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"Comparative evaluation of efficacy of calcium silicophosphate putty versus particulate xenograft in maxillary sinus augmentation procedure"

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ABSTRACT: Background: Dental implant placement in edentulous ridges is a predictable treatment modality. However, implant placement in the posterior maxilla is often challenging due to post-extraction bone resorption, maxillary sinus pneumatization, poor bone quality, and increased occlusal forces. Maxillary sinus elevation procedures are commonly performed to overcome these limitations and facilitate successful implant rehabilitation.

Objectives: To clinically and radiographically evaluate the efficacy of calcium silicophosphate putty (NovaBone™) and particulate xenograft as grafting materials in maxillary sinus elevation procedures.

Methodology: Written informed consent was obtained from all patients. Sinus elevation procedures were performed under local anesthesia, and graft materials were placed according to the study protocol. Patients were followed postoperatively at 1 day, 7 days, 14 days, and 1 month. Clinical assessments were carried out on the 1st, 7th, and 14th postoperative days, while radiographic evaluation was performed after 1 month to assess changes in bone height and density.

Results: A statistically significant increase in bone height was observed following sinus elevation with particulate xenograft, with a mean gain of 9.8 ± 1.21 mm. The newly formed bone demonstrated greater density than the pre-existing bone, achieving a mean radiographic density of 759 ± 211 Hounsfield Units in sites grafted with xenograft after sinus membrane elevation.

Conclusion: All implants placed in the augmented sites were successfully rehabilitated. Particulate xenograft demonstrated a significant increase in both bone height and bone density following maxillary sinus elevation, indicating its effectiveness as a grafting material for implant site development in the posterior maxilla.

I. INTRODUCTION

The maxillary sinus, also known as the **Antrum of Highmore**, is the largest and first-developed paranasal sinus. First described by Leonardo da Vinci (1489) and later by Nathaniel Highmore (1651), it is located within the body of the maxilla. The sinus has a pyramidal shape with a volume of approximately **12–15 mL** in adults.

Its floor is formed by the alveolar process of the maxilla, which supports the posterior teeth. The sinus ostium, located high on the medial wall, facilitates drainage into the nasal cavity while reducing the risk of obstruction during sinus augmentation procedures.

The maxillary sinus is lined by the **Schneiderian membrane**, a pseudostratified ciliated respiratory epithelium with an average thickness of **0.13–0.8 mm**. This delicate membrane plays a crucial role during sinus lift surgery, as membrane perforation is the most common intraoperative complication. Anatomical variations such as sinus septa, present in approximately **25–31.7%** of cases, can further increase surgical difficulty.

A **maxillary sinus lift** is indicated when insufficient bone height exists in the posterior maxilla for successful dental implant placement, typically when the residual bone height is **10 mm or less**. First introduced by Tatum in 1976 and clinically reported by Boyne and James in 1980, the procedure increases vertical bone height by elevating the Schneiderian membrane and placing bone graft material beneath it.

Two main surgical techniques are used. The **lateral window (direct) approach** is recommended for severe bone deficiency, allowing significant augmentation and simultaneous or delayed implant placement. The **crestal (indirect or trans-alveolar) approach** is less invasive and preferred when more than **5 mm** of residual bone height is present. Both techniques aim to create sufficient bone volume for long-term implant stability.

Various graft materials have been used to support bone regeneration. **Xenografts**, derived from bovine or porcine bone, provide excellent osteoconductive properties but exhibit slower resorption and delayed vascularization. **Bioactive ceramics**, such as **NovaBone® putty (calcium silicophosphate)**, have gained popularity because they are synthetic, biocompatible, easy to manipulate, and actively stimulate bone formation while maintaining graft stability.

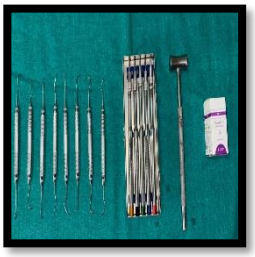
Clinical and radiographic evaluation using **cone-beam computed tomography (CBCT)** after six months has demonstrated favorable outcomes with xenografts. Studies reported a **mean bone height gain of 9.8 ± 1.21 mm** and a **new bone density of 759 ± 211 Hounsfield Units (HU)**, indicating successful bone regeneration and adequate support for dental implant placement.

II. MATERIAL AND METHOD

The current study was conducted in the Department of Oral and Maxillofacial Surgery at Maharana Pratap College Of Dentistry And Research Center, Gwalior (M.P.) 474001. After obtaining complete history, patients were examined clinically and were explained about the procedure, its complications and follow up period involved in the study. Informed consent was taken prior to the procedure. Data were entered into Excel sheet.

Picture 1
ARMAMENTARIUM

Picture 2
ARMAMENTARIUM



Picture 3
ARMAMENTARIUM

Picture 4
NOVA BONE PUTTY

Picture 5 BIO OSS
(Xenograft)

- **CRITERIA FOR INCLUSION :**
- Patients with ASA Grade I status.

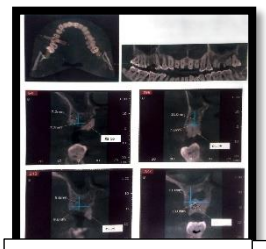
- Patients between 16-50 years of age undergoing extraction of maxillary molars.
- Patient willing to participate in the study.
- Patient either male or female.

- **CRITERIA FOR EXCLUSION**
- Patients with systemic diseases such as HTN, DM, blood dyscrasias, immuno- compromised status.
- Patients with poor oral hygiene and chronic smokers and chronic alcoholism.
- Pregnant or nursing women, female patients taking OC pills.
- Patient on oral or intravenous Bisphosphonate treatment.
- Associated pathology like cyst and tumor
- Patients having gross infection in Mandibular molar region.
- Patients having known allergy to the drug used in the study.

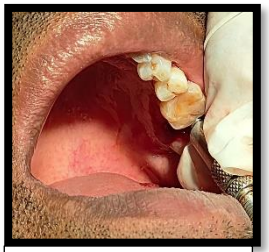
PROCEDURE:

All procedures were performed in a standardized manner and were carried out by the same surgeon. According to Group A:-

- Written consent is obtained from the patient
- Patient is prepared and painted with betadine solution
- PSA &GP is administered on the affected side by LA
- Tooth is extracted
- Incision is given on the vestibular region 2mm above the root apex
- Direct sinus lift is done by creating the window approximately 2mm
- Indirect sinus lift is done using osteotomes and implant is placed and calcium silicophosphate putty is inserted(NOVA BONE) and sutured placed with 3-0 silk.

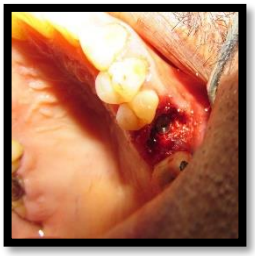


PICTURE 1
PREOPERATIVE CBCT SCAN

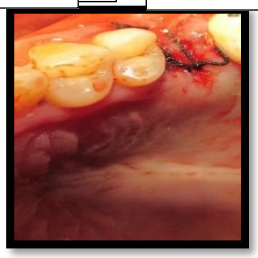


PICTURE 2
INDIRECT SINUS LIFT PICTURE OF THE PATIENT

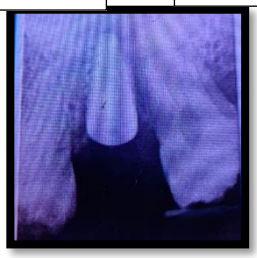
PICTURE 3
IMPLANT PLACEMENT PICTURE OF THE PATIENT



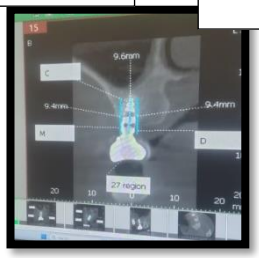
PICTURE 4
PLACEMENT OF NOVA BONE GRAFT



PICTURE 5
SUTURES PLACED



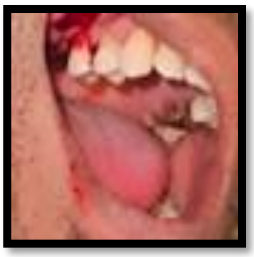
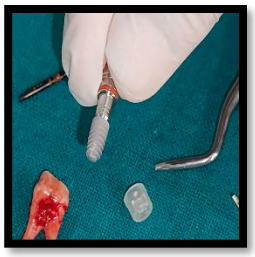
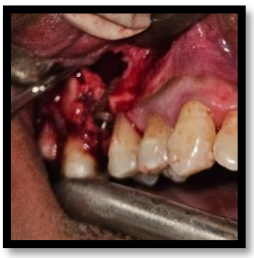
PICTURE 6
POSTOPERATIVE RADIOGRAPH OF THE PATIENT



PICTURE 7
POSTOPERATIVE CBCT AFTER 6 MONTHS

According to Group B:-

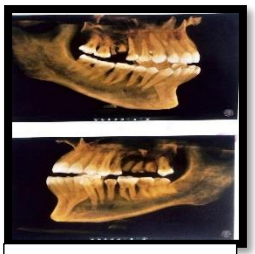
- Written consent is obtained from the patient
- Patient is prepared and painted with betadine solution
- Local anesthesia is given on the affected side
- Tooth is extracted
- Incision is given on the vestibular region 2mm above the root apex

- Direct sinus lift is done by creating the window

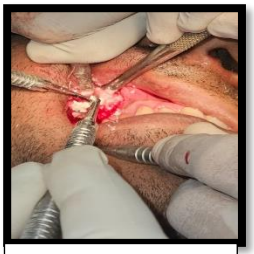
approximately 2mm

- Indirect sinus lift is done using osteotomes
- Then implant is placed and bio-oss (xenograft) is inserted
- Socket is sutured with 3-0 silk.



PICTURE 8
PREOPERATIVE CBCT SCAN (Oblique lateral view)

PICTURE 9
MIXING OF XENOGRAFT



PICTURE 10
INSERTION OF BIO-OSS

PICTURE 11
POST OPERATIVE RADIOGRAPH

PICTURE 12
EXTRATION OF THE TOOTH

PICTURE 13
UNWRAPPING OF IMPLANT

PICTURE 14
IMPLANT PLACEMENT

ASSESSMENT METHOD:

Radiographic methods:-

IOPA/ OPG/ CBCT

SOFT TISSUE HEALING MEASUREMENT :

Subject was evaluated for wound healing on Post operative 7th day using Landry's index. The assessment included grading of colour of tissues, epithelialization of wound margins, presence of bleeding on palpation, granulation and suppuration. Suture removal was done on 7th day.

PAIN BY VAS :

Post operative pain was evaluated using a "Visual Analogue Scale (VAS)". Patients were asked to rank the intensity of their pain on a scale of 0 to 10 [Fig 1]

SWELLING:- A swelling is measured using scale by marking the lines as given in the figure.

GINGIVAL INFLAMMATION:-It is a 0-3 scale assessing clinical inflammation based on color, texture and bleeding on probing.

III. RESULTS

AGE:-

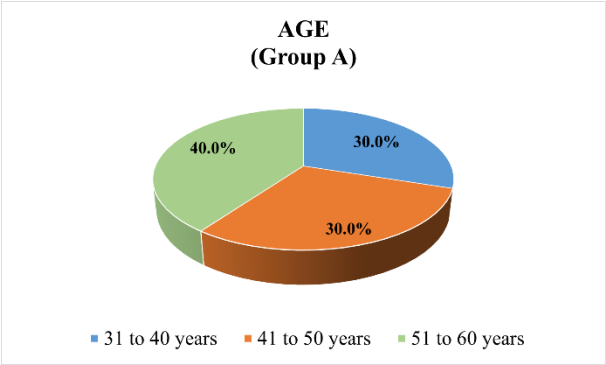
GROUP A

The age distribution of the study participants shows that the majority of subjects belonged to the 51–60 years age group, accounting for 40% of the total sample. The age groups 31–40 years and 41–50 years each comprised 30% of the participants.

Table 1. Age-wise distribution in Group A.

Age group	Number of subjects	Percentage
31 to 40 years	3	30.0%
41 to 50 years	3	30.0%
51 to 60 years	4	40.0%
Total	10	100.0%

Figure 1. Age-wise distribution in Group A.



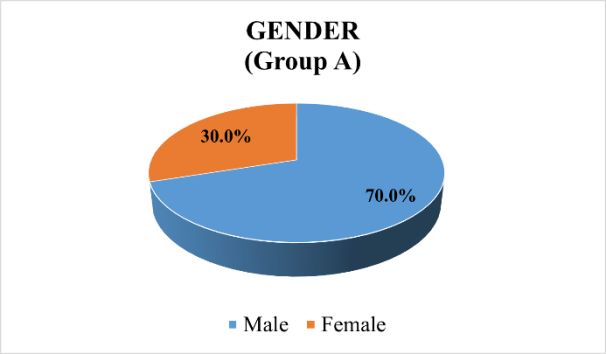
Gender

The gender distribution of the study participants indicates a predominance of males. Out of the total 10 subjects, 7 (70%) were male and 3 (30%) were female.

Table 2. Gender-wise distribution in Group A.

Gender	Number of subjects	Percentage
Male	7	70.0%
Female	3	30.0%
Total	10	100.0%

Figure 2. Gender-wise distribution in Group A.



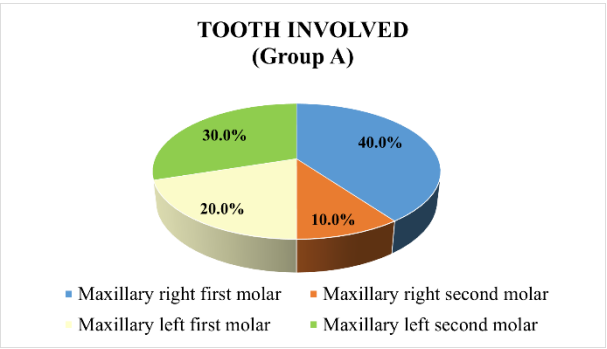
Tooth involved

The distribution of teeth involved shows that the maxillary right first molar was the most commonly affected tooth, accounting for 40.0% of cases. This was followed by the maxillary left second molar at 30.0%, and the maxillary left first molar at 20.0%. The maxillary right second molar was the least commonly involved, comprising 10.0% of the cases. Overall, first molars were more frequently affected than second molars, and right-sided involvement (50.0%) was slightly higher compared to the left side (50.0%), showing an equal bilateral distribution.

Table 3. Distribution of study subjects based on tooth involved in Group A.

Tooth involved	Number of subjects	Percentage
Maxillary right first molar	4	40.0%
Maxillary right second molar	1	10.0%
Maxillary left first molar	2	20.0%
Maxillary left second molar	3	30.0%
Total	10	100.0%

Figure 3.TOOTH INVOLVED



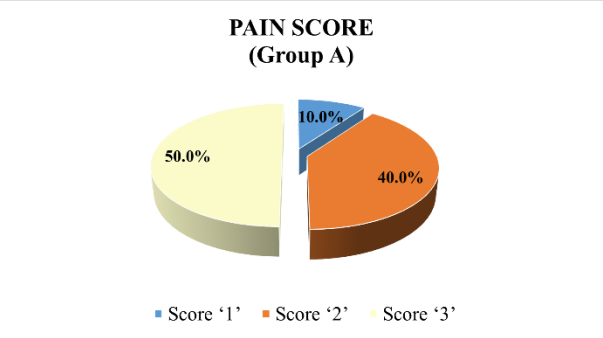
Pain

The distribution of pain scores shows that the majority of subjects experienced higher levels of pain. **Score '3'** was the most commonly reported, accounting for **50.0%** of the participants, followed by **Score '2'** at **40.0%**. Only **10.0%** of the subjects reported **Score '1'**. This indicates that most individuals in the study experienced moderate to severe pain, with relatively few reporting mild pain.

Table 4. Distribution of study subjects based on pains score.

Pain score	Number of subjects	Percentage
Score '1'	1	10.0%
Score '2'	4	40.0%
Score '3'	5	50.0%
Total	10	100.0%

Figure 4. PAIN SCORE



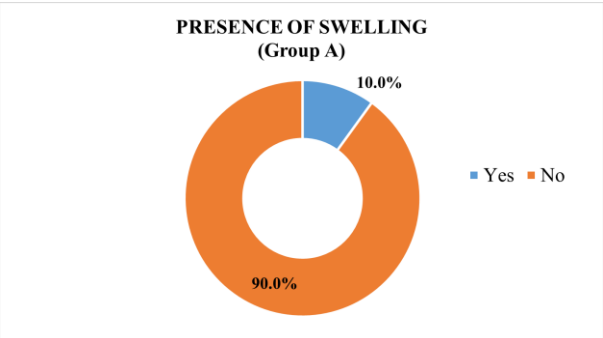
Swelling

The distribution of swelling among the study participants shows that the majority of subjects (90.0%) did not present with swelling, while only 10.0% exhibited swelling. This indicates that swelling was an uncommon clinical finding in the present study population.

Table 5. Distribution of study subjects based on presence of swelling.

Presence of swelling	Number of subjects	Percentage
Yes	1	10.0%
No	9	90.0%
Total	10	100.0%

Figure 5. PRESENCE OF SWELLING



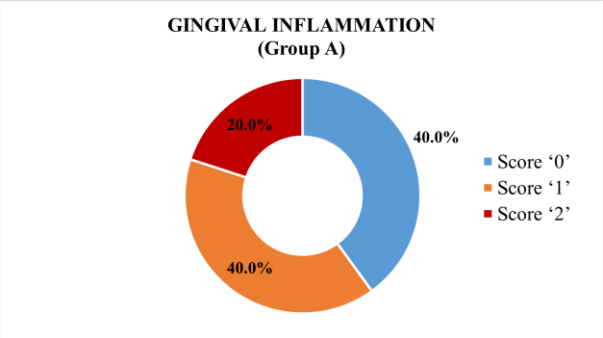
Gingival inflammation

The distribution of gingival scores indicates that Score '0' and Score '1' were equally prevalent, each accounting for 40.0% of the subjects. Score '2' was observed in 20.0% of the participants. These findings suggest that the majority of subjects exhibited either healthy gingiva or mild gingival inflammation, while a smaller proportion showed moderate gingival involvement.

Table 6. Distribution of study subjects based on gingival score.

Gingival score	Number of subjects	Percentage
Score '0'	4	40.0%
Score '1'	4	40.0%
Score '2'	2	20.0%
Total	10	100.0%

Figure 6.



Post-operative complications

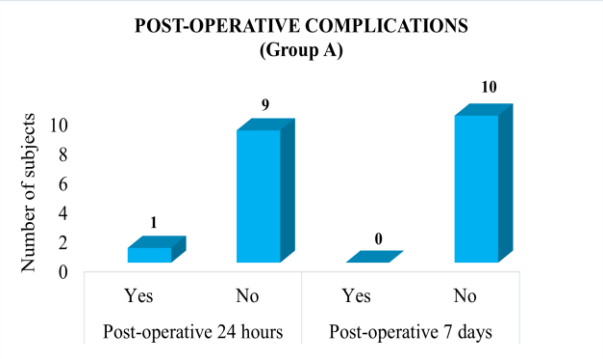
The distribution of post-operative complications shows that at 24 hours post-operatively, only 10.0% of subjects experienced complications, while the majority (90.0%) did not report any complications.

At 7 days post-operatively, none of the subjects (0.0%) experienced complications, and 100.0% were free from post-operative complications.

Table 7. Distribution of study subjects based on post-operative complications.

Time interval	Post-operative complications	Number of subjects	Percentage
Post-operative 24 hours	Yes	1	40.0%
	No	9	40.0%
	Total	10	100.0%
Post-operative 7 days	Yes	0	40.0%
	No	10	40.0%
	Total	10	100.0%

Figure 7.



Height of alveolar bone

Intra-group comparison

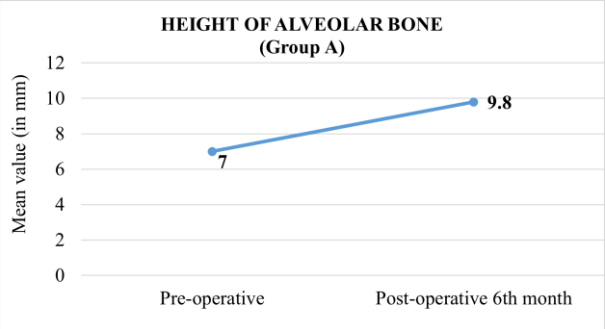
In Group A, the mean bone height increased from 7.0 ± 1.35 mm pre-operatively to 9.8 ± 0.73 mm at 6 months. This increase was highly statistically significant (T = 5.74, p < 0.001).

Table 8. Inter-group comparison of height of alveolar bone among the study subjects.

Time interval	Group A	T- value	p-value
Pre-operative	7.0 ± 1.348	5.74	<.001*
Post-operative 6th month	9.8 ± 0.733		

Paired t test. *Statistically significant.

Figure 8.



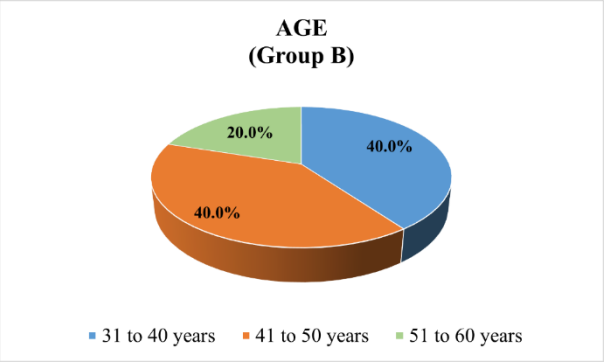
Age

The age distribution of the study participants indicates that the majority of subjects were in the 31–40 years and 41–50 years age groups, each accounting for 40.0% of the total sample. In contrast, only 20.0% of the subjects belonged to the 51–60 years age group. This suggests that the condition was more commonly observed among individuals in the third and fourth decades of life, with comparatively fewer cases in older adults.

Table 9. Distribution of study subjects based on age.

Age group	Number of subjects	Percentage
31 to 40 years	4	40.0%
41 to 50 years	4	40.0%
51 to 60 years	2	20.0%
Total	10	100.0%

Figure 9.



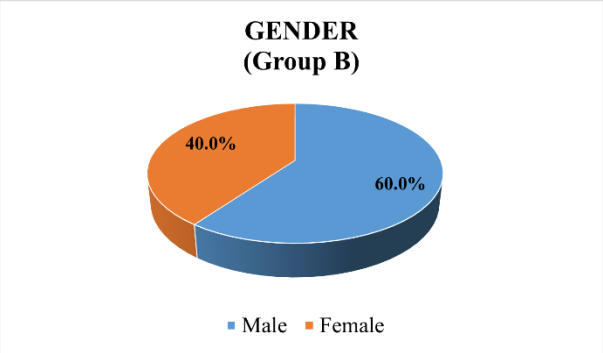
Gender

The gender distribution shows that males constituted the majority of the study participants, accounting for 60.0% of the total sample, while females comprised 40.0%. This indicates a higher prevalence of the condition among males compared to females in the present study.

Table 10. Distribution of study subjects based on gender.

Gender	Number of subjects	Percentage
Male	6	60.0%
Female	4	40.0%
Total	10	100.0%

Figure10.



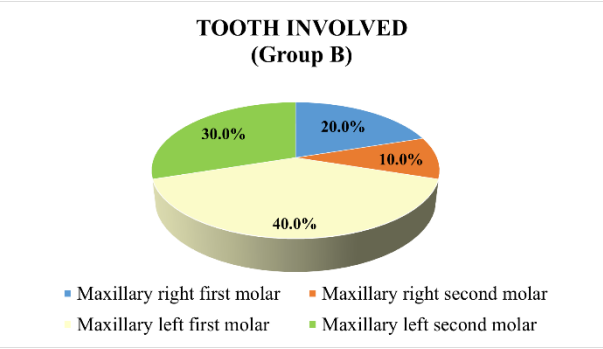
Tooth involved

The distribution of teeth involved shows that the maxillary left first molar was the most commonly affected tooth, accounting for 40.0% of the cases. This was followed by the maxillary left second molar at 30.0%, and the maxillary right first molar at 20.0%. The maxillary right second molar was the least commonly involved, comprising 10.0% of the cases.

Table 11. Distribution of study subjects based on tooth involved in Group A.

Tooth involved	Number of subjects	Percentage
Maxillary right first molar	2	20.0%
Maxillary right second molar	1	10.0%
Maxillary left first molar	4	40.0%
Maxillary left second molar	3	30.0%
Total	10	100.0%

Figure 11.



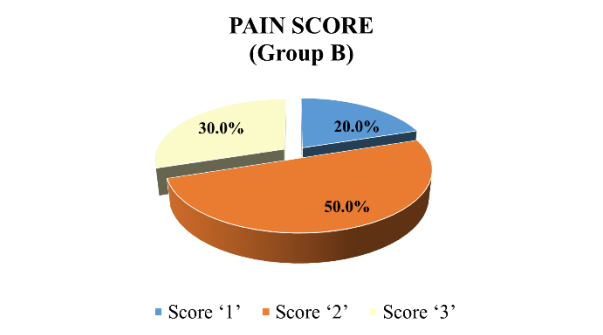
Pain

The distribution of pain scores indicates that Score '2' was the most frequently reported pain level, accounting for 50.0% of the subjects. This was followed by Score '3' at 30.0%, while Score '1' was reported by 20.0% of participants. Overall, the findings suggest that the majority of subjects experienced moderate pain, with fewer individuals reporting either mild or severe pain levels.

Table 12. Distribution of study subjects based on pains score.

Pain score	Number of subjects	Percentage
Score '1'	2	20.0%
Score '2'	5	50.0%
Score '3'	3	30.0%
Total	10	100.0%

Figure12.



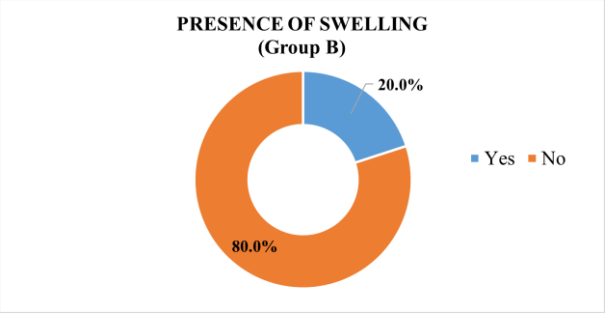
Swelling

The distribution of swelling among the study participants shows that the majority of subjects (90.0%) did not present with swelling, while only 10.0% exhibited swelling. This indicates that swelling was an uncommon clinical finding in the present study population.

Table 13. Distribution of study subjects based on presence of swelling.

Presence of swelling	Number of subjects	Percentage
Yes	1	10.0%
No	9	90.0%
Total	10	100.0%

Figure 13.



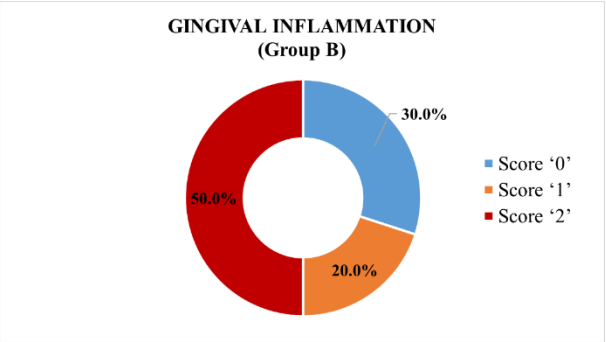
Gingival inflammation

The distribution of gingival scores reveals that Score '2' was the most frequently observed, accounting for 50.0% of the subjects. This was followed by Score '0' at 30.0%, while Score '1' was the least common, observed in 20.0% of participants. These findings indicate that half of the study population exhibited moderate gingival inflammation, whereas a smaller proportion showed either healthy gingiva or mild inflammation.

Table 14. Distribution of study subjects based on gingival score.

Gingival score	Number of subjects	Percentage
Score '0'	3	30.0%
Score '1'	2	20.0%
Score '2'	5	50.0%
Total	10	100.0%

Figure 14.



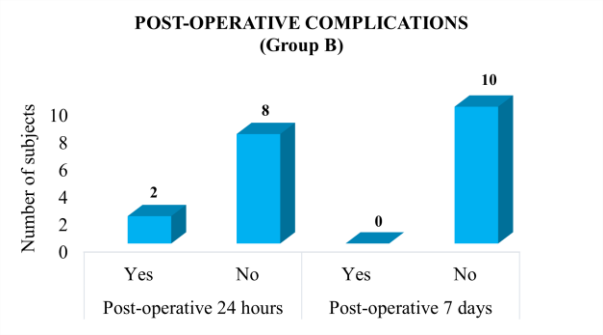
Post-operative complications

The distribution of post-operative complications indicates that at 24 hours post-operatively, 20.0% of the subjects experienced complications, while the majority (80.0%) did not report any complications. By 7 days post-operatively, none of the subjects (0.0%) experienced complications, and 100.0% were free from any post-operative issues.

Table 15. Distribution of study subjects based on post-operative complications.

Time interval	Post-operative complications	Number of subjects	Percentage
Post-operative 24 hours	Yes	2	40.0%
	No	8	40.0%
	Total	10	100.0%
Post-operative 7 days	Yes	0	40.0%
	No	10	40.0%
	Total	10	100.0%

Figure 15.



Height of alveolar bone

Intra-group comparison

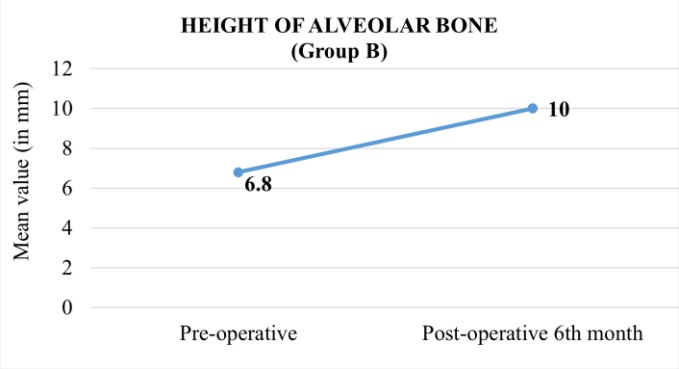
In Group B, the mean bone height improved from 6.8 ± 0.98 mm pre-operatively to 10.0 ± 0.65 mm at 6 months. This change was also highly statistically significant (T = 8.64, p < 0.001).

Table 16. Inter-group comparison of height of alveolar bone among the study subjects.

Time interval	Group B	T value	p-value
Pre-operative	6.8 ± 0.982	8.64	<.001*
Post-operative 6th month	10.0 ± 0.653		

Paired t test. *Statistically significant.

Figure 16 .



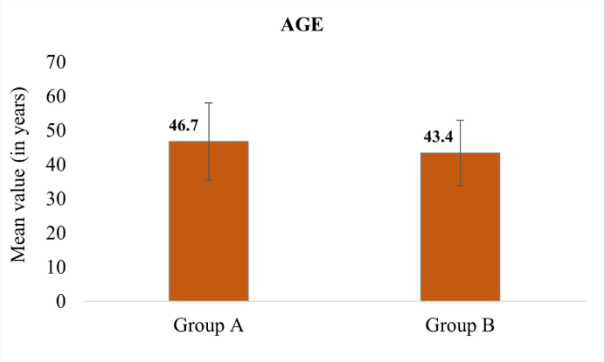
Inter Group Comparison Of group A and Group B

Table 17. Inter-group comparison of age of the study subjects.

Age	Group A	Group B	t-value	p-value
Mean ± standard deviation	46.7 ± 11.402	43.4 ± 9.582	.701	.492

Independent t test.

Figure 17. Inter-group comparison of age of the study subjects.



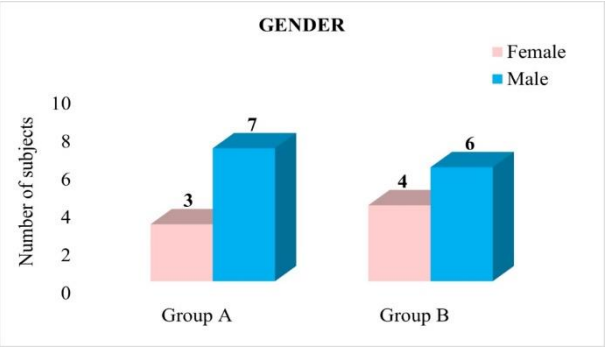
Gender

Table 18. Inter-group comparison of gender of the study subjects.

Gender	Group A	Group B	Total	Chi-square value	df	p-value
Male	7	6	7	.220	1	.639
	30.0%	40.0%	35.0%			
Female	3	4	13			
	70.0%	60.0%	65.0%			
Total	10	10	20			
	100.0%	100.0%	100.0%			

CHI SQAURE TEST

Figure 18. Gender-wise distribution of the study subjects.



Tooth involved

Table 19. Inter-group comparison of tooth involved of the study subjects.

Tooth involved	Group A	Group B	Total	Chi-square value	df	p-value
Maxillary right first molar	4	2	6	1.33	3	.721
	40.0%	20.0%	30.0%			

Maxillary right second molar	1	1	2			
	10.0%	10.0%	10.0%			
Maxillary left first molar	2	4	6			
	20.0%	40.0%	30.0%			
Maxillary left second molar	3	3	6			
	30.0%	30.0%	30.0%			
Total	10	10	20			
	100.0%	100.0%	100.0%			

Chi-square test.

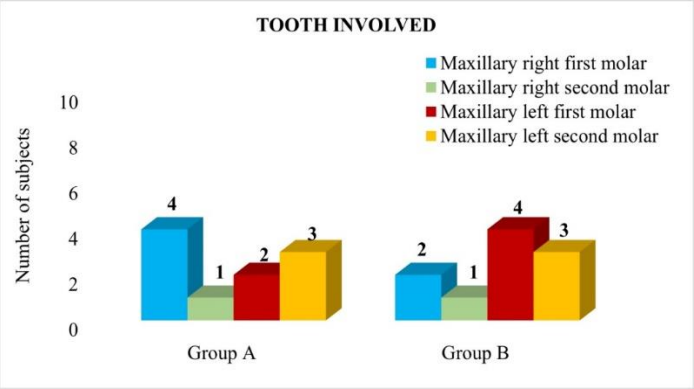


Figure 19. Distribution of study subjects based on tooth involved.

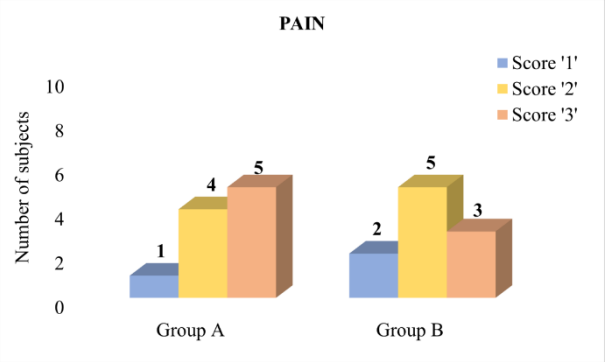
Pain

Table 20. Inter-group comparison of pain among the study subjects.

Pain	Group A	Group B	Total	Chi-square value	df	p-value
Score '1'	1	2	3	.944	2	.624
	10.0%	20.0%	15.0%			
Score '2'	4	5	9			
	40.0%	50.0%	45.0%			
Score '3'	5	3	8			
	50.0%	30.0%	40.0%			
Total	10	10	20			
	100.0%	100.0%	100.0%			

Chi-square test.

Figure 20. Distirbution of study subjects based on severity of pain.



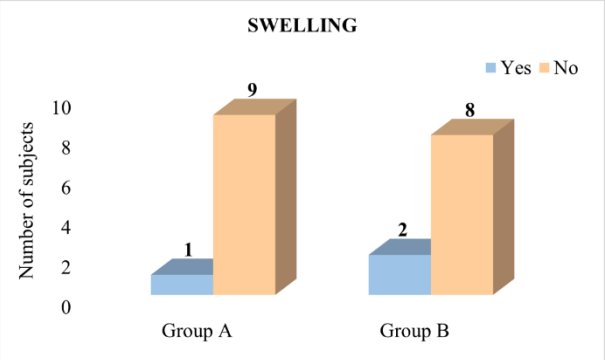
Swelling

Table 21. Inter-group comparison of swelling among the study subjects.

Swelling	Group A	Group B	Total	Chi-square value	df	p-value
Yes	1	2	3	.392	1	.531
	10.0%	20.0%	15.0%			
No	9	8	17			
	90.0%	80.0%	85.0%			
Total	10	10	20			
	100.0%	100.0%	100.0%			

Chi-square test.

Figure 21. Distribution of study subjects based on presence of swelling.



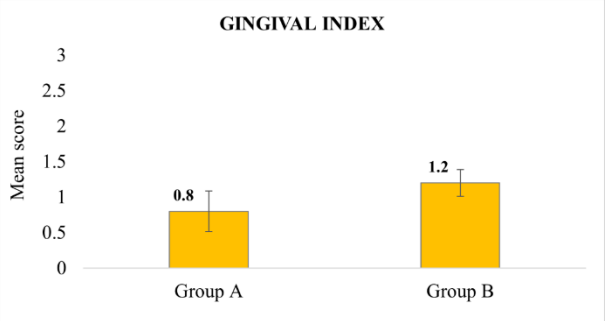
Gingival index

Table 22. Inter-group comparison of gingival index score of the study subjects.

Gingival index score	Group A	Group B	T-value	p-value
Mean ± standard deviation	0.8 ±0.2881	1.2 ± 0.189	-1.044	.310

Independent t test.

Figure 22. Gingival index score among study subjects.



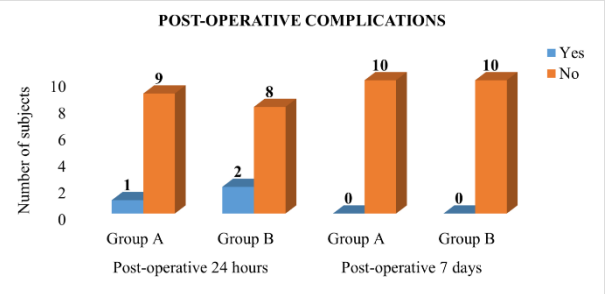
Post-operative complications

Table 23. Inter-group comparison of post-operative complications among the study subjects.

Time interval	Post-operative complications	Group A	Group B	Total	Chi-square value	df	p-value
Post-operative 24 hours	Yes	1	2	3	.392	1	.531
		10.0%	20.0%	15.0%			
	No	9	8	17			
		90.0%	80.0%	85.0%			
	Total	10	10	20			
		100.0%	100.0%	100.0%			
Post-operative 7 days	Yes	0	0	0	-	-	-
		0.0%	0.0%	0.0%			
	No	10	10	20			
		100.0%	100.0%	100.0%			
	Total	10	10	20			
		100.0%	100.0%	100.0%			

Chi-square test.

Figure 23. Distribution of study subjects based on post-operative complications.



Height of alveolar bone

Inter-group comparison

The mean pre-operative height of alveolar bone was 7.0 ± 1.35 mm in Group A and 6.8 ± 0.98 mm in Group B. The difference between the groups was not statistically significant (T = 0.252, p = 0.668), indicating comparable baseline values.

At the 6th month post-operatively, the mean bone height increased to 9.8 ± 0.73 mm in Group A and 10.0 ± 0.65 mm in Group B. Although Group B showed a slightly higher mean value, the difference was not statistically significant (T = 0.556, p = 0.414).

The mean change in bone height was 2.7 ± 1.04 mm in Group A and 3.2 ± 0.73 mm in Group B. Despite Group B demonstrating a marginally greater gain in bone height, the difference in change between the groups was not statistically significant (T = 0.317, p = 0.230).

Table 24. Inter-group comparison of height of alveolar bone among the study subjects.

Time interval	Height of alveolar bone (Mean ± standard deviation)		T-value	p-value
	Group A	Group B		
Pre-operative	7.0 ± 1.348	6.8 ± 0.982	.252	.668
Post-operative 6th month	9.8 ± 0.733	10.0 ± 0.653	.556	.414
Change	2.7 ± 1.039	3.2 ± 0.733	.317	.230

Independent t test.

Figure 24. Change in alveolar bone height.

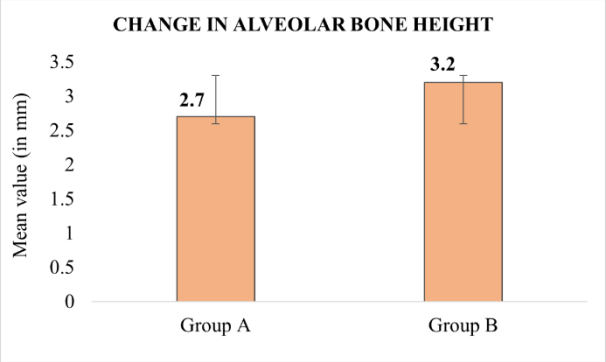
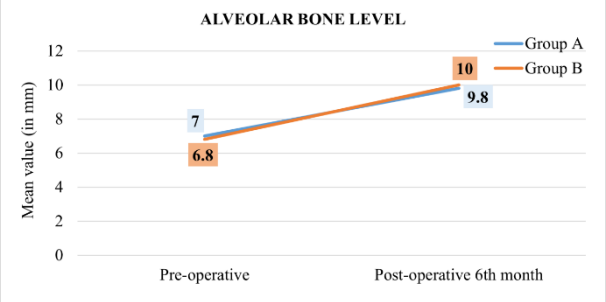


Figure 25. Alveolar bone level among study subjects.



IV. DISCUSSION

Both Nova Bone® Dental Putty and Bio-Oss® were effective in promoting bone regeneration following maxillary sinus augmentation, with satisfactory healing and no major postoperative complications. CBCT evaluation demonstrated significant bone gain in both groups; however, the Bio-Oss® group showed greater radiographic bone density, better maintenance of graft height, and superior volumetric stability after six months. These findings are consistent with previous studies attributing the superior performance of Bio-Oss® to its slow resorption rate and prolonged osteoconductive scaffold function.

Nova Bone® Dental Putty demonstrated favorable handling properties, good biocompatibility, and satisfactory bone formation, making it a useful synthetic alternative, particularly for patients who prefer non-animal-derived graft materials. However, its relatively faster remodeling may result in slightly lower long-term volume preservation compared with Bio-Oss®. Overall, the findings support the clinical effectiveness of both graft materials, while indicating superior radiographic performance of Bio-Oss® for maxillary sinus augmentation.

PAIN

Pain was measured using Visual Analogue Scale (VAS) scale at different follow ups. Regarding pain the VAS was employed to measure the severity of pain felt after maxillary augmentation procedureand implant placement, according to which overall pain was more in GROUP A as compared to GROUP B at all time intervals indicating better pain control in particulate xenograft.

In the study by **DEL FEBBRO et al** (2008) pain was not quantitatively analysed however review noted xenografts are associated with reduced donor site morbidity compared to calcium silicophosphate putty.

SWELLING

Swelling was observed more in GROUP B as compared to GROUP A

In the study by **KIM et al** (2022) there was a mild swelling in patients with calciumsilico phosphate putty as compared to bio oss(xenograft). But according tomy study mild swelling was observed more with xenograft patients as compared to the patients with calcium silicophosphate putty though overall acceptance was good in both.

GINGIVAL INFLAMMATION

At 24hours postoperatively complications were reported in 15% of total cases. In GROUP A it was 10% and in GROUP B it was 20%. However difference was not statistically significant indicating short term post operative complications.

In the study by **SHAHOOD** et al (2024) it was slightly more with calcium silicophosphate putty as compared to bio oss (xenograft) and showed better soft tissue acceptance but as per my study gingival inflammation ws slightly ore in patients with xenograft scompared to thepatients with calcium silico phosphate putty.though the results were significant in both.

ALVEOLAR BONE HEIGHT

The alveolar bone height was measured after 6 months . in GROUP A the mean height increased from 7.0+_1.35mm preoperatively to 9.8+_ 0.73mm after 6 months .This increase was statistically significant (T = -8.278, p less than 0.001) Similarly, in Group B, the mean bone height improved from 6.8 plus/minus 0.98 * mm pre-operatively to 10 plus/minus 0.65 * mm at 6 months. This change was also highly statistically significant 13.528, $p < 0.001$) . Overall, both groups demonstrated a significant gain in alveolar bone height. According to the study of Mallik et al(2018) the Mean increase in alveolar bone height after 6 months: 9.8 ± 1.21 mm

This increase was statistically significant and higher compared with the synthetic putty group

Limitations and Areas for Future Research

Several limitations should be acknowledged. This study's follow-up period, while clinically relevant, is relatively short compared with the prolonged remodeling time of xenografts. Future studies with longer longitudinal evaluation (e.g., 12–24 months) are essential to determine whether the early differences in density and volume translate into clinically significant advantages or disadvantages over time.

Additionally, histological and histomorphometric analyses — including bone volume fraction, percentage of residual graft, and bone quality indices — would provide deeper insights into the biological processes underlying the radiographic observations. Randomized controlled trials with larger sample sizes and standardized outcome measures would further validate the comparative efficacy of these graft materials.

Finally, combination approaches integrating synthetic grafts with biologic enhancers such as platelet-rich fibrin (PRF), stem cells, or growth factors represent promising avenues. Such composite techniques may harness the complementary strengths of multiple graft types, providing both structural stability and enhanced osteogenic potential.

V. CONCLUSION

The present study demonstrated that both calcium silicophosphate putty (NovaBone® Dental Putty) and particulate xenograft (Bio-Oss®) are effective graft materials for maxillary sinus augmentation, resulting in satisfactory bone regeneration and uneventful healing. However, Bio-Oss® exhibited superior radiographic outcomes, including greater bone density, improved graft height maintenance, and better volumetric stability over the six-month follow-up period.

The enhanced performance of Bio-Oss® can be attributed to its slow resorption rate and excellent osteoconductive properties, which provide prolonged scaffold support for new bone formation and maintain the augmented sinus volume. In contrast, NovaBone® showed satisfactory clinical performance but demonstrated comparatively faster remodeling and lower radiographic bone density.

These findings are consistent with previous studies reporting that deproteinized bovine bone mineral offers predictable clinical outcomes and superior volume preservation in sinus floor elevation procedures. Although synthetic grafts provide advantages such as easy handling, biocompatibility, and the absence of disease transmission risk, their faster resorption may limit long-term volumetric stability. Both materials can be successfully used for sinus augmentation; however, Bio-Oss® appears to provide more favorable conditions for maintaining graft volume and achieving higher bone density, which are important for predictable implant rehabilitation.

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