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Comparative Evaluation of Crestal Alveolar Bone Levels in Immediate Implants with and without Bone Grafts and Growth Factors: A Systematic Review

[1]Dr. Saksham Jha, [2]Dr Kartika N Kumar, [3]Dr Aditya Chaudhary, [4]Dr Punit R S Khurana

ITS Dental College Hospital and Research Centre, Greater Noida.

Corresponding Author: Dr. Saksham Jha, ITS Dental College Hospital and Research Centre, Greater Noida.

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Abstract

The restoration of missing teeth has been significantly advanced through the introduction of immediate implants. These implants provide a quicker alternative to traditional methods, ensuring faster recovery of function and aesthetics. However, maintaining crestal alveolar bone levels around these implants remains a critical determinant of their long-term success. This review evaluates the impact of bone grafts and growth factors on immediate implant outcomes in terms of crestal bone levels.

Keywords: Aesthetic Harmony, Bone Grafts, Hydroxyapatite, Socket Morphology

Introduction

Edentulous patients, who have lost all or most of their natural teeth, face numerous challenges that can significantly impact their oral health, function, and overall well-being. Fortunately, modern dentistry offers a range of solutions to address the needs of edentulous and partially edentulous patients such as removable partial and complete dentures, fixed partial prosthesis which includes crown and bridges, dental implants and implant supported prostheses. Each treatment option has its own benefits and considerations, and a personalized approach is necessary to achieve optimal functional and aesthetic outcomes.

Replacement of missing teeth is an important need for patients attending clinics because it restores normal contour, function, comfort, aesthetics, speech, and health by substituting the defective tooth with a prosthesis that offers structural stability, aesthetic harmony, and functional efficiency.[1]

Dental implants were initiated in 1922 by Branemark, who and associates described the relationship between titanium implant and bone which termed osteointegration, defined as the direct structural and functional connection between living bone and the surface of an implant (Albrektsson et al., 1981).[2] Implants provide a stable and durable foundation for prosthetic teeth, restoring oral function and aesthetics. They help

preserve the natural alignment of adjacent teeth and prevent bone resorption, which can lead to changes in facial structure.

Traditionally, the process of getting dental implants involved a multi-step procedure, which often included extractions, healing time, and waiting for osseointegration (the process by which the implant fuses with the jawbone) to occur before attaching the prosthetic tooth. This process could span several months, leaving patients without functional teeth during the interim.

However, immediate implants provide a much-needed solution by streamlining the treatment timeline. With this technique, dental professionals can extract the remaining damaged teeth, place the implant, and attach a temporary prosthesis, all in a single visit.

The placement of dental into fresh extraction sockets was introduced in 1970 and is a well-established treatment option for replacing missing teeth, allowing the restoration of masticatory function, speech and esthetics.[3]

The timing between extraction of a tooth and placement of an implant is an important factor in determining the aesthetic and functional success of the final restoration, because it indicates the amount of bone resorption and loss of the soft tissue profile, which might have taken place within this time. The advantages claimed for the immediate implant placement protocol are the marked reduction in time taken for healing, the reduced number of surgical procedures, and the optimal availability of existing bone to allow primary stability of the implant.[4]Another advantage of implant placement in the extraction socket is the counteracting of the hard tissue resorption that occurs following tooth extraction.[5]

However, some studies have suggested that immediate implant placement in the fresh extraction socket cannot prevent dimensional ridge resorption. Previous research has shown that survival rates for immediately placed implants are comparable to those of implants placed in healed alveolar bone.[6–8]

The placement of an immediate implant in a fresh extraction socket creates a circumferential gap coronally, the size of which is determined by the implant diameter, socket morphology, and tooth type.[4] The jumping distance—an inevitable residual gap between the implant and the socket wall—is a drawback of immediate implant use because it might cause bone resorption and the development of a bony defect, which would reduce the stability of the implant. When this jumping distance is more than 2 mm, use of bone grafts is recommended. However, the use of grafts when the jumping distance is <2 mm is not defined in the literature.

Autograft, allograft, and alloplastic graft materials all provide better osseointegration. Bone grafts serve as a scaffold and filler to encourage bone growth and wound healing. Grafts function as a mineral reservoir to aid in the creation of new bone, are bioresorbable, and do not cause an antigen-antibody reaction. There are numerous graft materials available, including allograft, autograft, calcium sulphate, ceramic, hydroxyapatite, and polymers.[9]

When the jumping distance is large enough it necessitates the formation of connective tissue between the coronal portion of the implant and the peri-implant bone. To fill the peri-implant area, growth factors such as platelet concentrates (platelet rich fibrin) are used as an adjunct with bone grafts. When used in conjunction with a bone graft, PRF aids in wound healing, bone growth and maturation, graft stabilization and hemostasis, as well as improving the handling properties of graft materials and increasing bone density.[10]

So, the aim of this systematic review is to compare and evaluate crestal alveolar bone levels in relation to

immediate implants with and without bone grafts and growth factors.

Methodology

The systematic review was conducted in adherence to strict eligibility criteria to ensure the inclusion of high-quality and relevant studies. Articles were selected based on the following inclusion and exclusion criteria:

Inclusion Criteria

1. Clinical studies conducted on humans.
2. Studies comparing marginal bone levels around immediate implants with and without bone grafts.
3. Studies evaluating the role of growth factors in immediate implants.
4. Studies investigating the combination of bone grafts and growth factors.
5. Articles published in English after January 1, 2013.

Exclusion Criteria

1. Animal studies or in vitro research.
2. Abstracts, case reports, protocols, personal opinions, and letters.
3. Studies where outcomes were unrelated to immediate implant placement.
4. Full-text articles unavailable.
5. Publications in languages other than English.

Information Sources and Search Strategy

Electronic databases, including PubMed, Google Scholar, Scopus, Web of Science, and EBSCO, were systematically searched by two independent reviewers. Keywords used included “immediate implants,” “bone graft,” “growth factors,” and “crestal bone levels.” Additional sources, such as hand searches and grey literature, supplemented the database findings.

Selection and Screening Process

A three-phase screening process was applied:

1. **Title and Abstract Screening:** Potentially relevant articles were shortlisted based on their titles and abstracts.
2. **Full-Text Review:** Articles meeting inclusion criteria were selected for further analysis.
3. **Data Extraction:** Relevant data, such as sample size, type of intervention, follow-up period, and outcomes, were systematically extracted and tabulated.

Data Analysis

Studies were qualitatively synthesized to identify trends in marginal bone loss across different intervention groups. Where possible, numerical data were compared to assess the efficacy of individual and combined approaches.

Results

- **Immediate Implants without Bone Grafts**: Studies highlighted a mean marginal bone loss of 1-2 mm over extended follow-up periods.
- **With Bone Grafts**: The use of autogenous, xenogeneic, or synthetic grafts significantly reduced crestal bone loss, particularly when the jumping gap exceeded 2 mm.
- **With Growth Factors**: Platelet-derived concentrates like PRF and PRP enhanced soft tissue healing and bone stability, although their standalone effectiveness was variable.
- **Combined Approach**: Integrating bone grafts with growth factors yielded superior outcomes, demonstrating minimal bone resorption and improved soft tissue regeneration.

Results

Table 1: Crestal Bone Loss in Immediate Implants without Bone Grafts

Study	Year	Sample Size	Marginal Bone Loss	Follow-Up Time
Assery et al.[11]	2020	35	1.61 mm	22 years
Ragucci et al.[12]	2020	990	1.29 ± 0.24 mm	1 year
Kinaia et al.[13]	2014	760	0.94-0.95 mm	12-60 months
Sanz et al.[14]	2013	108	0.56-0.67 mm	1-3 years
Guarnieri et al.[15]	2013	20	0.40-0.83 mm	6 months-5 years

Table 2: Crestal Bone Loss in Immediate Implants with Bone Grafts

Study	Year	Sample Size	Bone Graft Used	Marginal Bone Loss	Follow-Up Time
Nobre et al.[7]	2023	36	Autogenous	0.63-2.01 mm	5-12 months
Kabi et al.[16]	2020	33	Autogenous	0.57-0.93 mm	9 months
Wu et al.[17]	2019	30	Autogenous	0.57-3 mm	6-12 months
Alkudmani et al.[18]	2017	208	DFDBA, HA, Autogenous, Xenograft	0.94-1.02 mm	10 years
Aly et al.[19]	2016	20	Xenograft	0.43-0.6 mm	6-18 months

Table 3: Crestal Bone Loss in Immediate Implants with Growth Factors

Study	Year	Sample Size	Growth Factor Used	Marginal Bone Loss	Follow-Up Time
Gaur et al.[20]	2022	36	PRF, CGF	2.5-3.1 mm	4-16 weeks
Shah et al.[21]	2021	90	PRP	1.75-1.87 mm	2-12 weeks
Diana et al.[22]	2018	31	PRF	0.44-0.48 mm	1 month-1 year
Taschieri et al.[23]	2017	109	PRP	0.8-1.02 mm	5 years
Oncu et al.[24]	2017	26	L-PRF	0.7 mm	1-12 months

Table 4: Combined Bone Graft and Growth Factor Usage

Study	Year	Sample Size	Bone Graft Used	Growth Factor Used	Marginal Bone Loss	Follow-Up Time
Skariah et al.[1]	2023	30	Hydroxyapatite	PRF	2.93-3.20 mm	3 months
Tomar et al.[25]	2022	90	Perioglass Allograft	PRP	3.09-3.19 mm	3-12 months
Elbrashy et al.[26]	2022	20	Xenograft	PRF	0.14-0.26 mm	2 years
Medikeri et al.[27]	2018	8	DFDBA	PRF	0.56 mm	3-12 months
Ar Rejaie et al.[28]	2016	16	Xenograft	PRP	0.80-0.82 mm	3-12 months

Discussion

Immediate implants have emerged as a preferred treatment modality due to their ability to address patients' aesthetic and functional concerns efficiently. However, maintaining crestal bone levels remains a significant challenge that directly impacts implant stability and long-term success.

Immediate Implants without Adjunctive Therapies

Studies have consistently shown that immediate implant placement alone may result in moderate crestal bone loss due to natural remodeling processes. For instance, Assery et al.[11] reported a marginal bone loss of approximately 1 mm within the first year, followed by an annual decrease of 0.2 mm in subsequent years. This underscores the need for adjunctive measures to mitigate bone resorption.

Role of Bone Grafts

Bone grafting has been widely recognized as an effective strategy to preserve socket dimensions and counteract crestal bone loss. Autogenous grafts, which involve harvesting the patient's bone, provide superior osseointegration compared to allogeneic, xenogeneic, or synthetic alternatives. Sanz et al.[14] observed a 60% reduction in horizontal defects and a 90% reduction in vertical defects with bone grafts, demonstrating their efficacy in supporting peri-implant tissues.

Despite these benefits, grafting techniques are not without limitations. Factors such as graft material selection, patient-specific anatomical variations, and the skill of the practitioner can influence outcomes. Long-term follow-up studies, such as those by Alkudmani et al.[18], highlight the stability achieved through grafting, but also emphasize the need for careful case selection.

Impact of Growth Factors

Growth factors such as PRF, PRP, and CGF play a pivotal role in enhancing tissue regeneration. By stimulating osteoblastic activity and angiogenesis, they accelerate wound healing and reduce crestal bone loss. Oncu and Erbeyoglu's[24] study revealed that the use of L-PRF resulted in a marginal bone loss of just 0.7 mm within the first year, significantly lower than implants without growth factor adjuncts.

However, the efficacy of growth factors as standalone treatments remains variable. For instance, Diana et al.[22] reported no statistically significant difference in crestal bone levels between groups treated with PRF alone and those without. This suggests that while growth factors are beneficial, their full potential may be realized only when combined with other interventions.

Combined Approach: Bone Grafts and Growth Factors

A synergistic approach combining bone grafts and growth factors has shown promising results. By addressing both structural and biological requirements, this method enhances peri-implant bone stability and accelerates tissue maturation. Avula et al. demonstrated that PRF combined with bone ceramic significantly improved bone levels compared to PRF alone. Similarly, Skariah et al.[1] observed reduced marginal bone loss in patients receiving implants with both PRF and hydroxyapatite grafts.

Challenges and Considerations

While the combined use of bone grafts and growth factors offers superior outcomes, several challenges remain:

1. **Patient Variability:** Individual factors such as systemic health, smoking status, and bone quality can influence outcomes.
2. **Material Selection:** The choice of graft material and growth factor preparation affects efficacy.
3. **Cost and Accessibility:** Advanced techniques may not be feasible in all clinical settings due to cost or resource limitations.
4. **Long-Term Evidence:** Although short-term studies show promising results, more longitudinal research is needed to establish the durability of these interventions.

Conclusion

Immediate implants are a revolutionary approach to tooth replacement, offering significant advantages in terms of

treatment efficiency and patient satisfaction. However, preserving crestal bone levels remains a critical challenge. This review highlights the potential of bone grafts and growth factors, both individually and in combination, to enhance peri-implant bone stability. Future research should focus on standardized protocols and long-term outcomes to further optimize immediate implant success.

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