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Hard Tissue Augmentation Techniques: A Systematic Review

[1]Dr. Mandava Manasa, B.D.S, PG Student, Drs. Sudha & Nageswara Rao Siddartha Institute of Dental Sciences, Vijayawada

[2]Dr. Sriharsha Babu Vadapalli, M.D.S, Associate Professor, Department of Prosthodontics, Drs. Sudha & Nageswara Rao Siddartha Institute of Dental Sciences, Vijayawada

[3]Dr. Tripuraneni Sunilchandra, M.D.S, Professor & HOD, Department of Prosthodontics, Drs. Sudha & Nageswara Rao Siddartha Institute of Dental Sciences, Vijayawada

[4]Dr. Atluri Kaleswara Rao, M.D.S, Professor, Department of Prosthodontics, Drs. Sudha & Nageswara Rao Siddartha Institute of Dental Sciences, Vijayawada

Corresponding Author: Dr. Mandava Manasa, B.D.S, PG Student, Drs. Sudha & Nageswara Rao Siddartha Institute of Dental Sciences, Vijayawada

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Abstract

Prosthetic-driven implant placement has emerged as a pivotal approach in contemporary implant dentistry, emphasizing the integration of prosthetic outcomes with surgical techniques. Successful implant treatment necessitates meticulous management of both soft and hard tissues to achieve optimal esthetic and functional results. This abstract comprehensively overviews hard tissue management strategies in prosthetic-driven implant placement.

Hard tissue management encompasses procedures focused on preserving and augmenting bone volume to provide adequate support for implant placement and long-term stability. Bone augmentation techniques like guided bone regeneration (GBR) and sinus augmentation address deficient ridge dimensions and ensure ideal implant positioning.

Keywords: Augmentation procedures, Bone augmentation, Hard tissue augmentation, Implants

Introduction

Implant specialists are facing increased difficulty in attaining ideal outcomes due to the impact of the increasing demand for cosmetic dentistry on dental implants. One of the most important challenges is managing and modeling hard tissue effectively.

The shape and color of the finished restoration are not the only factors that contribute to its aesthetic acceptability. Additionally, the hard structures around the implant, abutment, and final restoration must be carefully considered and, at times, handled[1]. The surgical component is necessary to give a strong hard tissue foundation before creating the appropriate soft tissue profile.[2]

Loss of hard tissue significantly complicates implant placement, thereby affecting the final prosthetic outcome. Therefore, it is imperative to maintain extraction sites predictably to preserve the hard tissue volume, a factor that can greatly influence the success of the procedure.[3]

A dependable implant system is just one aspect of the situation. Implant placement and survival depend on both bone volume and bone quality. When grafting, the doctor must develop an Osseo-adaptive environment.[3]

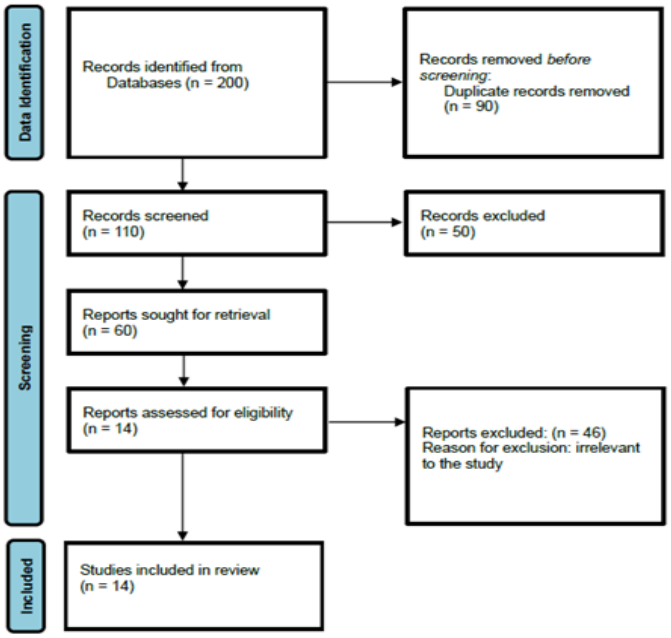
The development of bone augmentation procedures, which enable the regeneration of an optimum ridge form and the placement of implants in their optimal functional and cosmetic placements, has been largely responsible for the success of implant dentistry in the modern period.[3] In addition to improving the ultimate aesthetic outcomes, augmentation techniques establish a reliable biomechanical basis to reduce potential risks.

Inclusion Criteria

- Systematic reviews
- Randomized control trails
- Case reports with novel techniques
- Prospective studies
- Articles published in English

Exclusion Criteria

- Case reports
- Supplemental articles
- Articles published in different languages, other than English.



Methods

Vertical Defects

1. Mario Roccuzzo et al observed 41 patients for 10 years who received 82 implants. Before implant implantation, they have a corono-apical height that is insufficient for at least some of the alveolar process. He used titanium (Ti) screws and a Ti mesh to stabilize autogenous bone grafts in some of his patients. He treated some patients using bone graft along with Ti mesh (or) a bone graft alone. After 10 years of examination, the probing depth around all the implants remained the same with a small, significant reduction in keratinized tissue width. Patients with poor periodontal health (PCP) and those with healthy periodontal health (PHP) have significantly different total mean bone loss. The PHP group lost one implant, while the PCP group lost three implants.[4]
2. Michael et al did a vertical reconstruction of the alveolar crest with a modified shell technique. They used an autogenous graft for the procedure. A block

of corticocancellous bone, about 3 mm thick, was taken from the mandible's ascending ramus. They used a bone mill to thin the block to 1 mm and then utilized it as a shell. Using Ti screws, this shell is positioned in the defect location at the level of the nearby bone crest. The vertical space between the shell and the alveolar crest is filled with the milled bone chips that were mixed with autogenous blood and used as a particulate bone for the augmentation. This approach allowed for a good vertical bone healing for an appropriate implant placement. There were no indications of irritation at the surgical site after the procedure.[5]

3. Istvan et al treated 6 patients with a vertical ridge defect in the maxillary anterior region. For soft tissue contouring, they employed a modified apically positioned flap with free gingival graft, and for ridge height enhancement, they employed a titanium-reinforced polytetrafluoroethylene (PTFE) membrane or dense PTFE membrane with autogenous bone and bovine-bone derived mineral (Composite bone graft). A favorable gingival and inter-implant bone shape was achieved by using both hard and soft tissue grafting; nevertheless, additional procedures are required to obtain sufficient hard and soft tissue support.[6]
4. Perret et al placed 70 implants in 35 patients who needed vertical bone augmentation for implant placement. They have performed one-stage surgery, or simultaneous implant placement, on certain patients and two-stage surgery, or delayed implant placement, on others. They employed occlusive titanium barriers in conjunction with guided bone regeneration (GBR). All implants were in place and there had been no evidence of prosthetic failure after a two-year follow-up. Patients who underwent two-stage surgery experienced a much greater vertical bone growth than those who underwent one-stage surgery. Compared to one-stage surgery, two-stage surgery results in a wider horizontal bone. The flap thickness in both groups before and after the GBR differed in a highly significant way.[7]

Aesthetic Considerations

1. Palacci stated that based on the clinical situation both hard and soft tissue augmentation procedures can be advised simultaneously. Sometimes both can be done simultaneously, and other times soft tissue augmentation in the anterior maxilla can be done either before or after hard tissue augmentation. With minimal hard tissue augmentation during surgery, a direct implant placement is occasionally possible. For a satisfying aesthetic result in cases of partial edentulism, the crown-abutment junction should roughly align with the most apical extension of the neighbouring teeth CEJ.[8]
2. Igor Ashurko et al have performed socket preservation techniques along with soft tissue augmentation. Alveolar ridge augmentation was done right after extraction in order to reduce the amount of hard tissue volume lost in both the horizontal and vertical directions. Immediate ridge augmentation has been shown by the majority of experts to decrease bone resorption and improve the environment for subsequent implant insertion. To improve the anterior region's aesthetics, he employed a free-connective tissue graft. A CBCT performed after seven years of monitoring revealed no bone resorption surrounding the implant, and the soft tissues were in perfect health.[9]
3. Kirmani et al performed a segmental ridge-split procedure for an implant placement in the anterior maxilla. The segmental ridge-split procedure usually

requires 3–4 mm of alveolar width and more than 10 mm of alveolar height in order to repair the edentulous ridge of a single tooth. In order to achieve an aesthetic result in the gingival deficient area, they employed a subepithelial connective tissue graft at the second stage of surgery following implant placement. The patient experienced minor gingival irritation at the neighbouring teeth during the one-year follow-up. There was a slight loss of crestal bone surrounding the implant-supported prosthesis in the periapical radiograph.[10]

Materials/Barrier Membranes

1. Dahlin et al did a study to evaluate bone augmentation by Guided Bone Regeneration (GBR) in combination with Bovine Hydroxyapatite (BHA) Xenogenic filling material. Following implant implantation, BioOss combined with 20% autogenous bone chips was used to fill the defect region. Some patients received e-PTFE membranes, while others received Bio-Gide resorbable membranes. They have observed one membrane exposure and one implant failure over their five-year follow-up period.[11]
2. Raymond et al have placed hydroxyapatite-coated cylindrical implants immediately after tooth extraction. They have filled the socket using blood-wet calcium-hydroxide grafts (HTR). The area was sealed with a collagen bandage. After six months, three of the thirty implants required further grafting with HTR, and one implant failed. Over the course of these six months of healing, almost 40% of the locations have showed a decrease in width. When HTR was used, there was no notable tissue necrosis, inflammation, or other negative side effects.[12] They concluded that HTR had fulfilled the purpose of ridge preservation in conjunction with the immediate placement of hydroxyapatite-coated implants in fresh sockets. [12]

Augmentation Methods

1. Christoph H. F et al did a study to review the techniques and membrane materials applied for Guided Bone Regeneration (GBR) in conjunction with implant-based oral rehabilitation. Under normal circumstances, GBR therapy is a reliable and effective method of augmenting bone at locations where there is not enough bone volume for implant placement. The success rates of bioresorbable and non-resorbable membranes in treating horizontal defects were comparable. According to certain research, if an implant is placed right after a tooth is extracted without the use of membranes, the space between the implant and the socket wall may completely regenerate bone as long as it stays within a specific range. According to a few long-term studies, implants partially resting in enhanced bone had a survival probability comparable to implants implanted in regular bone. They anticipated that the use of growth and differentiation factors for bone regeneration would be crucial in the future.[13]
2. Bradley et al did a review on bone augmentation techniques for the reconstruction of bony defects. They have investigated the use of distraction osteogenesis, barrier membranes, autogenous and allogenic block grants, and particulate bone grafts and bone graft substitutes. They came to the conclusion that the method we employ should mostly depend on the severity of the defect and the particular steps that need to be taken in order to place the implant. When creating a treatment plan for cases involving bone augmentation, an evidence-based approach is most suited. [14]

3. Mauro Merli et al did a systematic review of randomized controlled trials on bone augmentation at implant dehiscences and fenestrations in one-stage implant placement. They came to the conclusion that there isn't enough data to say whether treatment is necessary or what the best course of action to take for fenestration or dehiscence defects at one-stage implant placement. In horizontal one-stage augmentation, the hard tissue can regenerate when a membrane is used. Comparing resorbable collagen membranes with non-resorbable ePTFE membranes revealed no differences. Using several non-resorbable membranes and grafts produced no appreciable variations. Research on cross-linked membranes showed a high degree of variability.[15]
4. In a case study, Baltacioglu E. et al. used Peri implant plastic surgery techniques to enhance both soft and hard tissues during implant rehabilitation. They have carried out two phases of implant surgery: preimplantation and implantation, as well as peri-implant plastic surgery. It was determined that the patient's vertical bone defect, shallow vestibule, and significant inflammation in the 23, 24, and 26 regions were appropriate for peri-implant plastic surgery techniques. [16]

   In two phases, they carried out surgical procedures: For the vertical ridge augmentation, sinus augmentation was used after free gingival graft (FGG) was used to improve the vestibule sulcus depth and the keratinized mucosa width (KMW) in the shallow vestibule area.[16] In order to reduce the crown-height space (CHS) and the crown-implant (C/I) ratio, they employed vertical ridge augmentation in conjunction with guided bone regeneration (GBR) during the same session as the implant procedure, following four months of sinus augmentation.[16] Phase 2 surgery was followed by prosthetic restorations. The peri-implant tissue health appeared to be preserved during the first year of the prosthetic treatment, and no issues were noted during the peri-implant plastic surgery procedures.[16]
5. Antonio D et al presented a review article on Soft and Hard Tissue Management in Implant Therapy- Surgical concepts. They stated that depending on the original state of the hard and soft architecture, implant specialists must first determine whether hard or soft tissue augmentation is required before implant placement, and if so, which procedure is suitable. Autogenous bone grafts, especially block grafts taken from the mandibular symphysis area or the ramus when a large quantity of graft material is required, are a viable treatment option for hard tissue augmentation when there is insufficient bone, according to the literature and their experience. [1]
6. Paolo F Manicone et al presented a review article on Soft and Hard Tissue Management in Implant Therapy- Prosthetic Concepts. According to them, precise prosthetic paradigm planning, including appropriate loading timing and the choice of an optimal abutment that can direct soft tissue remodeling during the provisional phase by enabling a complete stabilization and integration of the definitive restoration with the remaining natural dentition, are necessary for the optimization of soft and hard tissue management.[2]
7. Bhatavadekar N did a study on the Synergy of hard and soft tissue augmentation around implants. According to him, the idea of synergy refers to the sequencing of treatments, such as whether a hard tissue graft or a soft tissue graft should be performed first. Keratinized tissue, tissue biotype, and volume shortage are some of the variables that affect it. He

came to the conclusion that the best possibility of achieving a desired outcome for implant placement is through a synergistic approach that combines hard and soft tissue augmentation.[17]

Conclusion

The clinician's knowledge of the total treatment's complexity is essential for a successful outcome. To accomplish the desired outcome, the clinician must select appropriate treatment options. Before commencing any implant treatment, the clinical condition should be carefully assessed. The individual's bone and gingival problems must be taken into consideration when choosing an augmentation method. Every dentist should have adequate knowledge of the different augmentation techniques, including both soft and hard tissues, so that they can select an appropriate treatment option for the patient.

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