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# 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 surch 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 GBRand ramus block bone grafting before implant insertion in upper jaw with horizontal bone insuffiency. 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 osteotomy 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 cortica-lized alveolar bone of decreased width. Fracture of the buc-cal 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 per-formance 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 com-plex procedures, which should be performed from expe-rienced surgeon. On the other hand accordingly performed procedures result in very low risk of permanent neural alte-rations 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 demon-strated the following advantages: lower risk for traumatisa-tion 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 dam-ages of the nerve. Some of the described neurosensory dis-turbances 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 a defects such as dehiscence and fenestrations, when it is performed simul-taneously with the implant insertion. When there is a hori-zontal bone insufficiency, techniques such as bone block grafting, staged GBR and ridge split osteotomy are reliable.

Rodriguez and Nowzari [29] reported different complica-tions with bovine bone xenograft, including pathological reactions, associated with the sinus and upper jaw bone, fe-nestration 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 rege-neration of the treated area and high survival rate of the im-plants 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 mem-brane of pericardial origin. The method could provide ade-quate bone volume and soft tissue stability [40].

In a study, which aim was to investigate the outcome of us-ing 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 con-centrates can improve the local conditions, which could ben-efit 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 transpo-sition 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 latera-li-zation 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

[1] Peev, S, Sabeva, E. Bone Block Augmentation - A Long Term Follow-Up. Scripta Scientifica Medicinae Dentalis. 2018;4(2): 29-35.
[2] Gultekin BA, Bedeloglu E, Kose TE, Mijiritsky E. Comparison of Bone Resorption Rates after Intraoral Block Bone and Guided Bone Regeneration Augmentation for the Reconstruction of Horizontally Deficient Maxillary Alveolar Ridges. Biomed Res Int. 2016;2016:4987437.
[3] Thoma DS, Payer M, Jakse N, Bienz SP, Hüsler J, Schmidlin PR, Jung UW, Hämmerle CHF, Jung RE. Randomized, controlled clinical two-centre study using xenogeneic block grafts loaded with recombinant human bone morphogenetic protein-2 or autogenous bone blocks for lateral ridge augmentation. J Clin Periodontol. 2018 Feb;45(2):265-276.
[4] Rocchietta I, Simion M, Hoffmann M, Trisciuoglio D, Benigni M, Dahlin C. Vertical Bone Augmentation with an Autogenous Block or Particles in Combination with Guided Bone Regeneration: A Clinical and Histological Preliminary Study in Humans. Clin Implant Dent Relat Res. 2016 Feb;18(1):19-29.
[5] Tumedei M, Savadori P, Del Fabbro M. Synthetic Blocks for Bone Regeneration: A Systematic Review and Meta-Analysis. Int J Mol Sci. 2019 Aug 28;20(17). pii: E4221.
[6] Benic GI, Eisner BM, Jung RE, Basler T, Schneider D, Hämmerle CHF. Hard tissue changes after guided bone regeneration of peri-implant defects comparing block versus particulate bone substitutes: 6-month results of a randomized controlled clinical trial. Clin Oral Implants Res. 2019 Oct;30(10):1016-1026.
[7] Atef M, Osman AH, Hakam M. Autogenous interpositional block graft vs onlay graft for horizontal ridge augmentation in the mandible. Clin Implant Dent Relat Res. 2019 Aug;21(4):678-685.
[8] Karan NB, Akinci HO. A Novel Approach for Horizontal Augmentation of Posterior Maxilla Using Ridge Split Technique. J Craniofac Surg. 2019 Jul;30(5):1584-1588.
[9] Simion M, Baldoni M, Zaffe D. Jawbone enlargement using immediate implant placement associated with a split-crest technique and guided tissue regeneration. Int J Periodontics Restorative Dent. 1992;12(6):462-73.
[10] Anitua E, Begoña L, Orive G. Controlled ridge expansion using a two-stage split-crest technique with ultrasonic bone surgery. Implant Dent. 2012 Jun;21(3):163-70.
[11] Brugnami F, Caiazzo A, Mehra P. Piezosurgery-assisted, flapless split crest surgery for implant site preparation. J Maxillofac Oral Surg. 2014 Mar;13(1):67-72.
[12] Stübinger S, Stricker A, Berg BI. Piezosurgery in implant dentistry. Clin Cosmet Investig Dent. 2015 Nov 11;7:115-24.
[13] Moro A, Gasparini G, Foresta E, Saponaro G, Falchi M, Cardarelli L, De Angelis P, Forcione M, Garagiola U, D'Amato G, Pelo S. Alveolar Ridge Split Technique Using Piezosurgery with Specially Designed Tips. Biomed Res Int. 2017;2017:4530378.
[14] Kheur MG, Kheur S, Lakha T, Jambhekar S, Le B, Jain V. Does Graft Particle Type and Size Affect Ridge Dimensional Changes After Alveolar Ridge Split Procedure? J Oral Maxillofac Surg. 2018 Apr;76(4):761-769
[15] Agabiti I, Botticelli D. Two-Stage Ridge Split at Narrow Alveolar Mandibular Bone Ridges. J Oral Maxillofac Surg. 2017 Oct;75(10):2115.e1-2115.e12.
[16] Elnayef B, Monje A, Lin GH, Gargallo-Albiol J, Chan HL, Wang HL, Hernández-Alfaro F. Alveolar ridge split on horizontal bone augmentation: a systematic review. Int J Oral Maxillofac Implants. 2015 May-Jun;30(3):596-606.
[17] Shibuya Y, Yabase A, Ishida S, Kobayashi M, Komori T. Outcomes and treatments of mal fractures caused by the split-crest technique in the mandible. Kobe J Med Sci. 2014 Sep 26;60(2):E37-42.
[18] Rathod M, Kshirsagar RA, Joshi S, Pawar S, Tapadiya V, Gupta S, Mahajan V. Evaluation of Neurosensory Function Following Inferior Alveolar Nerve Lateralization for Implant Placement. J Maxillofac Oral Surg. 2019 Jun;18(2):273-279.
[19] Castellano-Navarro JM, Castellano-Reyes JJ, Hirdina-Castilla M, Suárez-Soto A, Bocanegra-Pérez S, Vicente-Barrero M. Neurosensory issues after lateralisation of the inferior alveolar nerve and simultaneous placement of osseointegrated implants. Br J Oral Maxillofac Surg. 2019 Feb;57(2):169-173.
[20] Peev S, Ivanov B, Sabeva E, Georgiev T. Five-year follow-up of implants placed simultaneously with inferior alveolar nerve lateralisation or transposition. Scripta Scientifica Medicinae Dentalis. 2015;1(2):44-48.
[21] Naves Freire AE, Iunes Carrera TM, Rodriguez LS, Lara de Carli M, Filho AP, Costa Hanemann JA, Ribeiro Júnior NV, Pigossi SC. Piezoelectric Surgery in the Inferior Alveolar Nerve Lateralization With Simultaneous Implant Placement: A Case Report. Implant Dent. 2019 Feb;28(1):86-90.
[22] de Vicente JC, Peña I, Braña P, Hernández-Vallejo G. The use of piezoelectric surgery to lateralize the inferior alveolar nerve with simultaneous implant placement and immediate buccal cortical bone repositioning: a prospective clinical study. Int J Oral Maxillofac Surg. 2016 Jul;45(7):851-7.
[23] Atef M, Mounir M. Computer-Guided Inferior Alveolar Nerve Lateralization With Simultaneous Implant Placement: A Preliminary Report. J Oral Implantol. 2018 Jun;44(3):192-197.
[24] Khajehahmadi S, Rahpeyma A, Bidar M, Jafarzadeh H. Vitality of intact teeth anterior to the mental foramen after inferior alveolar nerve repositioning: nerve transpositioning versus nerve lateralization. Int J Oral Maxillofac Surg. 2013 Sep;42(9):1073-8.
[25] Lorean A, Kablan F, Mazor Z, Mijiritsky E, Russe P, Barbu H, Levin L. Inferior alveolar nerve transposition and reposition for dental implant placement in edentulous or partially edentulous mandibles: a multicenter retrospective study. Int J Oral Maxillofac Surg. 2013 May;42(5):656-9.
[26] Hashemi HM. Neurosensory function following mandibular nerve lateralization for placement of implants. Int J Oral Maxillofac Surg. 2010 May;39(5):452-6.

[27] Nocini PF, De Santis D, Fracasso E, Zanette G. Clinical and electrophysiological assessment of inferior alveolar nerve function after lateral nerve transposition. Clin Oral Implants Res. 1999 Apr;10(2):120-30.
[28] Milinkovic I, Cordaro L. Are there specific indications for the different alveolar bone augmentation procedures for implant placement? A systematic review. Int J Oral Maxillofac Surg. 2014 May;43(5):606-25.
[29] Rodriguez AE, Nowzari H. The long-term risks and complications of bovine-derived xenografts: A case series. J Indian Soc Periodontol. 2019 Sep-Oct;23(5):487-492.
[30] Ramos UD, Suaid FA, Wikesjö UME, Susin C, Taba M Jr, Novaes AB Jr. Comparison between two antimicrobial protocols with or without guided bone regeneration in the treatment of peri-implantitis. A histomorphometric study in dogs. Clin Oral Implants Res. 2017 Nov;28(11):1388-1395.
[31] Canullo L, Signorini L, Pistilli R, Patini R, Pistilli V, Pesce P. A prospective case series on surgical treatment of circumferential and semi-circumferential defects due to peri-implantitis. Braz Oral Res. 2019 Sep 30;33(suppl 1):e072.
[32] La Monaca G, Pranno N, Annibali S, Cristalli MP, Polimeni A. Clinical and radiographic outcomes of a surgical reconstructive approach in the treatment of peri-implantitis lesions: A 5-year prospective case series. Clin Oral Implants Res. 2018 Oct;29(10):1025-1037.
[33] Isler SC, Soysal F, Ceyhanlı T, Bakırarar B, Unsal B. Regenerative surgical treatment of peri-implantitis using either a collagen membrane or concentrated growth factor: A 12-month randomized clinical trial. Clin Implant Dent Relat Res. 2018 Oct;20(5):703-712.
[34] Miteva M, Peev S, Hristov I. The adjunctive use of the Er,Cr:YSGG laser in nonsurgical periodontal treatment. International Journal of Science and Research (IJSR). 2017;6(4):61-4.
[35] Miteva M, Peev S, Hristov I. Management of chronic generalized periodontitis by adjunctive use of diode laser. International Journal of Science and Research (IJSR). 2017;6(4):65-7.
[36] Miteva M. Comparison of Nd:YAG, Er,Cr:YSGG and Diode Lasers in Nonsurgical Periodontal Treatment. International Journal of Science and Research (IJSR). 2019;8(10):118 - 121
[37] Romanos GE, Nentwig GH. Regenerative therapy of deep peri-implant infrabony defects after CO2 laser implant surface decontamination. Int J Periodontics Restorative Dent. 2008 Jun;28(3):245-55.
[38] Azzeh MM. Er,Cr:YSGG laser-assisted surgical treatment of peri-implantitis with 1-year reentry and 18-month follow-up. J Periodontol. 2008 Oct;79(10):2000-5.
[39] Blume O, Hoffmann L, Donkiewicz P, Wenisch S, Back M, Franke J, Schnettler R, Barbeck M. Treatment of Severely Resorbed Maxilla Due to Peri-Implantitis by Guided Bone Regeneration Using a Customized Allogenic Bone Block: A Case Report. Materials (Basel). 2017 Oct 21;10(10). pii: E1213.
[40] Peev S, Gusiyska A, Sabeva E. Guided bone regeneration and simultaneous implant placement. International Journal of Science and Research (IJSR). 2016; 5(2): 1529-30.
[41] Younis M, Elshahat A, Elhabbaa G, Fareed A, Safe I. Onlay bone graft maintenance using guided bone regeneration, platelet rich plasma, and their combination. J Craniofac Surg. 2014 Nov;25(6):2237-40.
[42] Miteva, M. Emdogain (EMD) and platelet-rich plasma (PRP) in periodontal regeneration. Scripta Scientifica Medicinae Dentalis. 2019; 5(1):27-32.
[43] Peev S, Atanasov D. Platelet-rich plasma – an accelerator of the secondary stability of immediate loaded implants. J IMAB. 2007; 13(2):38-40.