vitality of the teeth after IAN lateralization or transposition and was found, that the nerve lateralization had advantage in regard to the preservation of the vitality of the teeth compared to the nerve transposition [24]. Lorean et al. [25] reported postoperative neural disturbances after IAN transposition or reposition were present for a period from 1 to 6 months. The authors didn't observe any permanent damages of the nerve. Some of the described neurosensory disturbances were: anesthesia, hypoesthesia, pain and burning [26]. The severity of IAN dysfunction could be evaluated using electrophysiological assessment in combination with clinical examination [27].

**Guided bone regeneration**

In a systematic review Milinkovic and Cordaro [28] reported that GBR is a successful treatment method for defects such as dehiscence and fenestrations, when it is performed simultaneously with the implant insertion. When there is a horizontal bone insufficiency, techniques such as bone block grafting, staged GBR and ridge split osteotomy are reliable.

Rodriguez and Nowzari [29] reported different complications with bovine bone xenograft, including pathological reactions, associated with the sinus and upper jaw bone, fenestration of the soft tissue, implant failure, migration and encapsulation of the graft.

Guided bone regeneration is also used in surgical treatment of peri-implantitis lesions [30, 31, 32, 33]. In addition to periodontal treatment [34, 35, 36], dental lasers could also be used in combination with guided bone regeneration for treatment of peri-implantitis [37, 38].

Blume et al. [39] used personalized CAD/CAM freeze-dried bone allograft block combined with GBR to treat advanced upper jaw bone defects and concluded, that this method could be an option for successful augmentation of severe bone loss in the aesthetic zone of upper jaw. Complete regeneration of the treated area and high survival rate of the implants can be expected, when the procedure is performed using certain bone grafting materials, such as sintered DBBM, synthetic biphasic calcium phosphate material with a high level of porosity and synthetic biphasic nano-hydroxyapatite paste in combination with a collagen membrane of pericardial origin. The method could provide adequate bone volume and soft tissue stability [40].

In a study, which aim was to investigate the outcome of using the combination of GBR and platelet-rich plasma (PRP) to minimized the resorption of onlay bone grafts, the authors compared the results obtained using GBR, PRP and the combination of both methods with the control group results. They came to the conclusion that the both methods (GBR and PRP) could be used to enhance the volume stability of the onlay bone graft, but their combination did not prevail over the performance of GBR separately [41]. Platelet concentrates can improve the local conditions, which could benefit the bone growth [42] and increase the implant stability [43].

**4. Results**

The selected articles provided data about the effectiveness of the bone block grafting, ridge split technique, lateralization or transposition of IAN and guided bone regeneration. The complications, associated with the mentioned procedures were also reviewed.

**5. Discussion**

The literature data confirmed the reliability of the four bone augmentation procedures: bone block grafting [1, 2, 3, 4], ridge split technique [8, 9, 10, 15], lateralization or transposition of IAN [18, 20, 23], guided bone regeneration [28, 40, 41]. All four methods were associated with some kind of complications or disadvantages, as they were as follows: unstable marginal bone level for bone block augmentation [1], fracture of bone wall for the ridge split technique [16, 17], temporary neural disturbances, associated with lateralization or transposition of IAN [20, 25] and the greater bone resorption, experienced with GBR [2]. For the three of the procedures was proposed the use of piezoelectric surgery: bone block grafting [1], ridge split technique (11, 12, 13) and lateralization or transposition of IAN [12, 20, 21, 22].

**6. Conclusion**

All mentioned procedures: guided bone regeneration, bone block graft augmentation, lateralization of IAN and ridge
split technique seem to be reliable methods for bone augmentation. Thanks to these techniques is possible to provide implant treatment, when the existing bone is of insufficient volume.

References


