RESEARCH PAPER

Comparative Efficacy of Chorion and Collagen Membranes with DFDBA in the Regeneration of Periodontal Intrabony Defects: A CBCT-Based Evaluation.

Dr. Divjot Kaur Narula[1], Dr. Kumar Saurav Singh[2], Dr. Kanishk Gupta[3], Dr. Kriti Agarwal[4], Dr. Vani Taneja[5], Dr. Pooja Palwankar[6]

[1]PG III, Department of periodontics and oral implantology,santosh dental college, ghaziabad.
[2]Proffessor department of Periodontics and Oral Implantology, Santosh Dental College, Ghaziabad.
[3]professor and HOD, Periodontics and Oral Implantology Santosh Dental College and Hospital, Ghaziabad
[4]Reader, Department of periodontics and oral Implantology, Santosh Dental College, Ghaziabad
[5]reader,Pedodontics and Preventive Dentistry Santosh Dental College and Hospital, Ghaziabad.
[6]MDS Periodontics and oral implantology, Santosh Dental College, Ghaziabad.

Corresponding author
Dr. Kumar Saurav Singh
Proffessor department of Periodontics and Oral Implantology,
Santosh Dental College, Ghaziabad,.

ABSTRACT Introduction: Regenerative periodontal therapy is the procedure for intrabony defect management. Although demineralized freeze-dried bone allograft (DFDBA) is frequently employed as an osteoconductive graft material, the selection of the barrier membrane plays an important role on the results of regeneration. As the placental chorion membranes supports the biological benefits including growth factors and qualities that promote the release of anti-inflammatory molecules that may improve healing and regeneration, collagen membranes serve as biocompatible, resorbable barriers that enable directed tissue regeneration. Cone-beam computed tomography (CBCT) provides precise evaluation of the defect morphology and regeneration results in three dimensions.

Aim: To determine the clinical and radiographic regenerative potential of Chorion and collagen membrane along with Demineralize Freeze Dried Bone Allograft with CBCT.

Materials and Methods: A CBCT based study was conducted on 10 patients with intrabony defects, aged 20-50 years, presenting to the Department of Periodontology, Santosh Dental college, Ghaziabad between February 2024 and September 2025. The study population included a major proportion of males with a mean age of 44.3 ± 7.2 years. Participants were randomly allocated into two groups: Group A received Open Flap Debridement (OFD) + Demineralized Freeze-dried Bone Allografts(DFDBA) + Collagen membrane, and Group B received Open Flap Debridement(OFD) + Demineralized Freeze-dried Bone Allografts (DFDBA) + Chorion membrane. CBCT was used to evaluate the width, depth and angle of the periodontal intrabony defect at baseline and 9 months post-operatively. Clinical parameters were studied at baseline, 6 months and 9 months and Haung's (2005) wound healing index was recorded at the 7th day post-operatively. Wilcoxon signed-ranked and Student's independent t-test were used for data analysis using SPSS version 26.0, with a significance threshold of $p \leq 0.05$.

Results: In this 9-month follow-up study, there was improvement in both the groups' clinical and radiological outcomes. Both groups showed a statistically significant increase in clinical attachment level (CAL) and decrease in pocket probing depth (PPD) within each group ($p < 0.001$). Intergroup comparison showed comparable clinical parameters and wound healing between the two groups, except for a significantly greater CAL gain in the chorion group at 9 months ($p = 0.008$). The radiographic regeneration results showed a significant decrease in defect width and depth and increase in defect angle within both groups, with no significant intergroup differences.

Conclusion: OFD with DFDBA using either chorion or collagen membrane produced significant and comparable regeneration of intrabony defects; the chorion membrane additionally showed a significantly greater gain in clinical attachment level at 9 months, while radiographic outcomes were statistically similar between the two membranes.

Running Title: Periodontal Intrabony defect regeneration with collagen, chorion and DFDBA

Keywords: Intrabony defects, demineralize freeze dried bone allograft, chorion membrane, defect angle, cone beam computed tomography.

How to cite this article: Divjot Kaur Narula1 Dr. Kumar Saurav Singh2 Dr. Kanishk Gupta3 Dr. Kriti Agarwal4 Dr. Vani Taneja5 Dr. Pooja Palwankar6. Comparative Efficacy of Chorion and Collagen Membranes with DFDBA in the Regeneration of Periodontal Intrabony Defects: A CBCT-Based Evaluation.. Int J Drug Deliv Technol. 2026;16(82s):870-876. DOI: 10.25258/ijddt.16.82s.95.

Introduction

Periodontal disease is a multifactorial disorder leading to gradual loss of tooth elements, such as is intrabony defects. These defects are classified as one-wall, two-wall or three-wall vertical bone defects, have varying regenerative potential, with three-wall defects showing the best results [2]. Autogenous grafts, xenografts, allografts, alloplasts, root surface bio-modification, biologically active chemicals, and guided tissue regeneration (GTR) are all widely utilized regenerative techniques. To enhance regeneration, GTR uses a barrier membrane to permit the selective reproduction of periodontal progenitor cells.

Extravesicular matrix proteins and growth-factors including Vascular Endothelial Growth Factor(VEGF) and Platelet Derived Growth Factor(PDGF) are abundantly present in chorion membranes, a placental extract and promote release of angiogenetic growth factors, proliferative mechanism, and anti-inflammatory action [3]. They also have a resorption times (8–12 weeks) [4], [5]. They are useful scaffolds for periodontal tissue formation because of their biological and structural stability.

DFDBA demonstrates a relatively rapid and variable resorption rate, primarily due to its demineralized nature, which facilitates osteoblastic activity and release of bone morphogenetic proteins[6]. Histologic and clinical studies have reported that DFDBA particles typically undergo partial to substantial resorption within 12-24 weeks, with concurrent replacement by newly formed bone, although the rate of resorption may vary depending on particle size, donor variability, and host factors[7].

Conventional radiography for example, two-dimensional techniques, may identify alveolar bone loss only when 30 - 50% of the bone has been destroyed.[11]When compared to typical two-dimensional imaging for artificial bone abnormalities, CBCT has a sensitivity of 80-100%, whereas intraoral radiographs have a sensitivity of 63-67%.[8]

Materials and methods

This split-mouth clinico-radiographic study involved screening 25 patients with intrabony periodontal defects, 10 systemically healthy patients fulfilling the inclusion and exclusion criteria were selected. The study was approved by the Institutional Ethical Committee of Santosh Dental College, Ghaziabad, Uttar Pradesh, India SU/2024/1349[14]. The study design based on the consort guidelines is mentioned in figure 1.

Inclusion criteria:

1. Participants 20-50 years
2. Probing pocket depths of 5–7 mm in mandibular molars in different quadrants
3. CBCT measurements of;

a) depth >3 mm (measured from CEJ to base of the defect)

b) width >2 mm (horizontal distance between the alveolar crest of two adjacent teeth)

c) defect angle >10°(measured from the CEJ of the affected tooth, base of the defect and alveolar crest of the adjacent tooth.)

Exclusion Criteria:

1. Past Antibiotic therapy
2. Periodontal surgery done in 3 month period
3. Pregnant women/ Lactating mother
4. Subjects who smoke
5. Endodontically treated teeth
6. Subjects with furcation defect
7. Subjects with loss of Cemento-enamel junction
8. History of allergy to the membrane(s)
9. Subjects not willing to give consent for the materials.

Study Procedure:

After screening of patients, oral prophylaxis was done, plaque index and the gingival index were brought to less than 1. Clinical and radiographic parameters were recorded (figure 2, figure 3, figure 4, figure 12, figure 13, figure 14); patients were randomly allocated into group A (figures 2-11) and group B (figures 12-22). The surgical procedure consisted of the application of local anesthesia, Lignocaine® (LOX 2% with adrenaline 1:200000) was injected. Sulcular incisions were given by the Kirkland method of Periodontal Flap Surgery. Mucoperiosteal flap was reflected with periosteal elevator, thorough debridement using area specific Gracey curettes®, (Hu-Friedy) was done (figure 5, figure 15). After visualizing the intrabony defect pre-suturing with 3-0 silk (LOTUS®) suture was done, DFDBA® (Tata Memorial Hospital, Mumbai) was mixed with a drop of saline and placed inside the defect area (figure 6, figure 16, figure 17). An 'H' shaped membrane, collagen membrane (Collaguide®) in the control group (figure 7) and chorion membrane® (Tata Memorial Hospital, Mumbai) in the test group (figure 18) was cut and placed over the DFDBA graft on both the buccal and lingual sites. Suture knot was placed after the membrane placement. (figure 8, figure 19) Patient was recalled for follow up after 7 days for suture removal and evaluation of the Haung healing index was done. Patient was recalled after 6 months for recording clinical parameters (figure 9, figure 20) and after 9 months for recording the radiographic parameters (figures 10,11,21,22). Oral hygiene maintenance was reinforced on every visit.

Statistical Analysis.

The data for this study was entered into Microsoft Excel 2007 and analyzed with the SPSS statistical program 23.0 Version. Descriptive statistics included frequency and percentage. Mean and Standard Deviation The level of significance for the current study was set at 5%. The Paired 't' test will be used for intragroup comparisons, whereas independent t tests will be used for intergroup comparisons. The data distribution was investigated using the Shapiro-Wilk test, and the variable homogeneity was explored using Levene's test.

Results

Intergroup Comparison of PPD and CAL

Pocket probing depth (PPD) decreased progressively in both groups over the study period, from 6.50 ± 0.85 mm (Control) and 6.60 ± 0.52 mm (Test) at baseline, to 3.50 ± 0.53 mm and 3.50 ± 0.71 mm respectively at 9 months. No statistically significant intergroup difference in PPD was found at any time point (all $p > 0.05$; Table 1).

Clinical attachment level (CAL) also improved in both groups, from 4.90 ± 0.32 mm (Control) and 4.90 ± 0.32 mm (Test) at baseline. At the 9-month follow-up, CAL was 3.50 ± 0.53 mm in the Control group versus 3.00 ± 0.00 mm in the Test group, a statistically significant difference favouring the Test group ($p = 0.008$; Table 1). No significant intergroup differences were seen at baseline, 1 month, or 6 months.

Table 1. Intergroup comparison of mean PPD and CAL scores between groups (n = 10/group)

Parameter	Control Mean ± SD	Test Mean ± SD	t-test p-value	Mann-Whitney p-value
PPD-Baseline	6.500 ± 0.850	6.600 ± 0.516	0.754	0.964
PPD-1 Month	5.400 ± 0.966	5.300 ± 0.675	0.791	0.808
PPD-6 Month	4.700 ± 0.483	4.500 ± 0.527	0.388	0.398
PPD-9 Month	3.500 ± 0.527	3.500 ± 0.707	1.000	0.863
CAL-Baseline	4.900 ± 0.316	4.900 ± 0.316	1.000	1.000
CAL-1 Month	3.800 ± 0.422	3.800 ± 0.632	1.000	0.962
CAL-6 Month	3.800 ± 0.422	3.800 ± 0.632	1.000	0.962

CAL-9 Month	3.500 ± 0.527	3.000 ± 0.000	0.008	0.014

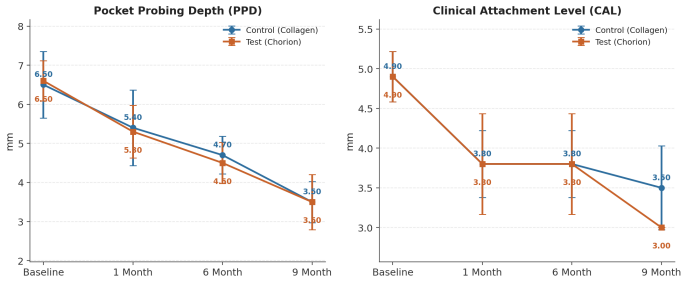

Figure 1. Mean PPD and CAL (± SD) over time, Control vs Test group.

Intergroup Comparison of GI, PI and WHI

Plaque index (PI) and gingival index (GI) scores dropped sharply in both groups after surgery and remained low and comparable between groups throughout follow-up (all $p > 0.05$), including at the 9-month time point (GI: Control = 1.100 ± 0.316, Test = 1.000 ± 0.000, p = 0.331; Table 2).

Wound healing (Huang's WHI, day 7) was slightly better in the Test group (1.00 ± 0.00) than Control (1.20 ± 0.42), but the difference was not statistically significant (p = 0.151; Table 2).

Table 2. Intergroup comparison of mean GI, PI and WHI scores between groups (n = 10/group)

Parameter	**Control Mean ± SD**	**Test Mean ± SD**	**t-test p-value**	**Mann-Whitney p-value**
GI-Baseline	2.100 ± 0.316	1.900 ± 0.316	0.174	0.192
GI-1 Month	1.000 ± 0.000	1.000 ± 0.000	NA	1.000
GI-6 Month	1.000 ± 0.000	1.000 ± 0.000	NA	1.000
GI-9 Month	1.100 ± 0.316	1.000 ± 0.000	0.331	0.368
PI-Baseline	2.000 ± 0.000	1.900 ± 0.316	0.331	0.368
PI-1 Month	1.000 ± 0.000	1.000 ± 0.000	NA	1.000
PI-6 Month	1.000 ± 0.000	1.000 ± 0.000	NA	1.000
PI-9 Month	1.000 ± 0.000	1.000 ± 0.000	NA	1.000
WHI-Baseline	1.900 ± 0.316	1.800 ± 0.422	0.556	0.583
WHI-7 Days	1.200 ± 0.422	1.000 ± 0.000	0.151	0.167

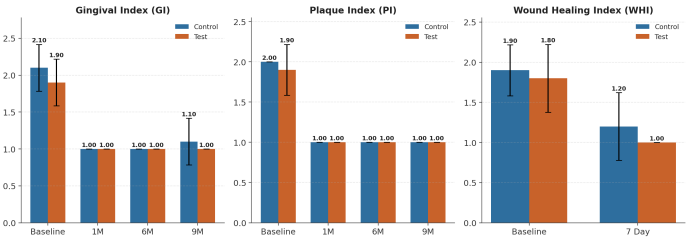

Figure 2. Mean GI, PI and WHI (± SD), Control vs Test group.

Intergroup Comparison of Radiographic Parameters

On CBCT, defect width decreased from baseline to 9 months in both groups, reaching 3.72 ± 1.42 mm (Control) and 3.44 ± 1.44 mm (Test) (p = 0.667). Defect depth similarly decreased to 4.22 ± 0.89 mm and 4.19 ± 0.89 mm respectively (p = 0.941). Defect angle increased in both groups, to 36.60° ± 8.99° (Control) and 36.89° ± 10.29° (Test) at 9 months (p = 0.947). None of the radiographic parameters differed significantly between the Control and Test groups at baseline or at 9 months (Table 3), indicating that both membranes supported comparable radiographic bone fill.

Table 3. Intergroup comparison of mean radiographic parameters between groups (n = 10/group)

Parameter	**Control Mean ± SD**	**Test Mean ± SD**	**t-test p-value**	**Mann-Whitney p-value**
Width of Defect-Baseline	4.450 ± 2.441	4.320 ± 2.411	0.906	0.850
Width of Defect-9 Month	3.720 ± 1.416	3.440 ± 1.443	0.667	0.288
Depth of Defect-Baseline	5.010 ± 1.114	5.180 ± 1.002	0.724	0.676
Depth of Defect-9 Month	4.220 ± 0.893	4.190 ± 0.888	0.941	0.761
Angle of Defect-Baseline	24.194 ± 7.202	24.871 ± 7.260	0.837	0.570
Angle of Defect-9 Month	36.602 ± 8.993	36.893 ± 10.292	0.947	0.677

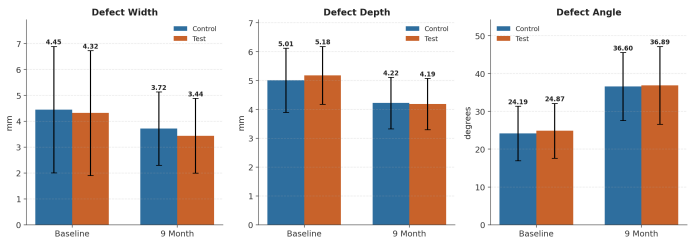

Figure 3. Radiographic defect width, depth and angle at baseline and 9 months, Control vs Test group.

Intragroup Comparison of Clinical and Radiographic Parameters

Within-group changes from baseline to the 9-month follow-up (7 days for WHI) were assessed using paired t-tests, with Wilcoxon signed-rank tests reported alongside for variables whose paired differences were non-normally distributed on Shapiro-Wilk testing.

Table 4. Intragroup comparison, baseline vs 9-month follow-up (baseline vs 7-day for WHI)

Group	**Parameter**	**Baseline Mean ± SD**	**Follow-up Mean ± SD**	**Paired t-test p-value**	**Wilcoxon p-value**
Control	PPD	6.500 ± 0.850	3.500 ± 0.527 (9	<0.001	0.002

			Month)		
Control	CAL	4.900 ± 0.316	3.500 ± 0.527 (9 Month)	<0.001	0.002
Control	GI	2.100 ± 0.316	1.100 ± 0.316 (9 Month)	<0.001	0.004
Control	PI	2.000 ± 0.000	1.000 ± 0.000 (9 Month)	<0.001	0.002
Control	WHI	1.900 ± 0.316	1.200 ± 0.422 (7 Day)	0.001	0.016
Test	PPD	6.600 ± 0.516	3.500 ± 0.707 (9 Month)	<0.001	0.002
Test	CAL	4.900 ± 0.316	3.000 ± 0.000 (9 Month)	<0.001	0.002
Test	GI	1.900 ± 0.316	1.000 ± 0.000 (9 Month)	<0.001	0.004
Test	PI	1.900 ± 0.316	1.000 ± 0.000 (9 Month)	<0.001	0.004
Test	WHI	1.800 ± 0.422	1.000 ± 0.000 (7 Day)	<0.001	0.008
Control	Width of Defect	4.450 ± 2.441	3.720 ± 1.416 (9 Month)	0.070	0.002
Control	Depth of Defect	5.010 ± 1.114	4.220 ± 0.893 (9 Month)	0.016	0.002
Control	Angle of Defect	24.194 ± 7.202	36.602 ± 8.993 (9 Month)	<0.001	0.002
Test	Width of Defect	4.320 ± 2.411	3.440 ± 1.443 (9 Month)	0.039	0.002
Test	Depth of Defect	5.180 ± 1.002	4.190 ± 0.888 (9 Month)	0.010	0.002
Test	Angle of Defect	24.871 ± 7.260	36.893 ± 10.292 (9 Month)	0.005	0.002

Every clinical and radiographic parameter improved significantly within both the Control and Test groups from baseline to follow-up (paired t-test and Wilcoxon signed-rank both $p < 0.05$ for nearly all comparisons), confirming that both regenerative protocols produced meaningful clinical and radiographic improvement over the 9-month study period. The one comparison where the parametric and non-parametric tests disagree is the Control group's change in defect width (paired t $p = 0.071$, not significant; Wilcoxon $p = 0.002$, significant) — given the non-normal distribution of the paired differences for this variable (Shapiro-Wilk $p < 0.001$), the Wilcoxon result is likely the more defensible one to report.

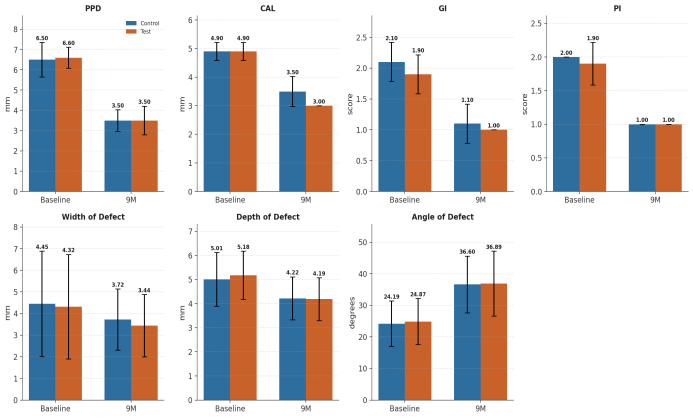

Figure 4. Baseline vs 9-month (or 7-day, WHI) values for each parameter, by group.

DISCUSSION:

This, split-mouth clinico-radiographic investigation compared

group A- DFDBA combined with collagen membrane (control group) to group B- DFDBA combined with a chorion membrane (test group) in managing periodontal intrabony defects. Split mouth approach was used to eliminate subject dependent confounding factors such as oral hygiene, systemic diseases, host reaction, which are known to impact periodontal wound healing.

From baseline to nine months, both treatment groups showed statistically significant decreases in PPD and increases in CAL, indicating effective inflammation resolution and periodontal attachment restoration. These results support the well-established theory that, when paired with appropriate plaque management and favorable defect morphology, regenerative surgical treatment enhances periodontal stability. Heitz-Mayfield and Lang stressed that when inflammation is successfully managed and supportive periodontal therapy is continued, periodontal surgical therapy produces consistent pocket reduction and attachment gain [9]. The importance of debridement and wound stabilization in fostering periodontal healing was also highlighted by Ramfjord et al., who observed a notable improvement in attachment after periodontal surgery [10].

Additionally, Cortellini and Tonetti showed that throughout the first year of healing, regenerative treatments carried out in confined intrabony defects exhibit increasing clinical improvement due to the stability of the blood clot and the maturation of newly generated connective tissue connection. Thus, the study also follows the regeneration concept. [11]

PPD decrease were similar in the two groups, according to intergroup comparison; however, at nine months, a statistically significant CAL gain in favor of the test group was noted. Increased attachment acquisition might be a sign of better regenerative component stability and positive periodontal tissue development.

Sculean et al. mentions that use of regenerative materials along with OFD produced better attachment gain in intrabony lesions than traditional surgical methods [12].

Needleman et al.'s systematic analyses have indicated that while regenerative biomaterials enhance clinical outcomes, surgical technique, defect containment, and patient-related factors may have a greater impact on regenerative success [13]. Significant reduction in PPD was achieved because oral hygiene instructions were reinforced at every follow up visit [14].

Highly significant results were seen in the reduction and maintance of plaque index and gingival index. Löe in 1967 established that, plaque management is a crucial factor in determining periodontal health by demonstrating the direct correlation between gingival inflammation and plaque buildup [15].

Early wound healing evaluation revealed significant improvement in WHI scores at seven days in both treatment modalities, indicating satisfactory soft tissue healing and early tissue stability. Early clot stabilization and rapid vascularization are fundamental prerequisites for successful regeneration, as a stable wound closure prevents epithelial downgrowth and facilitates periodontal ligament cell repopulation.[16]

In both treatment groups, radiographic examination showed improvement in defect angle and statistically significant intragroup decreases in defect width and depth. After regenerative treatment, these morphological alterations show increasing bone fill and hard tissue remodeling.

The substantial intragroup improvements seen in the current study are corroborated by Sculean et al.'s finding of quantifiable radiographic bone growth in treated intrabony defects [12].

The arrangement of intrabony defects and their potential for regeneration are reflected in the defect angle, a crucial morphological characteristic.

In the Test group, the mean defect angle increased from 24.87° ± 7.26° at baseline to 36.89° ± 10.29° at 9 months, and in the Control group from 24.19° ± 7.20° to 36.60° ± 8.99°, representing a comparable and substantial conversion to a wider, more stable defect configuration in both groups. Intergroup analysis did not show a statistically significant difference in defect angle at 9 months (36.89° ± 10.29° vs 36.60° ± 8.99°; $p = 0.947$), indicating that the two regenerative protocols produced a similar degree of morphological improvement in defect angle.

Certain studies done by Cortellini P in 2015 concluded that the best regeneration of intrabony defects is achieved in angles less than 33º [17]. The study found that both groups saw a substantial increase in defect angle from baseline to 9 months ($p < 0.001$ for the Control group and $p = 0.005$ for the Test group), suggesting effective remodelling of defect architecture. In the present study, both the baseline and 9-month mean defect angles exceeded this threshold in each group, and the extent of improvement was statistically comparable between the two membranes ($p = 0.947$).

The biologically active nature of the chorion membrane may still confer a soft-tissue advantage, as reflected in the significantly greater CAL gain observed in the Test group, even though this did not translate into a statistically distinguishable radiographic advantage in defect angle, width, or depth within this small sample. The persistent release of growth factors from the chorion membrane is thought to encourage osteoblastic differentiation and vascular ingrowth across the defect, which could contribute to more uniform bone repair if confirmed in a larger sample [17].

Supporting this, Tsitoura et al. demonstrated that biologically active membranes produce more favorable changes in defect angle compared to passive barriers [18] In both the test and control groups, the current study showed a statistically significant decrease in defect width from baseline to nine months, suggesting positive lateral bone fill after regenerative treatment.

Laurell et al. observed similar results, showing a considerable decrease in intrabony defect size and vertical defect fill on radiography after regenerative periodontal surgery. [19].

However, inconsistent results have been observed. Minabe et al. discovered that when collagen membranes were employed with bone grafts, they reduced defect width in the same way as biologic membranes did. This implies that, while chorion membranes may promote bone development, collagen membranes can still provide adequate space and wound stability for bone regeneration. [20]

This study implies that the chorion membrane increased DFDBA's osteogenic response, resulting in better vertical bone fill. DFDBA is known to have osteoinductive qualities because

it contains bone morphogenetic proteins (BMPs), which encourage the differentiation of mesenchymal stem cells into osteoblasts [21].

By obstructive inflammatory cytokines and matrix metalloproteinases (MMPs), chorion membranes have inherent anti-inflammatory and anti-scarring qualities. This results in a low-catabolic environment that promotes osteogenesis instead of fibrous tissue healing, which indicates a decrease in the measurement of vertical defects [22].

Overall, the improved outcomes shown with the chorion membrane may be attributed to its physiologically active matrix, which encourages periodontal regeneration beyond simple barrier function.

This is in line with the widespread belief that membranes with natural growth factors and structural integrity may improve the predictability of regeneration. [23]

Limitations:

The statistical power and generalizability of the results are hindered by the small number of patients (n = 10) in the study. The study did not include any histologic or microbiologic analysis of the biologically active membrane to judge the regeneration.

CONCLUSION

Both DFDBA with collagen membrane and DFDBA with chorion membrane produced statistically significant and clinically meaningful within-group improvement in all clinical (PPD, CAL, GI, PI, WHI) and radiographic (defect width, depth, angle) parameters over the 9-month follow-up. On intergroup comparison, the two membranes performed comparably for pocket depth, plaque and gingival scores, wound healing, and all radiographic parameters; the chorion membrane group showed one additional, statistically significant benefit — a greater gain in clinical attachment level (CAL) at 9 months. These findings suggest that DFDBA with chorion membrane is at least as effective as, and in terms of attachment gain potentially more effective than, DFDBA with collagen membrane for the regeneration of periodontal intrabony defects, while both approaches produced broadly equivalent radiographic bone fill in this study.

Ethical statement This study was conducted with the approval of Ethical Committee of Santosh Dental college & Hospital, Ghaziabad, Uttar Pradesh, India (SU/2024/1349[14])

Conflicts of interest

The authors have no potential conflicts of interest to report.

Funding

Nil

Data Availability Statements

All authors gave approval for the data in this study to be available

REFRENCES

1. Siaili M, Chatzopoulou D, Gillam DG. An overview of periodontal regenerative procedures for the general dental practitioner. Saudi Dent J. 2018;30(1):26–37

2. Goldman, H.M. and Cohen, D.W. (1958) The Infrabony Pocket: Classification and Treatment. Journal of Periodontology, 29, 272.

3. Rothamel D, Schwarz F, Sager M, Herten M, Sculean A, Becker J. Biodegradation of differently cross-linked collagen membranes: An experimental study in the rat. Clin Oral Implants Res. 2005;16(3):369–378.

4. Parolini O, Alviano F, Bagnara GP, et al. Concise review: Isolation and characterization of cells from human term placenta: Outcome of the first International Workshop on Placenta-Derived Stem Cells. Stem Cells. 2008;26(2):300–311

5. Koob TJ, Lim JJ, Massee M, Zabek N, Denozière G. Properties of dehydrated human amnion/chorion composite grafts: Implications for wound repair and soft tissue regeneration. J Biomed Mater Res B Appl Biomater. 2014;102(6):1353–1362

6. Urist MR. Bone: formation by autoinduction. Science. 1965;150(3698):893–899.

7. Becker W, Becker BE, Caffesse R, et al. A longitudinal study comparing autogenous bone grafts and demineralized freeze-dried bone allografts in periodontal defects. J Periodontol. 1994;65(10):998–1005.)

8. Misch KA, Yi ES, Sarment DP. Accuracy of cone beam computed tomography for periodontal defect measurements. J Periodontol. 2006;77(7):1261–1266

9. Heitz-Mayfield LJA, Lang NP. Surgical and nonsurgical periodontal therapy. Learned and unlearned concepts. Periodontol 2000. 2013;62(1):218-231.

10. Ramfjord SP, Nissle RR, Shick RA, Cooper H Jr. Subgingival curettage versus surgical elimination of periodontal pockets. J Periodontol. 1968;39(3):167-175

11. Cortellini P, Tonetti MS. Clinical concepts for regenerative therapy in intrabony defects. Periodontol 2000. 2015;68(1):282-307

12. Sculean A, Nikolidakis D, Schwarz F. Regeneration of periodontal tissues: combinations of barrier membranes and grafting materials - biological foundation and preclinical evidence: a systematic review. J Clin Periodontol. 2008;35(8 Suppl):106-116.

13. Needleman IG, Worthington HV, Giedrys-Leeper E, Tucker RJ. Guided tissue regeneration for periodontal infra-bony defects. Cochrane Database Syst Rev. 2006;(2):CD001724. Published 2006 Apr 19

14. Ningombam A, Palwankar P, Dhalla N, Goyal A, Pandey R. Comparative estimation of C-terminal cross-linked telopeptide of type I collagen levels in gingival crevicular fluid in diabetic and nondiabetic patients with chronic periodontitis: A prospective clinical study. J Int Oral Health. 2023;15(5):463-468

15. Löe H. The Gingival Index, the Plaque Index and the Retention Index Systems. J Periodontol. 1967;38(6):610-616

16. Cho YD, Kim KH, Lee YM, Ku Y, Seol YJ. Periodontal Wound Healing and Tissue Regeneration: A Narrative Review. Pharmaceuticals (Basel). 2021;14(5):456. Published 2021 May 12.

17. Cortellini P, Tonetti MS. Clinical concepts for regenerative therapy in intrabony defects. Periodontol 2000. 2015;65(1):285–317.

18. Tsitoura E, Tucker R, Suvan J, Laurell L, Cortellini P, Tonetti M. Baseline radiographic defect angle of the intrabony defect as a prognostic indicator in regenerative periodontal surgery with enamel matrix derivative. J Clin Periodontol. 2004;31(8):643–647

19. Niknejad H, Peirovi H, Jorjani M, Ahmadiani A, Ghanavi J, Seifalian AM. Properties of the amniotic membrane

for potential use in tissue engineering. **Eur Cell Mater.** 2008;15:88–99.

20. Minabe M, Kodama T, Kogou T, et al. A comparative study of combined treatment with a collagen membrane and enamel matrix proteins for the regeneration of intraosseous defects. Int J Periodontics Restorative Dent. 2002;22(6):595-60

21. Urist MR. Bone: formation by autoinduction. Science. 1965;150(3698):893-899.

22. Gupta SJ, Kothiwale SV, Anuroopa P, Gajiwala AL. Chorion versus collagen membrane in intrabony defects. J Indian Soc Periodontol. 2022;26(4):312–319

23. Narula D, Palwankar P, Gupta K, Aggarwal K, Priyadarshini, Periodontal Regeneration in Mandibular Intrabony defects using DFDBA with chorion membrane vrs DFDBA with collagen membrane and I-PRF augmentation in mandibular supra-bony defects: A Split Mouth Case Report. A Journal of Clinical Dentistry-Heal Talk, 18(02), 55–59.