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Comparative Evaluation Of Bioactive Glass And Xenograft With Platelet Rich Fibrin For Bony Defects- An Experimental And Prospective Clinical Study

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ABSTRACT-

BACKGROUND-Bioactive glass and calcium phosphosilicate materials have demonstrated their ability to enhance bone regeneration through interfacial reactions and osteoblastic activation. The study aims to compare and evaluate the potency of bioactive glass and xenograft with platelet rich fibrin for bony defects.

METHODS-An experimental and prospective study was conducted on 40 cases (20 cases of Bioactive glass with PRF and 20 cases of Xenograft with PRF) in patients with clinical and radiological evidence of bone loss who reported to the department of Oral & Maxillofacial Surgery, People's College of Dental Sciences and Research Centre, Bhopal. Parameters assessed were- pain, inflammation, wound breakdown and infection.

RESULTS-Overall the study infers no difference in the outcome variables of pain, chemical mediators of inflammation. But during the procedure it was noted that ease of handling was better appreciated in Bioactive glass response.

CONCLUSION- Based on the findings of the study, it may be summarised that Bioactive glass is a material which possess favorable biological response when in contact with surrounding fibro-osseous tissues, due not only to an osteoconductive property, but also to an osteostimulatory capacity, and superior biocompatibility for use in human body.

KEYWORDS- Bioactive glass, Xenograft,Novabone putty, Platelet Rich Fibrin, Osteostimulative property, Osteoconductive property.

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I. INTRODUCTION:

Existing bone grafts lack the ideal combination of properties desired in a biomaterial for bone repair: strong osteoconductive and angiogenic capabilities, biological safety, minimal patient complications, excellent volumetric stability, widespread availability, extended shelf life, and cost-effectiveness.There is an exceedingly high demand for a new generation of manufactured bone grafts with enhanced biological effectiveness and mechanical durability achieved through cost-effective manufacturing techniques.[1]The use of osseous grafting materials to accomplish periodontal regeneration arising from various periodontal diseases such as periodontitis, two- and three-walled intrabony defects and furcation defects havedemonstrated enhancements in periodontal probing depths, gains in probing attachment, and bone regeneration.[2]

Alveolar ridge loss following extraction although unpredictable can occur in horizontal or vertical dimension which results in extraction site reconstruction and alveolar bone changes often compromise implant placement due to thin volume of bone. Reduction in quantity and quality of bone can compromise functional and aesthetic outcomes of implant and fixed partial dentures. Bone grafting has become a solution that attempts to limit tissue loss surrounding bone.Cystic lesions of jaws are common pathology. An adequately executed endodontic procedure can encounter failure due to persistent microbial infection that remains unresolved.This can lead to the development of periapical abscess which requires surgical intervention bymeansofmarsupialization or enucleation.[3] Bony Defects remaining after surgical treatment can be filled by bone graft which shortens the recovery time after cyst removal.

Bioactive glass bonds to bony tissue and due to the osteoconductive property improves bone regeneration. Series of interfacial reactions results in the bonding between surrounding bone and glasses that initiate the development of a Silicon-rich layer enshrouding by a Calcium- Phosphate rich layer.[4]Recently, putty formulations of bioactive glass with other materials minimizes graft wastage and reduces chair-side time.[5]Calcium phosphosilicate materials, classified as bioactive glass, have been documented to release ions, stimulate osteoblasts, and promote the proliferation of osteoblasts. This osteostimulation leads to the generation of new bone within and around the transplanted area.[6]

DemineralisedXenograft was developed for bone regenerative procedures.[7] Xenograft is a natural bone substitute that provides structural components enacting the human bone that will improve its osteoconductive and osteoinductive capability. Deproteinated bovine derived bone replacement grafts are available that supports resorption and also retains its natural micro-porosity. This enables the product to be replaced as new bone.[8]

Platelets are a mainstay of hemostasis after any injury, and they also play a crucial role in healing process. Platelets deliver hydrolytic enzymes, endostatin, serotonin, histamine and coagulation factors[9] which helps clearing the dead and necrotic debris in turn hastens the rate of healing. Presently, studies have shown its application in various disciplines of dentistry. Healing with PRF was found to be satisfactory and showed excellent results.Hence, in the proposed study, the Xenograft with PRF and Bioactive glass with PRF will be compared and evaluated to find a better material to be used in treating the bone defects.

II. AIM:

To compare and evaluate the potency of Bioactive glass and Xenograft with PRF for bony defects.

III. OBJECTIVES:

- To compare the relative effectiveness of Bioactive glass and Xenograft in bone regeneration.
- To study the amount of bone gain by using Bioactive glass and Xenograft.
- To evaluate comparative post operative complications of Bioactive glass and Xenograft.

IV. MATERIALS AND METHODS:

This experimental and prospective clinical study was performed in the department of Oral and Maxillofacial Surgery in People's College of Dental Sciences and Research Centre, Bhopal on 40 cases divided into two groups- group A (20 cases of Bioactive glass with PRF) and group B (20 cases of Xenograft with PRF) in patients with evidence of bone loss. The study was conducted after getting approval from IRB/IEC with IEC no.- EC201920from January 2020 to October 2021. Patients provided written informed consent to participate in the study and undergo the proposed treatment.

The inclusion criteriawere-

- ASA 1 category patients.
- Patients requiring bone formation for implants and other prosthetic rehabilitation.
- Patients with radiographic evidence of periodontal osseous defects.
- Patients within the age group of 18-60 years.

The exclusion criteria were-

- Patient suffering from systemically debilitated conditions like diabetes, hypertension, asthma, cardiac disorders and pregnant or lactating etc.
- Mentally compromised patients (where radiographic assessment will not be feasible).
- Patients with severe periodontal disease.
- Patients with any known hypersensitivity/allergy to any product.

STANDARD OPERATIVE PROCEDURE:

Standard painting and draping was done under all aseptic measures.Local anesthesia (Inj. Lignocaine 2% with adrenaline) was administered at the surgical sites. Required vestibular incision was given and mucoperiosteal flap was raised to expose the intrabony defect. It was thoroughly irrigated with betadine and 0.9% saline to avoid any chance of infection and further graft rejection.Platelet Rich Fibrin (PRF) was prepared as per method documented by Choukroun et al[10]and mixed with the graft (Bioactive glass/Xenograft) as per requirement. Prepared bone graft was taken and was placed inside the prepared surgical site.The flap was then repositioned followed by closure of the surgical site with simple interrupted suturing technique using 3-0 silk or 4-0 vicryl suture. Post-operative radiographs were taken for radiographic evaluation and bone height and width assessment.

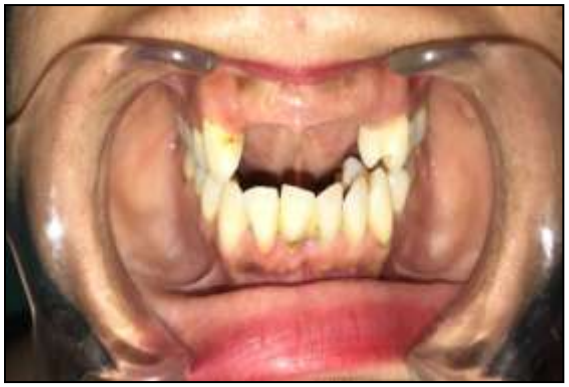


Fig.1 showing missing teeth 11,12,21,22,23 due to trauma

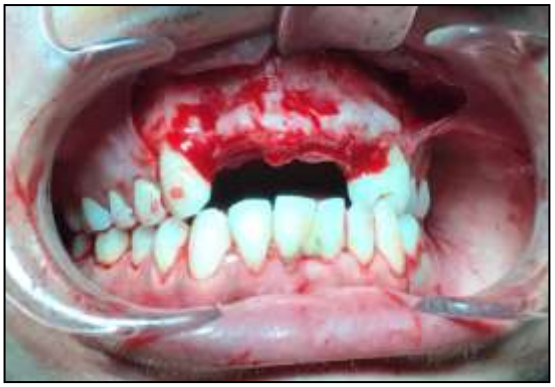


Fig.2 Flap raised to expose bone prior implant placement

Fig.3 Filling Xenograft particulate graft material in the alveolar ridge

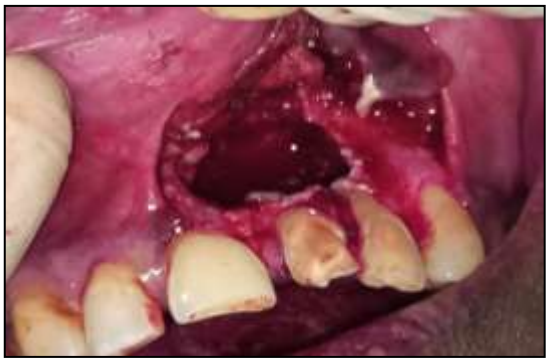


Fig.4 Periapical lesion with bone perforation with tooth no. 21 and 22

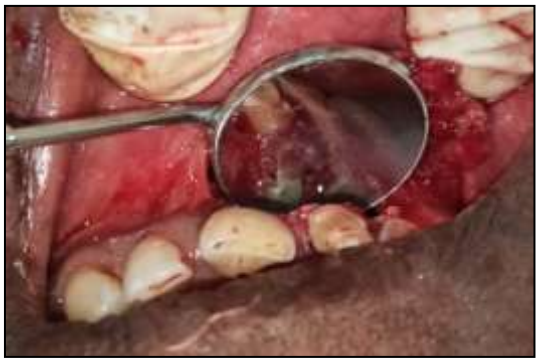
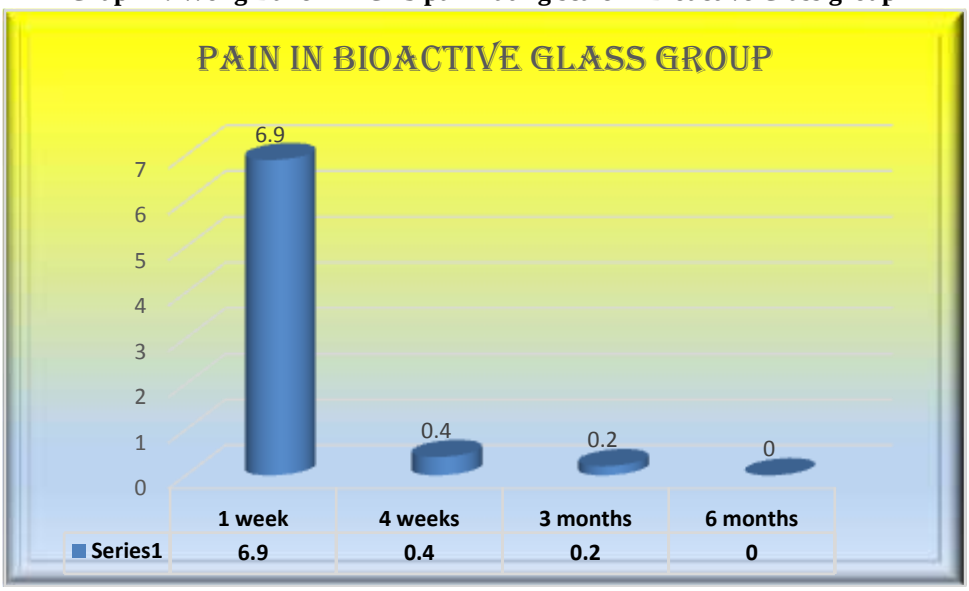


Fig.5 Bioactive glass bone graft material in the bony defect

V. RESULTS

Statistical analysis included mean, standard deviation, and significance tests (ANOVA, student 't' test, and Chi square). Student 't' test showed differences in pain, inflammation, wound breakdown, infection between Bioactive glass and Xenograft. Chi square assessed wound distribution and infection differences at 1-week intervals. Significance was determined at $p<0.05$.

Graph 1: Wong Baker FACES pain rating scale in Bioactive Glass group

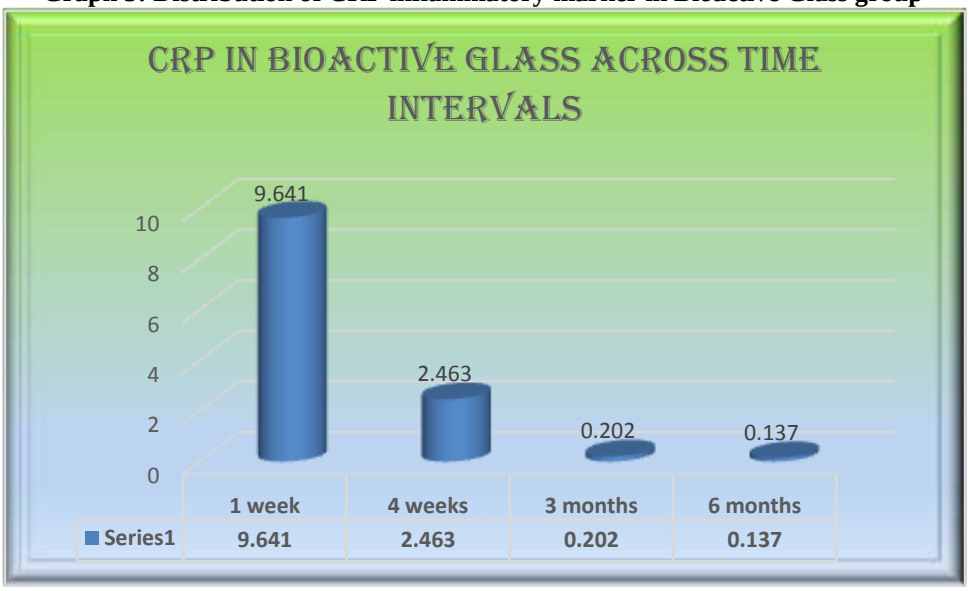


The average pain levels in the bioactive group were displayed over various time intervals. The highest level of pain was observed during the first week, with a mean of 6.900 ± 1.020. However, there was a significant reduction in pain by the fourth week, and it completely disappeared by the sixth month (p=0.000).

Graph 2: Wong Baker FACES pain rating scale in Xenograft group

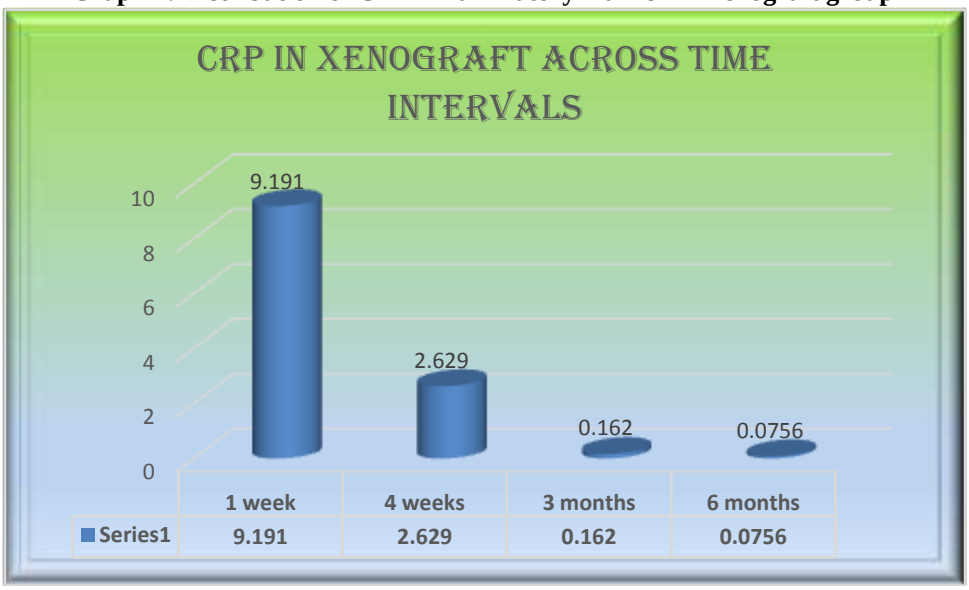
Wong Baker pain rating scale showed greater pain scores at 1 week interval after Xenograft placement at a mean of 6.400 $\pm$ 1.391. Pain reduced in the further time intervals which was significant at $p = 0.000$.

Graph 3: Distribution of CRP inflammatory marker in Bioactive Glass group



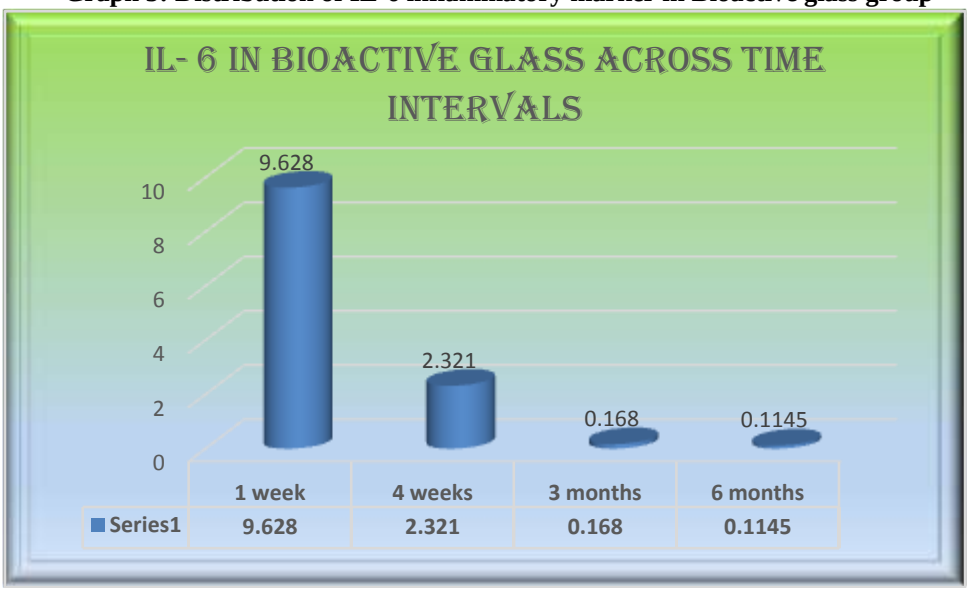
CRP inflammatory markers were found to be concentrated in the 1st week at a mean of 9.641 ± 1.226 which drastically reduced to 2.463 ± 1.617 by the 4th week which was significant at p = 0.000. At 3 months and 6 months the CRP marker was literally non- existent.

Graph 4: Distribution of CRP inflammatory marker in Xenograft group



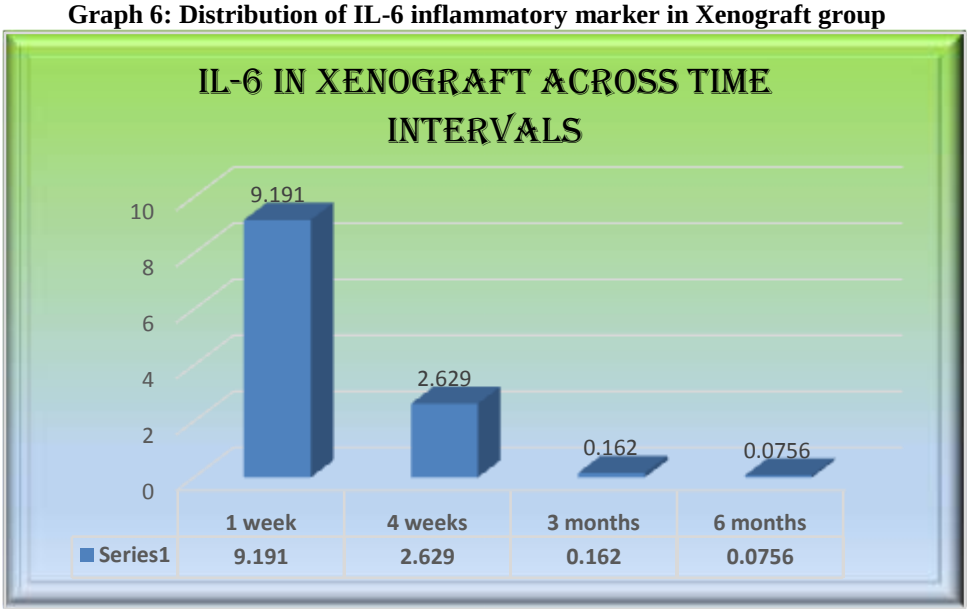
1st week CRP levels were significantly higher as compared to 4th week, 3 month and 6 month. A significant difference was noted between 1st week and subsequent intervals.

Graph 5: Distribution of IL-6 inflammatory marker in Bioactive glass group



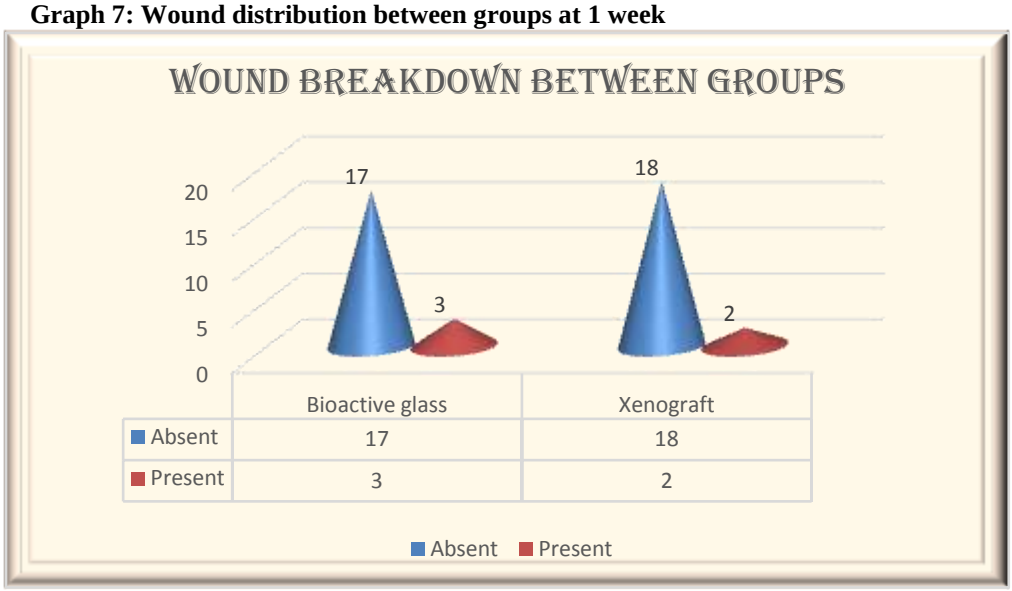
IL-6 inflammatory markers were found to be concentrated in the 1st week at a mean of 9.628 ± 1.465 which drastically reduced to 2.321 ± 1.790 by the 4th week which was significant at p = 0.000. At 3 months and 6 months the IL-6 was literally non- existent.

Graph 6: Distribution of IL-6 inflammatory marker in Xenograft group



Xenograft group exhibited greater inflammation in the 1st week at a mean of 9.191 ± 1.712 of IL-6 which reduced in the next intervals which is significant.

Graph 7: Wound distribution between groups at 1 week



Two cases each of Bioactive glass and Xenograft showed infection at 1 week. The rest of the time intervals no infection was noted and hence not computed.

VI. DISCUSSION

Periodontal therapy aims to stop the advancement of periodontal disease and restore lost periodontal tissues. Achieving complete regeneration is challenging and involves multiple cell types and interactions. Different approaches like root-conditioning chemicals, guided tissue regeneration, bone replacement grafts, and growth attachment factors have been used with varying levels of success for regenerating intraosseous lesions in periodontal tissues.[11]

This study examined how well Bioactive glass and Xenograft combined with Platelet Rich Fibrin (PRF) could regenerate intra-osseous defects. The outcome variables assessed were pain, inflammatory markers of CRP and IL-6 and wound breakdown.

PRF has physical and biochemical properties that make it appealing for use in periodontal wound healing and it was studied as a potential regenerative agent for intrabony periodontal defects for these reasons. A study by **Joseph Choukroun et al** was done in which histologic effects of PRF on bone allograft material was done, results of which showed that when FDBA was incorporated with PRF, the time of healing was reduced to 4 months. Histology showed formation of new bone at a faster rate.[10]

Bioactive glass, a synthetic allograft material known for its ability to support bone growth, has been employed as a substitute for damaged bone in periodontal osseous abnormalities in the past.[12] When treating generalized chronic periodontitis, the use of slow-resorbing biomaterials like xenografts or a combination of graft types (such as xenografts with or without autogenous bone or alloplasts) is recommended, as autogenous bone grafts have a high absorption rate. Studies indicate that xenografts, with their slower resorption rate, are preferred for periodontal surgery during both cessation and exacerbation periods, while platelet-rich fibrin (PRF) enhances prognosis by providing growth factors.[13]

In the present study, results showed thatpain manifested the highest in 1st week with a mean of 6.900 + 1.020, which drastically reduced by the 4th week at a mean of 0.400 + 0.820. Xenograft had a pain score of 6.400 + 1.391 in the first week. The study found no notable distinction between the two groups, suggesting that the distribution of pain response was comparable. Pain was observed only during the initial week in both groups. Pain was assessed by using Wong-Baker FACES Pain Scale. **McRae M et al**highlighted the reliability and widespread adoption of the Wong-Baker FACES Pain Scale in clinical settings. The scale offers several advantages, such as its straightforward administration (requiring minimal instruction) and ease of use, making it a convenient tool in assessing pain levels and cost-effectiveness.[14]**Keck J et al**categorized pain as physiological and clinical. Modulation of clinical pain perception in individuals can be attributed to changes in the central nervous system. These changes involve both the suppression of pain transmission and the facilitation of pain transmission.[15] In this studywe found that both pain and inflammation was noted till 1st week, suggesting that pain in this study was mainly inflammatory.

Unver N et al in the study summarized thatIL-6 plays a crucial role in the initial immune response to acute conditions and is implicated in the development of various chronic inflammatory diseases. C-reactive protein (CRP) is an acute-phase protein that shows a substantial increase, up to 1,000 fold, at sites of infection or inflammation. CRP exists in its native form (nCRP) as a pentameric protein, but it can undergo irreversible dissociation at sites of inflammation.**[16]** IL- 6 concentration was at a mean of 9.628 + 1.465 in the Bioactive glass group while it was 9.191 + 1.712 in the Xenograft group in the 1st week. In the first week, CRP had a mean value of 9.641 + 1.226 in the Bioactive glass while it was 9.634 +1.127 for the Xenograft category. Both the readings suggest that there was no difference in the inflammatory marker concentration between the two treatment groups. Inflammation subsided following the first week suggesting the successful acceptance of both in the patients.The current study observed no instances of wound breakdown or adverse effects, suggesting that the application of Bioactive glass and Xenograft with Platelet Rich Fibrin in intra-osseous defects is safe and well-tolerated.

The study had a long term follow up of 6 months so as to check for recurrence of infection and the natural course of intervention response. The present study has a greater edge over the existing literature as it assess subjective (pain), objective (wound infection), biochemical (CRP and IL-6).

As far as we know, this study represents the first attempt to directly compare the outcomes of using Bioactive glass versus Xenograft in combination with Platelet Rich Fibrin for the treatment of intra-osseous defects.Overall the study infers no difference in the outcome variables of pain, and chemical mediators of inflammation. But during the procedure it was noted ease of handling was better appreciated in Bioactive glass response. The cost of Novabone Putty syringe form 0.5 cc syringe is Rs. 6000 while the cost of Demineralized Bone Matrix Xenograft granules- 2 vials each containing 0.25g is Rs. 3304 which suggests that bioactive glass is costlier than Xenograft. The study confirmed the safety and biocompatibility of using Bioactive glass and Xenograft with Platelet Rich Fibrin (PRF) for treating intrabony defects without adverse effects. Periodontal treatment focuses on halting disease progression and eliminating inflammation to maintain oral health. Both Bioactive glass and Xenograft with PRF demonstrated promising outcomes in periodontal regeneration.

VII. CONCLUSION

For periodontal regenerative therapy, a variety of treatment options are available, including bone transplants, bone substitutes, directed tissue regeneration, growth factors, tissue engineering, or a combination of these. Bioactive glass, a biocompatible synthetic alloplastic substance, aids in the development of bone, which is a novel intervention to be tested in periodontal regeneration. The study's findings suggest that Bioactive glass exhibits positive biological effects when in contact with surrounding fibro-osseous tissues. These effects arise from its ability to promote bone growth (osteoconductive property) and stimulate bone formation (osteostimulatory capacity). Additionally, Bioactive glass demonstrates excellent compatibility within the human body, making it a promising material for various medical applications. Bioactive glass is hence very useful for periodontal regeneration property. Cost is the limitation as compared to Xenograft which is quite cheaper than bioactive glass bone graft.Both interventions gave good outcome, but further studies with larger samples size are recommended.

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