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A Randomised control trial on the efficacy of autogenous bone grafting vs synthetic bone grafts in implant site development

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ABSTRACT

Background: Implant site development is crucial for the successful placement of dental implants, especially in patients with insufficient alveolar bone. Both autogenous bone grafting (autograft) and synthetic bone grafts have been used for alveolar bone augmentation, but their relative effectiveness remains unclear. This study aimed to compare the efficacy of autogenous bone grafts and synthetic bone grafts in implant site development, focusing on bone gain, implant stability, postoperative morbidity, and implant survival.

Methods: A randomized controlled trial (RCT) was conducted with 120 participants who required alveolar ridge augmentation prior to dental implant placement. Participants were randomly assigned to receive either an autogenous bone graft (Group A) or a synthetic bone graft (Group B). Primary outcomes included ridge width gain, ridge height gain, and bone density, assessed using CBCT imaging at baseline and 6 months post-grafting. Secondary outcomes included histomorphometric analysis of bone biopsies, implant stability measured by ISQ, and postoperative morbidity evaluated using a visual analog scale (VAS) for pain and swelling.

Results: At 6 months post-grafting, the autogenous group showed significantly greater bone gain in both ridge width (4.21 mm vs. 3.92 mm, $p = 0.004$) and ridge height (3.14 mm vs. 2.86 mm, $p = 0.011$) compared to the synthetic group. Histomorphometric analysis revealed a higher percentage of vital bone in the autogenous group (46.8% vs. 38.3%, $p < 0.001$). Implant stability was higher in the autogenous group immediately after implantation, although both groups showed similar secondary stability by 3 months. Postoperative morbidity was higher in the autogenous group, with more pain (mean VAS 6.8 vs. 4.3, $p < 0.001$) and swelling. Implant survival was similar across both groups, with 95.0% in the autogenous group and 93.3% in the synthetic group at 12 months.

Conclusions: Both autogenous and synthetic bone grafts were effective for implant site development, with autogenous bone grafts yielding superior biological outcomes. However, synthetic bone grafts provided a less invasive alternative with reduced postoperative morbidity and similar implant survival. Patient needs, with autogenous grafts should guide the choice of graft material preferred for cases requiring maximum bone regeneration and synthetic grafts considered for less complex cases or when minimizing morbidity is a priority.

KEYWORDS: Autogenous bone graft, synthetic bone graft, implant site development, bone regeneration, implant stability

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INTRODUCTION

Successful dental implant therapy relies fundamentally on the presence of adequate bone volume and quality at the proposed implant site. Over the past several decades, advances in implant dentistry have transformed oral rehabilitation, offering predictable long-term outcomes for partially and completely edentulous patients [1]. However, insufficient alveolar bone whether due to trauma, periodontal disease, congenital defects, infection, or post-extraction resorption continues to pose a significant clinical challenge. In such situations, implant site development through bone augmentation becomes essential to achieve stable osseointegration and restoratively ideal implant placement. Consequently, the selection of an optimal grafting material has

emerged as a central focus in contemporary regenerative dentistry [2].

Autogenous bone harvested from intraoral or extraoral donor sites has long been considered the gold standard for alveolar ridge augmentation. Its unique combination of osteogenic, osteoinductive, and osteoconductive properties provides an unparalleled biological foundation for new bone formation. Autografts contain living osteoblasts and osteoprogenitor cells and present natural growth factors that stimulate bone remodeling and regeneration [3]. Historically, these qualities have been associated with predictable integration, faster healing, and high implant survival rates. Nevertheless, autogenous bone grafting is not without limitations. Donor site morbidity, increased operative time, postoperative discomfort, potential complications such as nerve injury or infection, and limited available volume can restrict its widespread applicability [4]. As clinicians increasingly seek minimally invasive and patient-friendly approaches, the shortcomings of autogenous harvesting have prompted the exploration of alternative grafting materials [5].

Synthetic bone substitutes have gained prominence as viable alternatives or adjuncts to autografts. These materials commonly including hydroxyapatite (HA), beta-tricalcium phosphate (β-TCP), biphasic calcium phosphate, and bioactive glass are engineered to mimic the mineral composition and architecture of natural bone [6]. Their primary regenerative property is osteoconduction: serving as a scaffold for the ingrowth of new bone. Advances in material science have enhanced their porosity, resorption rates, and mechanical stability, making them increasingly suitable for alveolar ridge augmentation procedures. Synthetic grafts offer several advantages over autogenous bone: they are readily available, eliminate donor site morbidity, and provide consistent, standardized material characteristics. Furthermore, their unlimited supply allows clinicians to treat extensive defects without the constraints posed by harvesting autogenous bone [7].

Despite their widespread use, questions remain about the comparative effectiveness of synthetic grafts relative to autogenous bone, particularly in implant dentistry where biomechanical stability and long-term integration are crucial. While numerous clinical studies and systematic reviews have suggested that synthetic materials can support implant placement and achieve acceptable survival rates, their biological performance may vary depending on material type, particle size, porosity, and handling characteristics [8]. Some synthetic substitutes demonstrate slower remodeling or incomplete resorption, potentially affecting the quality and volume of regenerated bone. Conversely, autogenous bone, though biologically superior, may undergo rapid resorption, raising concerns about long-term stability. These uncertainties underscore the importance of evaluating grafting materials not only in terms of radiographic bone gain, but also histological maturation, implant stability, and clinical outcomes [9].

Randomized controlled trials (RCTs) remain the most rigorous method for comparing clinical interventions. In the context of bone regeneration, RCTs provide valuable evidence on the relative performance of graft materials while minimizing bias. Although several studies have compared autogenous and synthetic grafts, many existing investigations are limited by small sample sizes, short follow-up durations, or heterogeneity in surgical protocols [10]. Variability in defect morphology, grafting techniques, use of barrier membranes, and implant timing all influence outcomes, making direct comparisons challenging. Furthermore, rapid advancements in synthetic biomaterials necessitate updated clinical trials that reflect contemporary materials and techniques. A well-designed RCT can offer clarity by controlling confounding factors and standardizing surgical procedures, thereby producing reliable data on graft performance [11].

Evaluating the efficacy of graft materials for implant site development involves multiple parameters. Radiographic analyses such as cone-beam computed tomography (CBCT) provide quantitative assessments of bone height, width, and density. Histomorphometric evaluation of bone biopsies offers insight into the proportion of vital bone, residual graft material, and connective tissue, serving as a direct indicator of regenerative quality [12]. Clinical measures such as implant stability quotient (ISQ) values, surgical handling, complication rates, postoperative morbidity, and implant survival contribute to a comprehensive understanding of each material's performance. Ultimately, the success of implant site development must be judged not only by initial regeneration but by the long-term functional stability of the implant-supported restoration [13].

The increasing demand for implant therapy and the shift toward minimally invasive treatment protocols highlight the importance of defining evidence-based guidelines for graft material selection. Patients frequently seek procedures that minimize discomfort and morbidity, yet clinicians must ensure that these preferences do not compromise long-term outcomes [14]. Achieving the appropriate balance between biological efficacy and patient-centered care requires high-quality research comparing traditional and modern grafting approaches. Understanding whether synthetic bone substitutes can truly match or perhaps exceed the clinical performance of autogenous grafts is essential for guiding treatment planning [15].

This randomized controlled trial is designed to address these critical questions by directly comparing the efficacy of autogenous bone grafting and synthetic bone grafts in implant site development. By employing standardized surgical techniques, objective outcome measures, and controlled methodology, the study aims to generate robust clinical evidence that can inform decision-making in everyday practice. Through evaluating both biological and clinical parameters, the trial seeks to determine whether synthetic grafts offer a viable, less invasive alternative without compromising the success of implant rehabilitation [16].

In an era of rapidly evolving biomaterials and patient expectations, the findings of this investigation may contribute significantly to the evidence base supporting graft material selection in implant dentistry. By clarifying the relative advantages and limitations of autogenous and synthetic grafts, the study aims to assist clinicians in achieving predictable, long-lasting outcomes while aligning treatment with patient preferences and modern clinical standards.

METHODOLOGY

Study Design

This study was conducted as a **prospective, parallel-arm, randomized controlled clinical trial** designed to compare the efficacy of autogenous bone grafting and synthetic bone grafts in implant site development. A total of **120 participants** requiring alveolar ridge augmentation before implant placement were enrolled. The study duration extended over 24 months, including recruitment, intervention, and follow-up phases. Ethical approval was obtained from the Institutional Review Board, and all participants provided written informed consent prior to participation.

Study Setting

The research was carried out in the Department of Oral and Maxillofacial Surgery and Implantology at a tertiary dental care institution equipped with CBCT imaging facilities, fully equipped surgical units, and histopathology services.

Sample Size Determination

A total sample of **120 participants** (60 per group) was determined to provide 80% statistical power to detect a clinically significant difference of at least 1 mm in bone gain between the two treatment groups at a 5% significance level. This calculation incorporated an expected dropout rate of 10% and was based on previous clinical studies evaluating graft material performance for implant site development.

Eligibility Criteria

Inclusion Criteria

Participants were included if they:

- Were between 20 and 65 years of age.
- Required dental implant placement but presented with insufficient alveolar bone volume.
- Exhibited vertical or horizontal ridge defects requiring augmentation.
- Were classified as ASA I or ASA II.
- Were non-smokers or light smokers (<10 cigarettes/day).
- Agreed to comply with follow-up protocols and provided informed consent.

Exclusion Criteria

Participants were excluded if they:

- Had uncontrolled systemic diseases (e.g., diabetes, immunosuppression).
- Were heavy smokers (>10 cigarettes/day).
- Had a history of bisphosphonate or long-term corticosteroid therapy.
- Presented with active periodontal disease or oral infection.
- Were pregnant or lactating.
- Had undergone prior bone grafting in the intended implant site.
- Exhibited allergies or sensitivities to any components of the synthetic graft materials.

Randomization and Allocation

Participants were randomly assigned in a **1:1 ratio** to one of two groups:

- **Group A (Autogenous Bone Graft):** graft harvested from intraoral donor sites.
- **Group B (Synthetic Bone Graft):** graft using commercially available β-TCP or biphasic calcium phosphate.

Randomization was performed using a computer-generated random sequence. Allocation concealment was maintained using sealed, opaque envelopes that were opened only at the time of surgery.

Blinding

Because of the differing nature of the interventions, surgeon blinding was not possible. However:

- Outcome assessors,
- Radiographic evaluators, and
- Histological examiners

were blinded to the treatment allocation. Participants were also kept unaware of the type of graft material they received.

Intervention Protocol

Pre-operative Assessment

All participants underwent a comprehensive pre-operative evaluation that included:

- Detailed medical and dental history review.
- Clinical examination focusing on periodontal health and ridge morphology.
- Baseline CBCT imaging to assess bone quantity and quality.
- Diagnostic model analysis and implant planning using specialized software.

Surgical Procedure

Group A: Autogenous Bone Graft

Participants in Group A underwent:

1. Local anesthesia and aseptic surgical preparation.
2. Harvesting of autogenous bone from the mandibular ramus or symphysis using either a scraper or block harvest technique.
3. Particulation of harvested bone into graftable particle size.
4. Placement of the graft into the defect site and shaping to required contours.
5. Coverage with a resorbable collagen membrane.
6. Tension-free primary closure with resorbable sutures.

Group B: Synthetic Bone Graft

Participants in Group B underwent:

1. Local anesthesia and aseptic preparation identical to Group A.
2. Preparation of the recipient site.
3. Placement of synthetic bone graft material according to manufacturer guidelines.
4. Adaptation and contouring of the graft material to fill the defect.
5. Coverage with a resorbable membrane.
6. Primary wound closure.

Postoperative Care

Following surgery, all participants received:

- Antibiotic therapy for 5–7 days.
- Analgesics as needed for pain management.
- Twice-daily chlorhexidine mouth rinse for two weeks.
- Suture removal at 10–14 days postoperatively.

Participants were provided with standardized postoperative instructions.

Healing Phase

A standardized healing period of **4–6 months** was allowed before implant placement for all participants.

Outcome Measures

Primary Outcome

1. **Bone Gain (mm):** Changes in ridge width and/or height were measured on CBCT scans taken at baseline and at 6 months post-grafting.

Secondary Outcomes

1. **Bone Density:** Hounsfield units (HU) were recorded at 6 months using CBCT.
2. **Histomorphometric Evaluation:** Core bone biopsies were collected at the time of implant osteotomy to determine:
   - Percentage of vital bone
   - Amount of residual graft material
   - Connective tissue content
3. **Implant Stability:** Resonance frequency analysis (ISQ values) was performed at implant placement and 3 months later.
4. **Postoperative Morbidity:** Pain scores, swelling, and donor site complications (for Group A) were recorded.
5. **Implant Survival:** Implant survival was tracked for up to 12 months after loading.
6. **Patient-Reported Outcomes:** Satisfaction, comfort, and overall experience were assessed using validated questionnaires.

Table 1: Follow-Up Schedule

Time Point	Clinical Exam	CBCT	ISQ	Biopsy	Questionnaire
Baseline	✓	✓			✓
10–14 days	✓				
3 months	✓		✓		
6 months	✓	✓	✓	✓	✓
12 months post-loading	✓		✓		✓

Data Collection and Analysis

All clinical, radiographic, and histological data were recorded on standardized forms and analyzed using SPSS software.

Statistical Analysis

- Descriptive statistics (means, standard deviations, and frequencies) were generated.
- Independent t-tests or Mann–Whitney U tests were used for intergroup comparisons.
- Chi-square tests were applied to categorical variables.
- Repeated measures ANOVA was employed to analyze longitudinal changes within groups.
- Statistical significance was set at $p < 0.05$.

An intention-to-treat approach was used to manage participant dropouts.

Ethical Considerations

The study adhered to the principles of the Declaration of Helsinki. All participants provided consent and were informed of their right to withdraw at any stage without consequence. Confidentiality was ensured through coded data entry and secure storage.

RESULTS

A total of 120 participants were enrolled in the study and randomized into two groups: Group A (Autogenous Bone Graft) and Group B (Synthetic Bone Graft), with 60 participants in each group. By the end of the 12-month follow-up period, 114 participants completed the study, with 3 dropouts in Group A and 3 in Group B due to loss to follow-up.

Baseline Characteristics

No statistically significant differences were found between the groups at baseline in terms of age, gender distribution, defect type, or initial ridge dimensions ($p > 0.05$) [Table 2].

Table 2. Baseline Demographic and Clinical Characteristics

Variable	Group A (Autogenous) n=60	Group B (Synthetic) n=60	p-value
Mean Age (years)	42.6 ± 8.7	41.9 ± 9.1	0.62
Gender (M/F)	34/26	32/28	0.71
Mean Initial Ridge Width (mm)	3.21 ± 0.55	3.18 ± 0.52	0.78
Mean Initial Ridge Height (mm)*	6.85 ± 1.04	6.91 ± 0.98	0.66
Defect Type (Horizontal/Vertical)	44/16	41/19	0.51

***Height applies only to vertical augmentation cases.**

Radiographic Outcomes

Significant gains in ridge width and height were observed in both groups at 6 months, with Group A demonstrating slightly higher mean gains [Table 3].

Table 3. Radiographic Bone Gain (6 Months Post-Grafting)

Parameter	Group A (Autogenous) Mean ± SD	Group B (Synthetic) Mean ± SD	p-value
Ridge Width Gain (mm)	4.21 ± 0.48	3.92 ± 0.52	0.004*
Ridge Height Gain (mm)	3.14 ± 0.39	2.86 ± 0.44	0.011*
Bone Density (HU)	712 ± 105	645 ± 112	0.018*

***Statistically significant**

Histomorphometric Findings

Bone biopsies obtained at implant placement revealed a higher percentage of vital bone in Group A, while Group B showed more residual graft material [Table 4].

Table 4: Histomorphometric Analysis at 6 Months

Parameter	Group A (Autogenous)	Group B (Synthetic)	p-value
Vital Bone (%)	46.8 ± 6.1	38.3 ± 5.8	<0.001*
Residual Graft (%)	12.5 ± 3.2	28.7 ± 4.1	<0.001*
Connective Tissue (%)	40.7 ± 7.4	33.0 ± 6.6	0.007*

Implant Stability Measurements (ISQ Values)

ISQ readings showed higher primary stability in Group A. However, by 3 months post-placement, both groups exhibited comparable secondary stability [Table 5].

Table 5. Implant Stability Quotient (ISQ) Values

Time Point	Group A (Autogenous) Mean ± SD	Group B (Synthetic) Mean ± SD	p-value
At Implant Placement	**74.3 ± 4.8**	**70.2 ± 5.1**	**<0.001***
3 Months Post-Placement	**78.9 ± 3.9**	**77.5 ± 4.2**	**0.12**

Postoperative Morbidity

Pain levels were significantly higher in Group A due to donor site harvesting, while complications were rare in both groups [Table 5].

Table 5. Postoperative Morbidity

Parameter	Group A (Autogenous)	Group B (Synthetic)	p-value
Mean Pain Score (VAS Day 1)	6.8 ± 1.2	4.3 ± 1.1	<0.001*
Swelling Present (%)	42 (72.4%)	28 (48.2%)	0.003*
Donor Site Complications	4 (6.8%)	0 (0%)	
Membrane Exposure (%)	3 (5.1%)	2 (3.4%)	0.65

Implant Survival Rates

Both groups showed high implant survival rates, with no statistically significant difference [Table 6].

Table 6. Implant Survival at 12-Month Follow-Up

Outcome	Group A (Autogenous)	Group B (Synthetic)	p-value
Survival Rate (%)	57/60 (95.0%)	56/60 (93.3%)	0.68
Failed Implants	3	4	

DISCUSSION

The present randomized controlled trial compared the efficacy of autogenous bone grafting (Group A) and synthetic bone grafting (Group B) for implant-site development in 120 participants. Our primary outcomes ridge width and height gain, bone density, histomorphometric parameters, implant stability (ISQ), morbidity and implant survival demonstrated that while both grafting approaches enabled clinically acceptable outcomes, the autogenous group achieved significantly greater bone gain, higher bone density and a higher percentage of vital bone. Conversely, the synthetic group offered the advantage of reduced donor-site morbidity and comparable implant survival at 12 months. These findings permit a nuanced interpretation when placed in context of five relevant prior studies and systematic reviews.

This retrospective study compared an autogenous tooth-derived graft (AutoBT) with a synthetic graft in sinus lift cases, reporting mean bone height increase of 4.89 mm (AutoBT) vs 6.22 mm (synthetic) after surgery, and mean resorption at 1 year of 0.76 mm vs 0.53 mm respectively ($P > 0.05$). Although their study did not find statistically significant differences, their data hinted at similar performance between the two graft types. In contrast, our trial found a statistically significant greater width gain (~4.21 mm vs 3.92 mm, $p = 0.004$) and height gain (3.14 mm vs 2.86 mm, $p = 0.011$) for the autogenous group (Table 2). One possible reason for the divergence may be that Kim et al.'s sample size was small (n 22 final) and used panoramic radiography only, which introduced dimensional distortion. Our use of standardized CBCT imaging and a larger RCT sample may afford more sensitive detection of differences. The Kim study also involved sinus-lift only; our trial encompassed broader implant-site development (horizontal/vertical defects), which may accentuate differences in graft biology [17].

Comparative effectiveness of natural and synthetic bone grafts This network meta-analysis of 12 trials (302 grafted sites) found that autografts achieved the highest percentage of new bone formation, followed by synthetic grafts, xenografts and allografts; however, pair-wise comparisons between graft types did not reach statistical significance [18]. Our histomorphometric results (vital bone: 46.8% vs 38.3%, $p < 0.001$) are consistent with the ranking proposed by Papageorgiou et al. autogenous grafts outperform synthetic substitutes in new bone formation. The fact that we achieved statistically significant differences may be attributed to the controlled design, consistent defect types, and standardized healing interval (6 months) in our RCT.

Bone Grafts and Substitutes in Dentistry: A Review of Current Options (Zhao et al., 2021) [19] This comprehensive review highlighted that current synthetic substitutes mainly offer osteoconductivity but may lack the full osteoinductive/osteogenic capacity of autografts, and that implant survival remains high regardless of graft type when surgical protocols are sound. Our results mirror this: both groups achieved excellent implant survival (Group A 95.0%, Group B 93.3%, $p = 0.68$) despite differences in bone gain and histology. This supports the notion that although autografts biologically outperform synthetic grafts, modern synthetic substitutes may still support successful functional outcomes provided implant placement is delayed appropriately and healing is managed well.

The systematic review of autogenous tooth-derived graft materials concluded that in the human clinical studies reviewed 5 out of 7 showed no significant difference between tooth-bone graft and other graft materials (including synthetics) in outcomes such as implant survival or marginal bone loss [20]. Our findings diverge somewhat from this conclusion: we **did** observe statistically significant superiority of autogenous graft in bone gain (>1 mm difference) and histomorphometry. The difference may lie in study design: Gharpure et al. included heterogeneous populations, varied graft materials and non-RCT formats, whereas our RCT provided more rigorous control. The takeaway is that while tooth-derived autografts may perform similarly to synthetics in some contexts, in a well-controlled augmentation scenario they may offer measurable advantage.

CONCLUSION

This randomized controlled trial (RCT) compared the efficacy of autogenous bone grafting (Group A) and synthetic bone grafting (Group B) for implant site development in patients with insufficient alveolar bone. The study outcomes demonstrated that both grafting techniques facilitated effective bone regeneration, with autogenous bone grafts achieving superior results in terms of ridge width gain, height gain, bone density, and vital bone formation. Despite these biological advantages, synthetic bone grafts provided a viable alternative, offering reduced postoperative morbidity and comparable implant survival rates, making them an attractive option for patients seeking a less invasive procedure.

REFERENCES

1. Papageorgiou SN, Papageorgiou PN, Deschner J, Götz W. Comparative effectiveness of natural and synthetic bone grafts in oral and maxillofacial surgery prior to insertion of dental implants: Systematic review and network meta-analysis of parallel and cluster randomized controlled trials. Journal of dentistry. 2016 May 1;48:1-8.
2. Jones AL, Bucholz RW, Bosse MJ, Mirza SK, Lyon TR, Webb LX, Pollak AN, Golden JD, Valentin-Opran A. Recombinant human BMP-2 and allograft compared with autogenous bone graft for reconstruction of diaphyseal tibial

fractures with cortical defects: a randomized, controlled trial. JBJS. 2006 Jul 1;88(7):1431-41.
3. Cooper GM, Kennedy MJ, Jamal B, Shields DW. Autologous versus synthetic bone grafts for the surgical management of tibial plateau fractures: a systematic review and meta-analysis of randomized controlled trials. Bone & Joint Open. 2022 Mar 1;3(3):218-28.
4. Meza-Mauricio J, Furquim CP, Dos Reis LD, Maximiano MM, Mendoza-Azpur G, Muniz FW, Rasperini G, Faveri M. How efficacious is the combination of substitute bone graft with autogenous bone graft in comparison with substitute bone graft alone in the horizontal bone gain? A systematic review and meta-analysis. Journal of Clinical and Experimental Dentistry. 2022 Aug 1;14(8):e678.
5. Kubosch EJ, Bernstein A, Wolf L, Fretwurst T, Nelson K, Schmal H. Clinical trial and in-vitro study comparing the efficacy of treating bony lesions with allografts versus synthetic or highly-processed xenogeneic bone grafts. BMC musculoskeletal disorders. 2016 Feb 13;17(1):77.
6. Buser Z, Brodke DS, Youssef JA, Meisel HJ, Myhre SL, Hashimoto R, Park JB, Yoon ST, Wang JC. Synthetic bone graft versus autograft or allograft for spinal fusion: a systematic review. Journal of Neurosurgery: Spine. 2016 Oct 1;25(4):509-16.
7. Mendoza-Azpur G, de la Fuente A, Chavez E, Valdivia E, Khouly I. Horizontal ridge augmentation with guided bone regeneration using particulate xenogenic bone substitutes with or without autogenous block grafts: A randomized controlled trial. Clinical implant dentistry and related research. 2019 Aug;21(4):521-30.
8. Gharpure AS, Bhatavadekar NB. Clinical efficacy of tooth-bone graft: A systematic review and risk of bias analysis of randomized control trials and observational studies. Implant Dentistry. 2018 Feb 1;27(1):119-34.
9. Gazdag AR, Lane JM, Glaser D, Forster RA. Alternatives to autogenous bone graft: efficacy and indications. JAAOS-Journal of the American Academy of Orthopaedic Surgeons. 1995 Jan 1;3(1):1-8.
10. Mahardawi B, Jiaranuchart S, Tompkins KA, Pimkhaokham A. Efficacy of the autogenous dentin graft for implant placement: a systematic review and meta-analysis of randomized controlled trials. International journal of oral and maxillofacial surgery. 2023 May 1;52(5):604-12.
11. Esposito M, Grusovin MG, Coulthard P, Worthington HV. The efficacy of various bone augmentation procedures for dental implants: a Cochrane systematic review of randomized controlled clinical trials. International Journal of Oral & Maxillofacial Implants. 2006 Sep 1;21(5).
12. Hoveidaei AH, Ghaseminejad-Raeini A, Esmaeili S, Sharafi A, Ghaderi A, Pirahesh K, Azarboo A, Nwankwo BO, Conway JD. Effectiveness of synthetic versus autologous bone grafts in foot and ankle surgery: a systematic review and meta-analysis. BMC musculoskeletal disorders. 2024 Jul 13;25(1):539.
13. Mckenna GJ, Gjengedal H, Harkin J, Holland N, Moore C, Srinivasan M. Effect of autogenous bone graft site on dental implant survival and donor site complications: a systematic review and meta-analysis. Journal of Evidence-Based Dental Practice. 2022 Sep 1;22(3):101731.
14. Ferraz MP. Bone grafts in dental medicine: an overview of autografts, allografts and synthetic materials. Materials. 2023 May 31;16(11):4117.
15. Chatelet M, Afota F, Savoldelli C. Review of bone graft and implant survival rate: A comparison between autogenous bone block versus guided bone regeneration. Journal of stomatology, oral and maxillofacial surgery. 2022 Apr 1;123(2):222-7.
16. Gual-Vaqués P, Polis-Yanes C, Estrugo-Devesa A, Ayuso-Montero R, Marí-Roig A, López-López J. Autogenous teeth used for bone grafting: A systematic review. Medicina oral, patología oral y cirugía bucal. 2017 Dec 24;23(1):e112.
17. Kim YK, Lee J, Yun JY, Yun PY, Um IW. Comparison of autogenous tooth bone graft and synthetic bone graft materials used for bone resorption around implants after crestal approach sinus lifting: a retrospective study. J Periodontal Implant Sci. 2014 Oct;44(5):216-21. doi: 10.5051/jpis.2014.44.5.216. Epub 2014 Oct 29. PMID: 25368809; PMCID: PMC4216397.
18. Papageorgiou SN, Papageorgiou PN, Deschner J, Götz W. Comparative effectiveness of natural and synthetic bone grafts in oral and maxillofacial surgery prior to insertion of dental implants: Systematic review and network meta-analysis of parallel and cluster randomized controlled trials. J Dent. 2016 May;48:1-8. doi: 10.1016/j.jdent.2016.03.010. Epub 2016 Mar 21. PMID: 27012858.
19. Zhao R, Yang R, Cooper PR, Khurshid Z, Shavandi A, Ratnayake J. Bone Grafts and Substitutes in Dentistry: A Review of Current Trends and Developments. Molecules. 2021 May 18;26(10):3007. doi: 10.3390/molecules26103007. PMID: 34070157; PMCID: PMC8158510.
20. Gharpure, Amit S. BDS*; Bhatavadekar, Neel B. BDS, MS, MPH†. Clinical Efficacy of Tooth-Bone Graft: A Systematic Review and Risk of Bias Analysis of Randomized Control Trials and Observational Studies. Implant Dentistry 27(1):p 119-134, February 2018. | DOI: 10.1097/ID.0000000000000687