RESEARCH PAPER

Evaluating Recombinant Platelet Derived Growth Factor With xenograft Versus Xenograft Using Modified Minimally Invasive Surgical Technique in Intrabony Defects Management

[1]Ahmed Ashraf El-Sayed*, [2]Aya allah Kamal Abdelaal and [3]Ahmed Abdallah Khalil

Oral Medicine,Oral Diagnosis &Periodontology Department, Faculty of Dentistry, Minia University, Minia, Egypt.
***Corresponding Author:** Ahmed Ashraf El-Sayed, Email:ahmedashraf5678@gmail.com*

Received: 14th June, 2026; Revised: 20th July 2026; Accepted: 20th August, 2026; Available Online: 05th September 2026

ABSTRACT

Background: The modified minimally invasive surgical technique (M-MIST), further enhances soft tissue stability, minimizes surgical trauma, and reduces patient injury. The aim of this work was to appraise the effectiveness of recombinant platelet derived growth factor(rhPDGF-BB) in management of intra-bony defect, and assess the radiographic and clinical results in isolated intrabony faults using M-MIST. **Aim** Assessment of the effectiveness of recombinant platelet derived growth factor in management of intra-bony defect & Assessment of the radiographic and clinical results in isolated intrabony faults utilizing M-MIST.

Patients & Methods: This randomized controlled clinical trial contained 30 patients with intrabony defects ≥2 mm and stage III periodontitis. Patients were erratically assigned into 3 groups: Group I (M-MIST alone), Group II (M-MIST + xenograft), and Group III (M-MIST + rhPDGF-BB with xenograft). Clinical parameters including clinical attachment level (CAL), probing depth (PD), gingival index (GI), and plaque index (PI) were recorded at starting point, three, six, and nine months. Radiographic assessment utilizing cone beam computed tomography (CBCT) assessed Vertical depth of defect(VD), width(W), area(A), alveolar crest height(ACH), and bone density(BD) at starting point and nine months.**Results:** All groups revealed significant clinical development with time ($p < 0.05$). CAL reduction was greatest in M-MIST alone ($p = 0.001$). GI and PI were significantly lower in the rhPDGF-BB group ($p < 0.001$). Radiographically, defect depth and area reduction were significantly larger in the adjunctive groups ($p < 0.01$), while bone density increased most in the rhPDGF-BB group. Significant correlations were found among defect morphology and clinical outcomes, particularly CAL.

Conclusions: M-MIST is effective for intrabony defect management. Adjunctive xenograft and rhPDGF-BB enhance specific radiographic and clinical outcomes, with RhPDGF-BB showing additional benefits in soft tissue healing and bone density improvement.

Keywords: Rh-PDGF; Xenograft; M-MIST; Intrabony Defects

How to cite this article: El-Sayed AA, Abdelaal AK, Khalil AA.., Evaluating Recombinant Platelet Derived Growth Factor With xenograft Versus Xenograft Using Modified Minimally Invasive Surgical Technique in Intrabony Defects Management t Int J Drug Deliv Technol. 2026;16(89s): 1347-1358; DOI: 10.25258/ijddt.16.89s.141
Source of support: Nil.
Conflict of interest: None

INTRODUCTION

Periodontal disease is a chronic disorder that begins as gingivitis and may develop to periodontitis, causing attachment loss and devastation of tooth-supporting structures. In advanced cases, this can result in tooth loss, migration, masticatory dysfunction, and eventual edentulism [1]. Intrabony defects, defined as periodontal defects enclosed by 1, 2, or 3 bony walls [2], present a significant clinical challenge.

Conventional periodontal surgical approaches, involving flap elevation and root debridement, may lead to additional attachment loss and postoperative complications such as sensitivity, food impaction, and aesthetic concerns. Therefore, slightly less aggressive methods have been introduced to improve clinical results while reducing morbidity [3].

The minimally invasive surgical technique (MIST) has shown significant improvements in Clinical attachment gain and probing depth (PD) decrease, with minimal gingival recession [4]. Its modification, the modified M-MIST, further enhances soft tissue stability, minimizes surgical trauma, and reduces patient morbidity [5].

To optimize periodontal regeneration, adjunctive therapies as guided tissue regeneration (GTR), enamel matrix derivatives (EMD), and growth factors have been utilized. Among these, recombinant human platelet-

Author for Correspondence: ahmedashraf5678@gmail.com

derived growth factor-BB (rhPDGF-BB) has demonstrated strong mitogenic and chemotactic effects, promoting fibroblast activity, collagen synthesis, and mesenchymal stem cell proliferation [6]. Additionally, PDGF plays a central part in bone rebirth through its effects on pericytes and osteoprogenitor cells [7].

Clinical evidence supports the effectiveness of rhPDGF-BB, particularly when combined with an osteoconductive scaffold such as xenografts, in enhancing periodontal regeneration outcomes [8].

Therefore, this work aimed to evaluate the radiographic and clinical outcomes of intrabony defects cured with rhPDGF-BB combined with xenogenic graft versus xenograft alone using the M-MIST.

Ethical regulations

The whole treatment plan was clarified to all patients counting complete steps, dangers, and probable outcomes and their full employed consent was gotten before access into the work.

An informed written consent was gotten from the patient. The work was performed after consent from the Ethical Committee Faculty of Dentistry, Minia University with Declaration of Helsinki, the ethical norm of the World Medical Association for human testing (929-2024).

The recent work was planned as a parallel arm, double-blind , controlled, randomized clinical trial and trailed the CONSORT report (http://www.consort-statement.org/)(figure 1)

MATERIALS AND METHODS

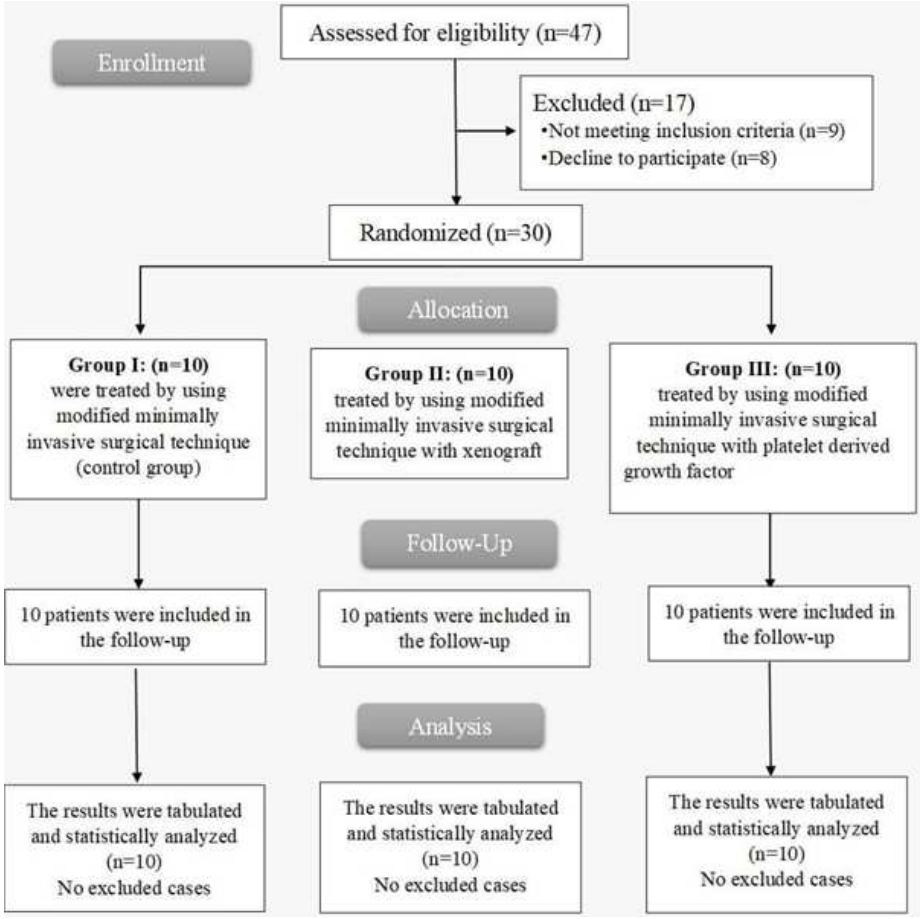


Figure I: CONSORT flowchart of studied patients

Patient selection

This work was achieved on 30 patients aged from 25 to 45 years old, either genders, were selected outpatient Periodontology Clinic, Faculty of Dentistry, Minia University, with stage III periodontitis, existence of at minimum 1 tooth with probing pocket depth more than six mm(PPD) and CAL loss of a minimum five mm related to an intrabony defect of a minimum 2mm according to Cortellini and Tonetti [4], good oral hygiene, little levels of residual infection: Full mouth bleeding score(FMBS) = 15%, and only patients with ideal obedience, as evaluated throughout the case – linked stage of therapy.

Exclusion criteria were related medical conditions: Patients with uncontrolled diabetes or uncontrolled, life threatening or unstable conditions, or necessitating antibiotic prophylaxis, smokers and pregnant patients, acute infection at surgical site, and patients with multiple interconnected vertical defect were omitted from this study.

Sample Size Calculation

To evaluate of the effect of rh-PDGF BB in intrabony defect ,the study was divided into three groups (GI, GII, and GIII) at four measuring points (baseline,three months, six month, and 9 months), the radiographic and clinical outcomes were statistically examined utilizing One-way analysis of variance (ANOVA), trailed by a

post hoc test or an equivalent non-parametric test. According to the previous studies, a minutest total sample size of thirty samples were adequate to spot an average result size of 0.31 with a power (1-β=0.90) at a significance prospect level of $p \leq 0.05$.

According to sample size calculations, there is a ninety percent accidental of properly refusing the null hypothesis of no significant effect in every group (GI,GII, and GIII). The sample size was measured according to G*Power software version3.1.9.7. f: is the effect size:

$$f = \frac{\sigma_\mu}{\sigma}$$

$$\sigma_\mu^2 = \frac{\sum_{i=1}^{k} n_j \left(\mu_i - \mu\right)^2}{N}$$

Grouping and randomization

Randomization for 30 patients was completed by computer-generated system (https://www.randomizer.org/). The list was covered in sealed coverings that were totaled and opened successively after gaining patient's consent. Patients were randomly owed utilizing computer generated randomization tables into 3 equal groups: Group I 10 patients were cured by utilizing M-MIST (control group), group II 10 patients cured by utilizing M-MIST with xenograft, and group III 10 patients were cured by utilizing M-MIST with rh-PDGF BB(from GEM21S kit)*with xenograft .*

Clinical And Radiographic measurements

All patients underwent comprehensive baseline evaluation including demographic data (age, sex) assessment was performed by Single calibrated masked periodontist recorded all clinical periodontal measurements at starting point, three, six, and nine months postoperatively and included PI, GI,PD restrained utilizing a UNC-15 periodontal probe, and CAL

PI: FMPS was noted as the percentage of whole surfaces (4 sides per tooth) that exposed the incidence of plaque by silness and loe index [9]

GI: FMBS was noted as the percentage of full surfaces (4 sides per tooth), that exposed the incidence of bleeding upon probing.

PD: restrained from the gingival margin to the bottom of the gingival sulcus.

CAL: restrained from the CEJ to the lowermost of the gingival sulcus.

Radiographic assessment was showed by utilizing Cone Beam Computed Tomography(CBCT) at baseline and nine months using standardized settings.

Scanning Standardization

- A single trained technician took all pre- and post-surgery CBCT scans. A calibration exercise was achieved to get intra-examiner consistency in CBCT measurements. The occlusal plane of the jawbone was situated horizontally to the scanned plane, and the mid-sagittal plane was centered. The beam height at the surface of the image receptor was adaptable and set to visualize the whole jaws among around twenty mm and sixty mm beam height. Measurements were made utilizing sagittal sections. The current, voltage, detection field, and exposure time were kept continuous for every patient at either times of exposure. The reference chosen to standardize the axial and sagittal planes was the bi-spinal line, concurring with the horizontal and vertical planes, singly. sagittal and Axial sections were attained 6 months after reconstruction utilizing the exact reference as starting point. Duplicate measurements were made, and the mean was noted as the final value.

- **Scanning Method**

before the CBCT scan, the patient's position was attuned utilizing the Frankfort-Horizontal plane and the office floor as reference points. All cases were gotten utilizing the **SCANORA® 3Dx CBCT dental unit(Finland)** (slice thickness of 0.2 mm, exposure of ninty kV, ten mA, with a scan time of 0.018 s/slice).

Bone level was leisurely from sagittal sections of CBCT for posterior teeth and coronal sections for anterior teeth.[10]

The most apical contour contacting the root surface was designated as base of the defect (BD) and the most coronal one was selected as alveolar crest (AC). Cementoenamel junction (CEJ) was the static coronal reference for these extents. After AC, BD and CEJ were resolute on the screen, the ensuing extents were performed: (figure II-1)

• **Vertical depth of defect (VD):** the length from CEJ to the base of defect (BD). (figure II-1) • **Alveolar crest height (ACH):** the length from CEJ to the crest of bone adjacent to defect (AC). (figure II-1)

• **Width of defect (WD):** the distance among the mesial and distal borders of the bony defect, which is the distance among the AC on the root surface and the lateral margin of the flaw (The length of perpendicular line from (AC) to (CEJ-BD)). (figure II-1)

• **Area of the defect (AD):** the surface area drawn among (CEJ-BD-AC-CEJ). (figure II-2)

II-Bone density (BD), using Hounsfield unit:

Restrained by region of interest (ROI) button in CBCT software among 2 fixed points (AC-BD). (figure II-3)

* **Rh-PDGF-BB**(From GEM21s kit®, Manufactured by BioMimetec Pharmaceuticals,Inc)

***CeraMatrix®** (Xenograft Bone substitute).

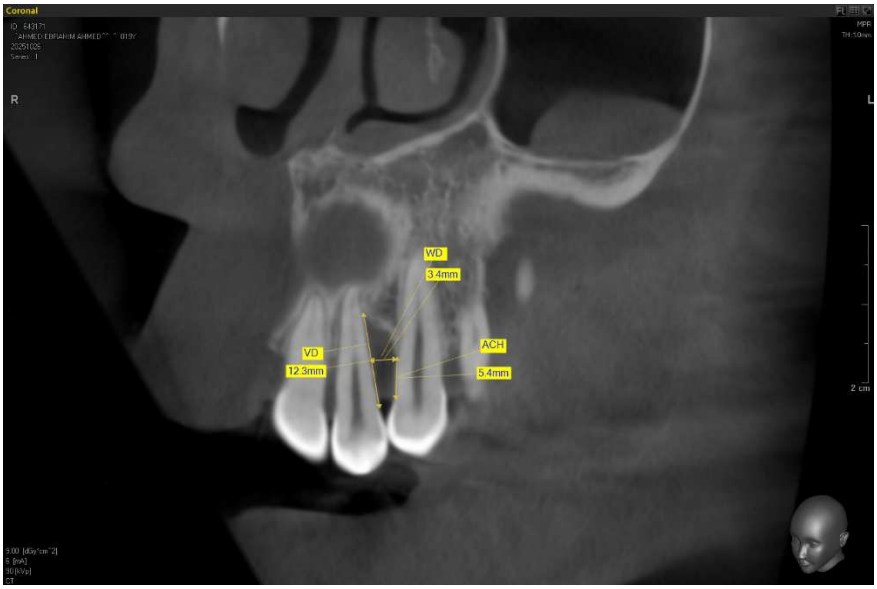


Figure II-1_: Cone beam computed tomography at baseline – coronal view - Vertical depth of defect- Alveolar crest height- Width of defect.

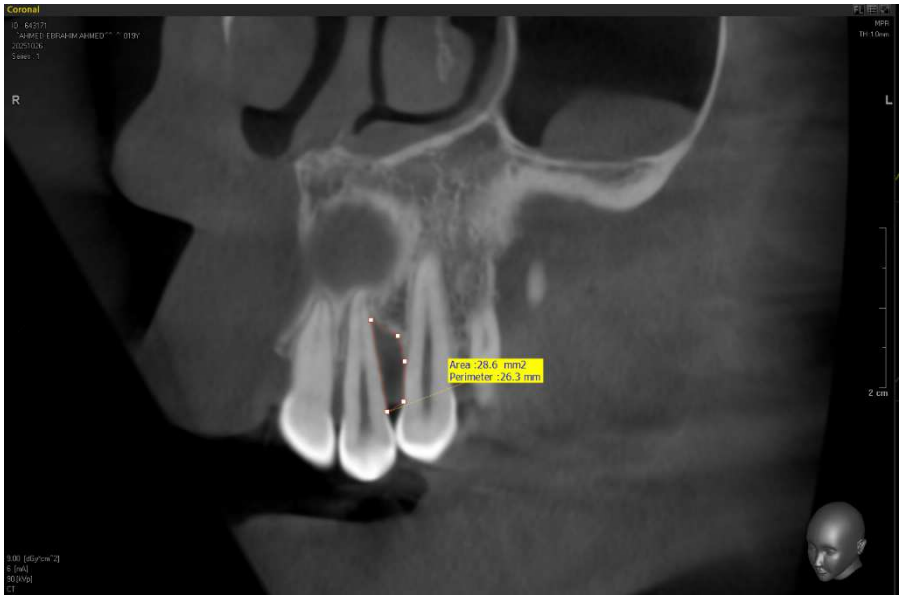


Figure II-2: Cone beam computed tomography at baseline – coronal view -Area of the defect.

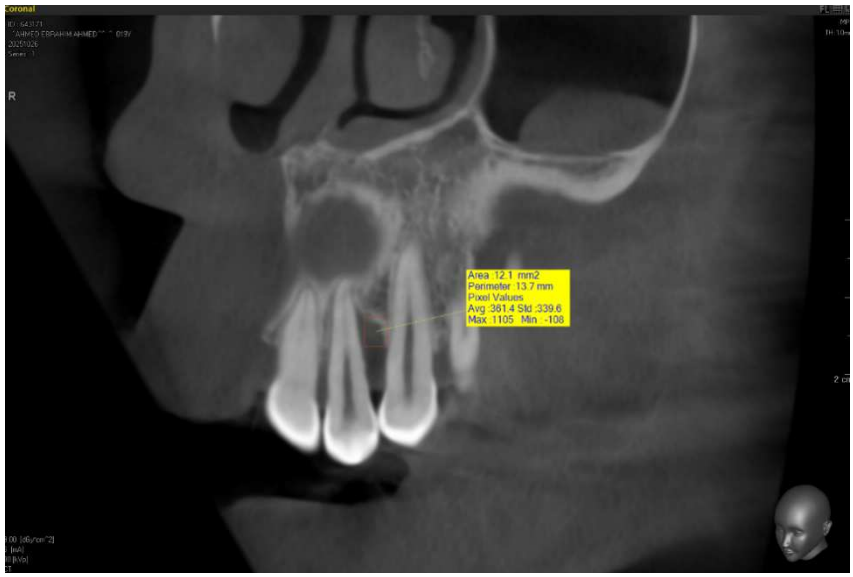


Figure II-3: Cone beam computed tomography at baseline – coronal view -Bone density by ROI

All the CBCT scans were performed by a single trained technician pre - and post -surgery by 9 months. The current, voltage, detection field and exposure time were saved endless for every patient at either times of exposure. The coronal and sagittal sections were recreated after 9 months at the similar axial slicing to that of the baseline. Duplicate extents were made and their mean well-thought-out as ending standards.

Presurgical preparation:

1. The participants established a full diagnostic workup counting a full mouth (GI, PI, PD and CAL).

2.Full mouth Scaling and root planning (SRP) were finished for all patients and also comprehensive oral hygiene instructions.

3. Re- evaluation was showed after four weeks to assess patient response to phase I therapy and to settle the necessity for periodontal surgery [11].

4.Occlusal stents was fabricated to be used as fixed references for accurate positioning of the measuring probes.

5.Standardized parallel periapical radiographs was taken to assess the intrabony defect depth.

According to the principles of radiation safety (ALADA/ALARA), standard 2D periapical radiographs prior to CBCT are the primary diagnostic screening tool for routine clinical examination.

Surgical Procedure:

All surgical procedures were performed by the same operator.

1 - before surgery patient was trained to rinse with 0.12% chlorhexidine gluconate for thirty seconds.

2-Anaesthesia was found by administration of 4% Articaine 1:100,000 epinephrine.

3-The defect-associated interdental papilla was surgically advanced either with the simplified papilla preservation flap when the width of the interdental space was two mm or narrower, or the modified papilla preservation technique at interdental sites wider than two mm.

4- The buccal aspect of the 2 teeth adjacent to the defect was involved in the interdental incision (SPPF or MPPT). The mesiodistal extension of these incisions will be kept to a minimum, ideally within the mid-buccal area of the affected teeth, to enable the reflection of a triangular buccal flap and the exposure of the coronal edge of the buccal bone crest (figure III-1,2,3-C). The incisions will be strictly intrasulcular to reserve the whole width and height of the gingiva.

5-The blade cut over the interdental tissues, splitting the coronal part (basically the supracrestal tissues) from the apical part (i.e. the “granulation” tissue filling the intrabony section of the defect)

6-The micro-blade was used to dissect the granulation tissue from the interdental and buccal bony walls, and it was subsequently meticulously removed from under the papilla using a pointed curette. The defect was debrided using a mixture of micro curettes and power-driven instruments, and the root was meticulously planed.(figure III-1,2,3-D)

7-At the end of instrumentation, EDTA *will be left on the root surface for two min. and then the affected area will be sensibly bathed with saline(Figure III-3-E)

8- a-For Group I :- The Flap was repositioned without Xenograft or

Recombinant platelet derived growth factor .(figure III-1)

b- For Group II:- Xenograft was used to fill the defect (figure III-2).

c- For Group III :- Recombinant platelet resulting growth factor* was mixed

with xenograft and it was used to fill the defect.(figure III-3)

9-a single modified internal mattress suture was situated at the defect related interdental area(figureIII-E)

10- periodontal pack was placed at defect site.

Postoperative Care:

*Patients established amoxicillin/clavulanic acid *(one g two times daily for seven days), ibuprofen* (400 mg three times daily), and 0.12 percent chlorhexidine mouthwash *2 times a day. Mechanical plaque control at the surgical place was avoided for 3–4 weeks. Sutures were detached after ten days. Patients were followed monthly for professional prophylaxis and oral hygiene support.*

Statistical analysis

Statistical analysis was performed by SPSS v26 (IBM Inc., Armonk, NY, USA). Quantitative variables were obtainable as standard deviation (SD) and mean and likened amid the three groups applying ANOVA (F) test. Qualitative variables were offered as percentage (%)and frequency and were analyzed using the Chi-square test. Correlation coefficient (r) was utilized for discovery of connection among 2 quantitative variables in 1 group A two tailed P value < 0.05 was measured statistically significant.

EDTA(from Meta biomed)

***Augmentin**®, GlaxoSmithKline, Egypt.

***Brufen**®, Abbott, Egypt.

***Hexitol**®, ARAB DRUG COMPANY(ADCO), Egypt.

Group I:

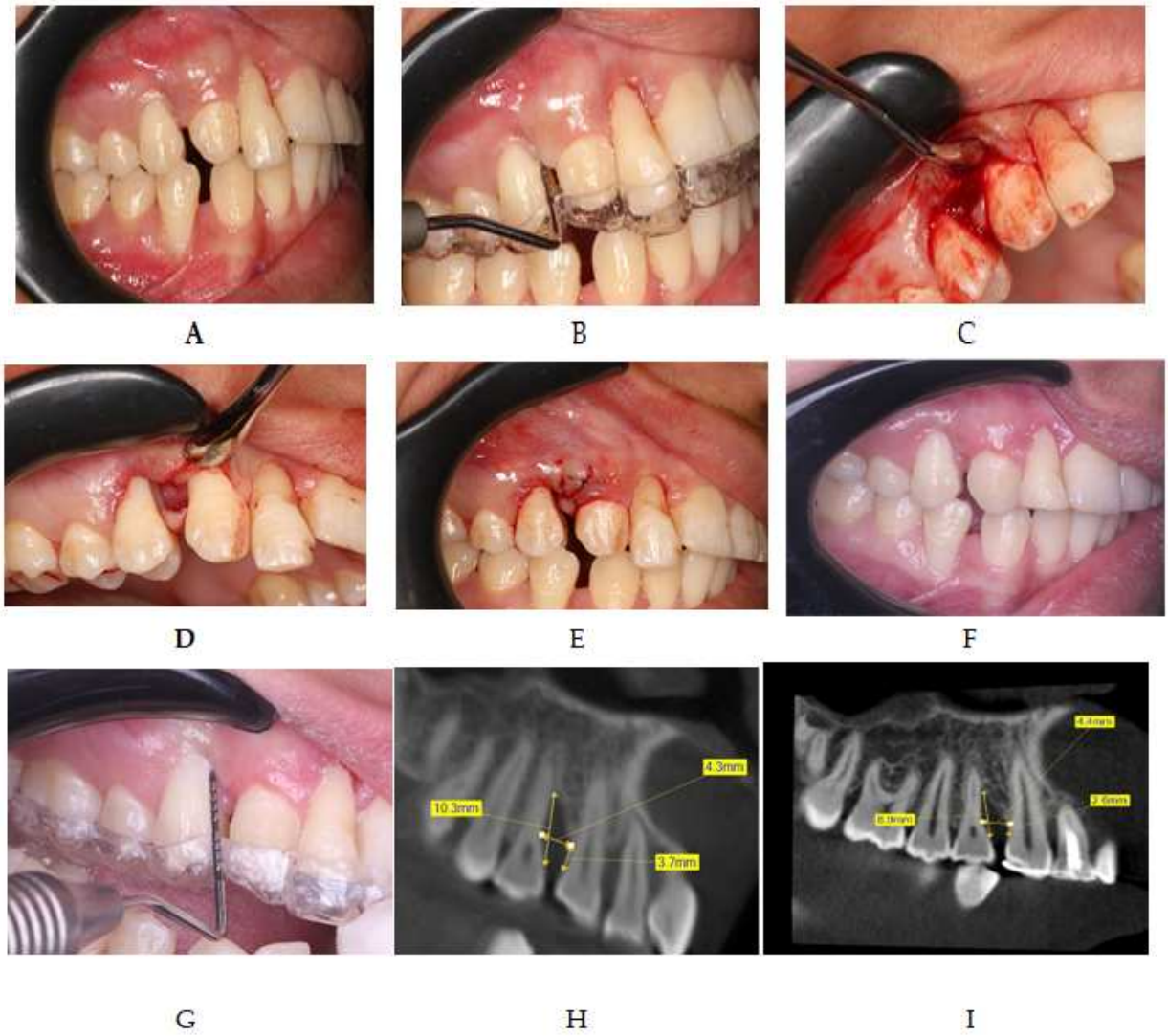
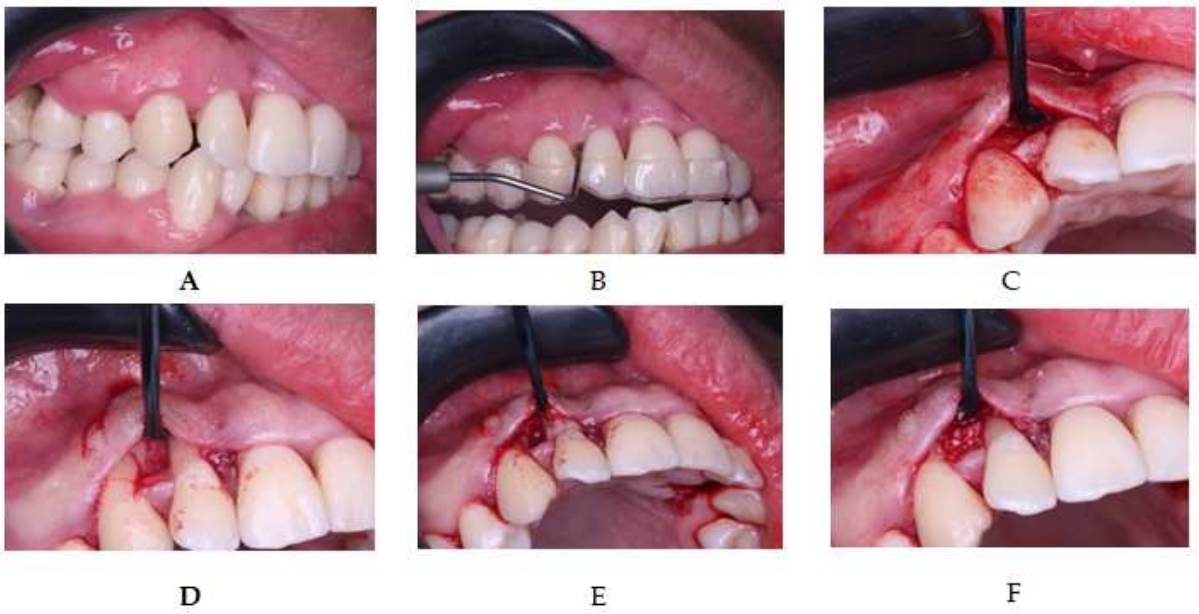


Figure III-1: (A) Pre operative, (B) measuring pre PD, (C) flap elevation, (D) curretage, (E) suturing, (F) follow up, (G) measuring follow up - PD,(G)Preoperative CBCT,(I)Postoperative CBCT

Group II:



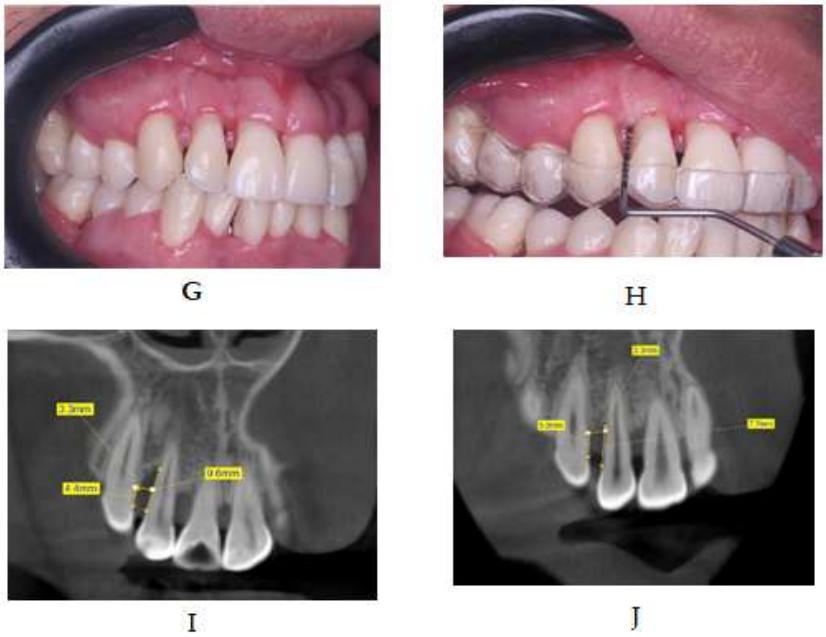


Figure III-2: (A) Preoperative (B) preoperative PD (C) Flap elevation, (D) Curettage, (E) EDTA application, (F) Bone graft in place, (G) Follow Up (H) postoperative PD, (I)Preoperative CBCT,(J)Postoperative CBCT

Group III:

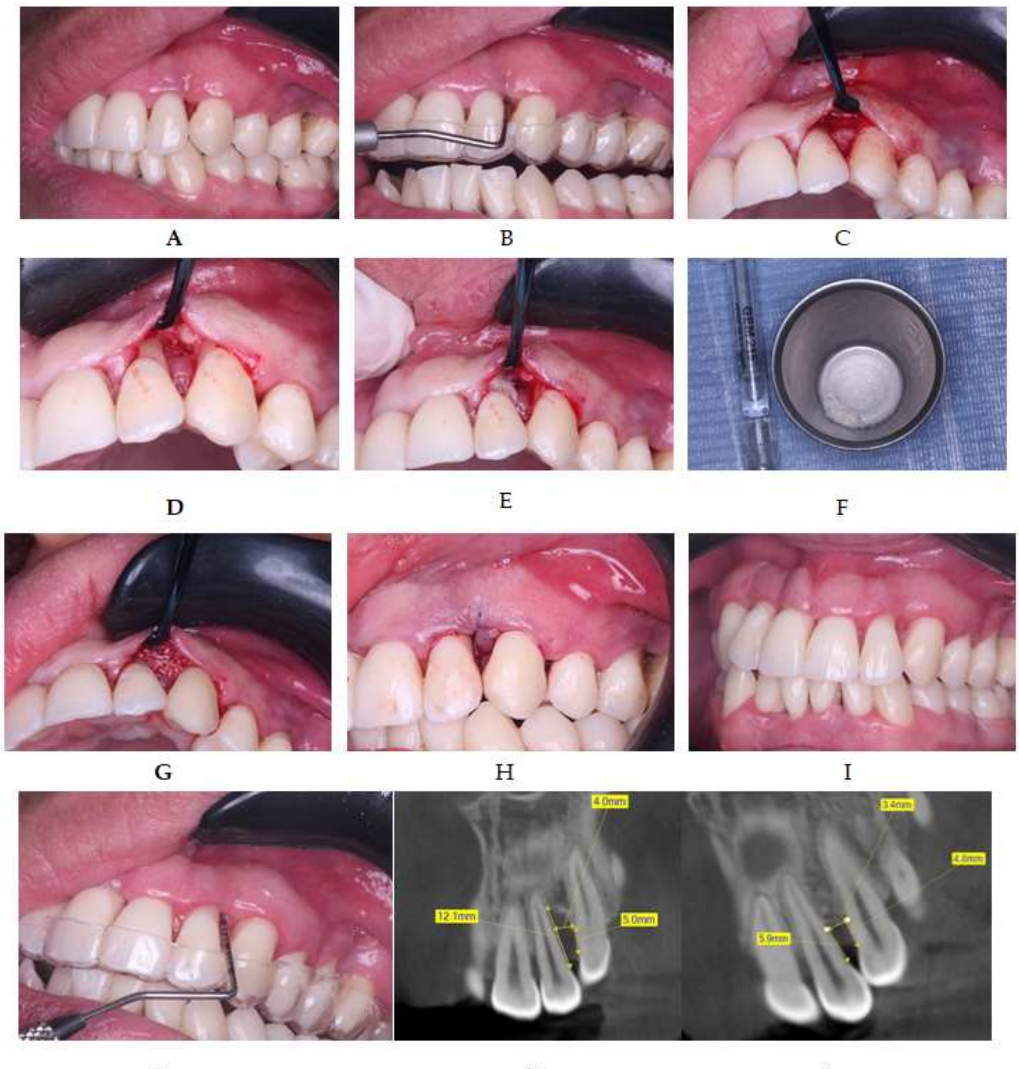


Figure III-3: (A) Preoperative, (B) preoperative PD, (C) Flap elevation, (D) Curettage, (E) EDTA application, (F) GEM21s + xenograft (mixing/preparation), (G) GEM21s + xenograft in place, (H) Suturing, (I) Follow-up photo, (J) PD follow up , (K)Preoperative CBCT,(L)Postoperative CBCT

Results

30 healthy patients with stage III periodontitis were separated into 3 groups :Group I (M-MIST)(control group) had 10 patient with 4 men and 6 women with mean age 33.40 ± 7.01 , Group II(M-MIST+Xenograft) had 10 patients with five men and five women with mean age 38.00 ± 11.23 while Group III(M-MIST+GEM21s+xenograft) had 10 patient with 4 men and 6 women with mean age 36.60 ± 8.58.

Significant alterations among the study groups were detected in several clinical parameters at follow-up. PD presented a statistically significant lessening at three, six, and nine months ($p = 0.039$), with post hoc analysis indicating significant alterations among Group II and both Group I and Group III, while no significant alteration was initiate among Groups I and III. However, the overall mean PD reduction did not change significantly among groups ($p = 0.87$).

CAL demonstrated highly significant differences at all follow-up intervals ($p = 0.001$), with greater improvement observed in Group I in contrast to Groups II and III. Post hoc analysis established significant variances among Group I and the other groups, with no significant alteration among Groups II and III. **Table 1**

PI showed significant differences at all follow-up time points ($p < 0.001$), with Group III demonstrating the greatest reduction. The mean change in PI was also statistically significant ($p = 0.002$), favoring Group III over Groups I and II. Similarly, gingival index (GI) revealed significant differences across all follow-up periods ($p < 0.001$), with Group III showing the most pronounced improvement. The mean GI reduction showed borderline statistical significance among groups ($p = 0.05$). **Table 1**

Table 1: Demographic and Clinical Parameters Across Study Groups

Parameter	Time	Group I	Group II	Group III	P value	Post hoc
Age (years)	**—**	33.40 ± 7.01	38.00 ± 11.23	36.60 ± 8.58	0.52	—
Gender	**Males**	4 (40%)	5 (50%)	4 (40%)	0.99	—
	Females	6 (60%)	5 (50%)	6 (60%)		
PD (mm)	**Baseline**	8.80 ± 1.23	9.40 ± 1.07	8.60 ± 0.84	0.23	—
	3 months	3.20 ± 0.42	3.80 ± 0.79	3.20 ± 0.42	**0.039***	**P1=0.05*,** P2=1, **P3=0.05***
	6 months	3.20 ± 0.42	3.80 ± 0.79	3.20 ± 0.42	**0.039***	**P1=0.05*,** P2=1, **P3=0.05***
	9 months	3.20 ± 0.42	3.80 ± 0.79	3.20 ± 0.42	**0.039***	**P1=0.05***, P2=1, **P3=0.05***
	Mean difference	5.60 ± 1.26	5.60 ± 0.84	5.40 ± 0.84	0.87	—
CAL (mm)	**Baseline**	5.80 ± 1.23	7.20 ± 1.23	8.20 ± 3.36	0.07	—
	3 months	0.20 ± 0.42	2.80 ± 2.44	4.60 ± 3.03	**0.001***	**P1=0.04*, P2<0.001*,** P3=0.19
	6 months	0.20 ± 0.42	2.80 ± 2.44	4.60 ± 3.03	**0.001***	**P1=0.04*, P2<0.001*,** P3=0.19
	9 months	0.20 ± 0.42	2.80 ± 2.44	4.60 ± 3.03	**0.001***	**P1=0.04*, P2<0.001*,** P3=0.19
	Mean difference	5.60 ± 1.26	4.40 ± 2.55	3.60 ± 1.58	0.07	—
PI	**Baseline**	1.40 ± 0.52	1.20 ± 0.42	1.60 ± 0.52	0.20	—
	3 months	1.00 ± 0.00	1.00 ± 0.00	0.40 ± 0.52	**<0.001***	P1=1, **P2<0.001*, P3<0.001***
	6 months	1.40 ± 0.52	1.00 ± 0.00	0.20 ± 0.42	**<0.001***	P1=1, **P2<0.001*, P3<0.001***
	9 months	1.00 ± 0.00	1.00 ± 0.00	0.40 ± 0.52	**<0.001***	P1=1, **P2<0.001*, P3<0.001***
	Mean difference	0.40 ± 0.52	0.20 ± 0.42	1.20 ± 0.79	**0.002***	P1=0.73, **P2=0.01*, P3=0.002***
GI	**Baseline**	1.80 ± 0.42	2.20 ± 0.42	2.00 ± 0.00	0.07	—
	3 months	0.20 ± 0.42	0.80 ± 0.42	0.00 ± 0.00	**<0.001***	**P1=0.002*,** P2=0.40, **P3<0.001***
	6 months	0.20 ± 0.42	0.80 ± 0.42	0.00 ± 0.00	**<0.001***	**P1=0.002*,** P2=0.40,

						P3<0.001*
	9 months	0.00 ± 0.00	0.80 ± 0.42	0.00 ± 0.00	**<0.001***	**P1<0.001*,** P2=0.40, **P3<0.001***
	Mean difference	1.80 ± 0.42	1.40 ± 0.84	2.00 ± 0.00	**0.05***	P1=0.24, P2=0.59, **P3=0.05***

Data are obtainable as mean ± SD, number (%). *: significant as P value < 0.05. P1: p value amid Group I and II, P2: p value amid Group I and III, P3: p value amid Group II and III

There were significant variances among the study groups were observed in several radiographic parameters. Vertical defect depth revealed a statistically significant alteration at baseline (p = 0.01), with post hoc analysis tightfitting significant alterations among Group I and both Group II and Group III. Though, no significant intergroup alteration was detected at nine months (p = 0.57), while the mean drop in defect depth was highly significant among groups (p < 0.001), favoring Groups II and III over Group I. **Table 2**

Similarly, defect area demonstrated a significant difference at baseline (p = 0.01), with post hoc analysis viewing a significant variance among Group I and Group III. The mean reduction in defect area was also statistically significant among groups (p = 0.002), with greater improvement observed in Groups II and III in contrast to Group I. Bone density showed highly significant intergroup differences at starting point (p < 0.001) and at 9 months (p = 0.005), with post hoc analysis indicating significantly developed values in Group III in contrast to the other groups. However, the mean change in bone density did not vary significantly among groups (p = 0.47). **Table 2**

In contrast, alveolar crest height and defect width presented no statistically significant alterations among groups at baseline, 9 months, or in mean change (all p > 0.05), indicating comparable outcomes across treatment modalities for these parameters. **Table 2**

Table 2: Radiographic Outcomes Across Study Groups

Parameter	Time	Group I	Group II	Group III	P value	Post hoc
Vertical Defect Depth (mm)	**Baseline**	7.96 ± 1.69	9.74 ± 0.65	9.92 ± 1.99	**0.01***	**P1=0.04*, P2=0.02***, P3=0.96
	9 months	6.58 ± 1.25	6.14 ± 1.99	5.84 ± 1.34	0.57	—
	Mean difference	1.38 ± 0.57	3.60 ± 1.51	4.08 ± 1.51	**<0.001***	**P1=0.002*, P2<0.001***, P3=0.68
Alveolar Crest Height (mm)	**Baseline**	4.26 ± 1.45	3.92 ± 0.75	4.10 ± 1.75	0.86	—
	9 months	3.34 ± 1.66	3.18 ± 1.18	3.36 ± 0.95	0.94	—
	Mean difference	0.92 ± 0.42	0.74 ± 0.85	0.74 ± 1.20	0.87	—
Defect Width (mm)	**Baseline**	3.02 ± 0.77	3.40 ± 0.27	3.70 ± 1.04	0.15	—
	9 months	2.92 ± 0.97	3.30 ± 0.27	3.28 ± 0.79	0.44	—
	Mean difference	0.10 ± 0.30	0.10 ± 0.40	0.42 ± 0.35	0.08	—
Defect Area (mm²)	**Baseline**	14.60 ± 5.10	19.98 ± 3.46	21.62 ± 6.71	**0.01***	P1=0.07, **P2=0.01*,** P3=0.76
	9 months	10.32 ± 6.17	11.44 ± 3.60	12.12 ± 4.92	0.72	—
	Mean difference	4.28 ± 1.80	8.54 ± 3.62	9.50 ± 3.57	**0.002***	**P1=0.01*, P2=0.02***, P3=0.77
Bone Density (HU)	**Baseline**	351.12 ± 113.55	317.10 ± 114.89	532.24 ± 108.09	**<0.001***	P1=0.77, **P2=0.003*, P3=0.001***
	9 months	448.32 ± 233.61	406.10 ± 97.88	746.60 ± 312.73	**0.005***	P1=0.91, **P2=0.02*, P3=0.008***
	Mean difference	97.20 ± 230.80	89.00 ± 197.99	214.36 ± 312.47	0.47	—

Data are obtainable as mean ± SD. *: significant as P value < 0.05. P1: p value amid Group I and II, P2: p value between Group I and III, P3: p value amid Group II and III

DISCUSSION

Conventional periodontal surgery, such as open flap debridement, mainly reduces infection and periodontal pockets but often leads to repair rather than true regeneration, with possible gingival recession and esthetic compromise. Therefore, modern therapy focuses on regenerative approaches that restore periodontal ligament, alveolar bone, and cementum [12].

M-MIST has newly gained attention as an actual approach for curing isolated intrabony periodontal defects. This technique integrates the concepts of minimally invasive flap design, papilla preservation, and microsurgical instrumentation to endorse optimal healing and improve wound stability. Clinical studies have confirmed that M-MIST can accomplish favorable outcomes, including reduced PD, improved CAL, and limited postoperative gingival recession, while also improving patient comfort and esthetic results [13].

PDGF-BB has strong mitogenic and chemotactic effects. Released mainly from platelet alpha granules, it stimulates DNA synthesis, chemotaxis, collagen, and glycosaminoglycan production in fibroblasts. Activated macrophages and fibroblasts also secrete PDGF, which promotes mesenchymal and PDL cell proliferation in preclinical studies [14].

PDGF-BB also strongly stimulates stem cell proliferation and marker expression in mesenchymal stem cells resulting from human periodontal ligament tissues [6].

Additionally, PDGF regulates bone regeneration through its effects on pericytes, which possess osteogenic MSC potential. It promotes pericyte proliferation and influences pericyte-MSC-osteoblast interactions, substitute as an osteoprogenitor mitogen and modulating osteogenic growth factors as BMPs [7].

Hence this Randomized controlled trial was performed to compare M-MIST alone Vs M-MIST+Xenograft Vs M-MIST+rh-PDGF+Xenograft through Clinical and radiographic evaluation.

The result of our study reveal no significant baseline difference in PD among groups, confirming comparable initial conditions. At three, six, and nine months, Group II displayed significantly higher PD values than Groups I and III, although mean PD reduction did not vary significantly amid groups.

These results agree with previous studies on M-MIST, which reported significant PD reduction regardless of adjunctive materials, with no significant intergroup differences [15, 16]. This suggests that all treatment modalities effectively reduced PD.

The higher PD values in Group II may be related to healing differences or graft effects on soft tissue adaptation. Although xenografts improve defect fill, they may not always enhance soft tissue shrinkage or pocket reduction.

Recent trials also indicate that while regenerative materials may improve some outcomes, overall PD reduction is often similar between groups, emphasizing the importance of surgical technique itself [17].

**Platelet-derived biologics such as PDGF, PRP, and PRF have been widely investigated in periodontal regeneration because their bioactive growth factors promote wound healing, angiogenesis, extracellular matrix formation, and cell proliferation.*

Among these biologics, rhPDGF has demonstrated promising regenerative potential when combined with bone graft materials. Clinical studies have stated advances in periodontal PDR, radiographic bone fill, and clinical attachment gain, supporting its use as an assistant to regenerative periodontal therapy [18].

The present study initiate no significant baseline alteration in CAL among groups ($p = 0.07$). Though, significant alterations were detected at 3, 6, and 9 months ($p = 0.001$), with Group I showing significantly lower CAL values than Groups II and III. Despite greater mean CAL reduction in Group I, intergroup differences in mean change were not statistically significant ($p = 0.07$).

All groups displayed significant CAL improvement over time, supporting the effectiveness of the surgical interventions. Similar findings have been reported with M-MIST alone or combined with regenerative materials, likely due to improved soft tissue preservation, wound stability, and clot protection [19, 20].

No significant baseline variance in PI was experimental among groups, confirming similar oral hygiene status initially. At follow-up, Group III showed significantly lower PI values and greater PI reduction compared with Groups I and II, while Groups I and II did not fluctuate significantly.

These findings are consistent with studies showing that PRP shared with bone grafts advances healing and reduces inflammation compared with grafting alone [21].

**In contrast, studies comparing surgery alone with grafting without biologics often report similar PI outcomes, suggesting that plaque control mainly depends on patient compliance and oral hygiene rather than xenograft use alone.*

The improved PI outcomes may be explained by platelet-derived biologics enhancing soft tissue healing and reducing inflammation through growth factor release [22]. Better gingival health may indirectly improve plaque control and oral hygiene practices.

Similarly, PRP may create a healthier gingival environment through anti-inflammatory and healing effects, improving patient comfort during brushing and supporting better plaque control [23].

The present study found no significant baseline difference in gingival index among groups. At follow-up, Group II showed significantly higher gingival index values than Groups I and III, whereas Groups I and III did not change significantly. Although mean reduction differed significantly overall, intergroup variances were mostly borderline or non-significant.

Likewise, studies evaluating PRF with graft materials reported gingival index reduction in all groups without significant alterations among control and test groups [24].

The similar outcomes between Groups I and III may reflect the anti-inflammatory benefits of minimally invasive surgery, which preserves blood supply, minimizes trauma, and enhances wound stability.

Higher gingival index values in Group II may relate to xenografts lacking biologic modifiers. Unlike PDGF that promote healing and reduce inflammation, xenografts mainly provide structural support [25].

However, gingival index is strongly influenced by oral hygiene and patient compliance. Many studies attribute gingival improvement mainly to initial therapy and patient motivation rather than regenerative materials.

Regarding Radiographic parameters ,At baseline, significant differences in vertical defect depth were observed among groups ($p = 0.01$), with Group I showing shallower defects than Groups II and III. After 9 months, defect depth became comparable among groups, although mean reduction differed significantly ($p < 0.001$).

Baseline differences in defect depth are common in periodontal trials and strongly influence regenerative outcomes. Deeper and narrower defects generally show greater bone fill due to improved clot stabilization and space maintenance [26].

No significant alteration in alveolar crest height was experiential among groups at baseline or after 9 months, and mean crest height change was also comparable among groups.

Similarly, recent evidence indicates that regenerative therapies mainly improve intrabony defect fill rather than marginal alveolar crest height [27].

Regenerative materials such as PRP, PRF, PDGF and xenografts primarily enhance defect bone formation and soft tissue healing rather than coronal migration of the alveolar crest.

Defect width was comparable among groups at baseline and afterwards 9 months, with no significant intergroup alterations in width reduction.

These findings agree with previous literature showing that defect morphology, especially width and remaining bony walls, is more important for healing than the specific regenerative material used [28].

The study showed significant baseline differences in defect area, with Group III presenting larger defects than Group I. After 9 months, defect area became comparable among groups, while Groups II and III demonstrated greater mean reduction than Group I.

Baseline variability in defect area is commonly reported and may influence regenerative outcomes, as larger defects often show greater absolute reductions because of higher regenerative potential.

Comparable defect area after 9 months suggests that all modalities effectively promoted defect resolution, consistent with studies showing that xenografts and platelet-derived biologics improve intrabony defect fill over time [29].

Bone density differed significantly among groups at starting point and afterward nine months, with Group III consistently showing higher values. However, mean bone density change did not vary significantly amid groups.

These findings partially agree with studies reporting improved radiographic bone parameters with PDGF and bone grafts, although intergroup differences are not always significant [21].

CONCLUSIONS

The findings of this study establish that M-MIST are effective in the management of intrabony periodontal defects, yielding favorable radiographic and clinical outcomes. The adjunctive utilize of regenerative materials provided additional benefits in certain parameters. Platelet-derived growth factor was related to enhanced improvements in PI, bone density, and defect area reduction, while the use of xenograft contributed positively to defect fill. Overall, both approaches showed effectiveness, with variations depending on the outcome measured, supporting the role of minimally invasive strategies as reliable treatment options in periodontal regeneration.

Financial support and sponsorship: *Nil*

Conflict of Interest: Nil

Author contributions

FBT; study design and conception. AFM; data collection. FBT and AFM; statistical analysis and interpretation of results. FBT, AFM and OHS; Writing - review & editing. Supervision; FBT and OHS. All authors revised the outcomes and permitted the final version of the manuscript to be published.

Acknoledgement and funding

There was no external support for this study.

Informed consent

Informed consent was gotten from all individuals or their guardians involved in this work.

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