

Management of Grade II Furcation Defect in Mandibular Molars with Allograft and Alloplastic Bone Graft: A Clinico- Radiographic Study

Teh Chai Liu^{1*}, Gopinath Vivekanandan², Karthik Krishna M³, Samarpita Nanda⁴, Nida Sultana⁵ and Smriti Gupta⁶

Abstract

Aim: The present study was carried out to compare clinically and radiographically the efficacy of regenerative potential of Demineralized freeze-dried bone allograft (DFDBA) and Bioactive glass putty (Novabone® dental putty) in mandibular grade II furcation defects.

Methods: In 34 Patients, 60 mandibular grade II furcation defects were treated using DFDBA and Bioactive glass putty. 30 furcations were treated using DFDBA, while bioactive glass putty was used to treat remaining 30 furcation defect. Clinical parameters evaluated were Plaque index (PI), Gingival index (GI), Probing pocket depth (PPD), Relative vertical attachment level (RVAL), Relative horizontal attachment level (RHAL) at baseline, 3 months and 6 months. Radiographic parameters recorded were linear measurement of defect depth and bone density in gray scale at baseline and 6 months.

Results: Both the group showed significant reduction in mean ($P \leq 0.05$) GI, PI, PPD, RVAL and RHAL at 6 months. Group I showed greater reduction in PPD. Radiographic evaluation showed significant ($P \leq 0.05$) reduction in defect depth and increase in bone density in both groups.

Conclusions: Bioactive glass putty showed comparable regeneration to that of DFDBA in the treatment of mandibular grade II furcation defect. Additional putty consistency of bioactive glass makes it easier and more convenient to use.

Keywords: Grade II furcation defect; demineralized freeze-dried bone allograft.

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¹Senior Lecturer, Rungta College of Dental Sciences and Research, Bhilai, Chhattisgarh, India

²Professor and Head of Department, Aditya Dental College and hospital, Beed, Maharashtra, India

³Professor and Head of Department, Dean, Rungta College of Dental Sciences and Research, Bhilai, Chhattisgarh, India

⁴MDS, Department of periodontology, Rungta College of Dental Sciences and Research, Bhilai, Chhattisgarh, India

⁵MDS, Department of periodontology, Rungta College of Dental Sciences and Research, Bhilai, Chhattisgarh, India

⁶MDS, Department of periodontology, Rungta College of Dental Sciences and Research, Bhilai, Chhattisgarh, India

*Corresponding Author: Teh Chai Liu, Senior Lecturer, Rungta College of Dental Sciences and Research, Bhilai, Chhattisgarh, India.

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Introduction

Periodontal diseases are amongst the most prevalent diseases worldwide and are the major cause of tooth morbidity and mortality. Periodontitis is a disease of the periodontium characterized by irreversible loss of connective tissue attachment and supporting alveolar bone. These changes often lead to an aesthetically and functionally compromised dentition [1]. According to osseous defects caused by periodontal disease can be interproximal craters, inconsistent margins, hemisepta, furca invasions, intrabony defects and combination of those defects [2].

Once the periodontal disease progresses, bone destruction extends to the furcation of multi-rooted teeth to cause furcation involvement. The complexity of furcation morphology often causes difficulty in the treatment of such defects. Routine home care measures and periodontal procedures may not be sufficient enough to keep the furcation area free of local factors and therefore specialized procedures are required [3,4].

Choice of therapy depends on degree of furcation involvement. Grade I furcation may be managed by scaling and root planning alone, whereas Grade II furcation may warrant the use of regenerative techniques, which would considerably re-establish and regenerate the supporting periodontal tissues that were damaged and destroyed during the course of periodontal disease [5].

Teeth with furcation defects are prone to periodontal disease and have less favourable prognosis due to their morphology that

limits care and interferes with accessibility for adequate subgingival scaling. Thus, the treatment of furcation defects is a challenge in clinical periodontics [6]. Conventional treatment approach to arrest the disease by debriding the root surfaces with either non-surgical or surgical modality had limited success [1].

Filling of the furcation defects with various types of bone grafts is one of the most widely employed techniques aimed at restoring the lost periodontal attachment apparatus. The use of intraoral or extraoral autografts and demineralised freeze-dried bone allograft (DFDBA) may not only lead to clinical improvements in terms of probing depth (PD) reductions and gains of clinical attachment, but also histologically by the formation of a new connective tissue attachment and new alveolar bone [7].

Natural and synthetic versions of bone graft have been used for treatment of periodontal defects. The synthetic bone substitutes i.e., alloplasts have numerous advantages like, unlimited availability, storage potential, no risk of disease transmission and no need for second surgical site. Novabone putty is a bioactive synthetic calcium phosphosilicate bone graft material with osteoconductive and osteostimulative properties that can accelerate the bone regeneration. Novabone dental putty is built from a bioactive glass platform as a successor calcium phosphosilicate bone material with supplements like polyethylene glycol and glycerine to improve handling and efficacy. On placement, the binder is absorbed and permits cell infiltration between the bioglass particles. The particles are slowly absorbed and replaced by new bone tissue [8].

Till date there is limited literature available on the use of this bioactive glass putty for the treatment of class II furcation defects, which captivated us to study this particular material. The present study was undertaken to clinically and radiographically evaluate the efficacy of novabone putty and DFDBA bone replacement graft in the regeneration of Grade II furcation involvement.

Materials And Methods

Thirty-four patients (age range of 25-55 years and mean age 41.8 ± 10.3 years) with moderate to advanced chronic periodontitis were selected from the outpatient department of Periodontology, Rungta College of Dental Sciences and Research, Bhilai, Chhattisgarh (Figure 1). Each patient exhibited at least one buccal or lingual grade II furcation defect in mandibular molars [9]. Orthopantomogram and

radiovisiography were taken to confirm the presence of suitable furcation defects for the selection of patient. The inclusion criteria were presence of mandibular grade II furcation defect in systemically healthy patients, who had not received any periodontal therapy for past 6 months. Patients with present or past systemic illness such as diabetes mellitus, cardiac disease, patients taking medication that are known to interfere with periodontal wound healing, patients allergic to medication, patients who were pregnant or lactating, patients using tobacco in any form and those showing unacceptable oral hygiene maintenance after phase I therapy were excluded from the study. Written informed consent was obtained from the short-listed study subjects. Ethical clearance was received from the institutional research committee.

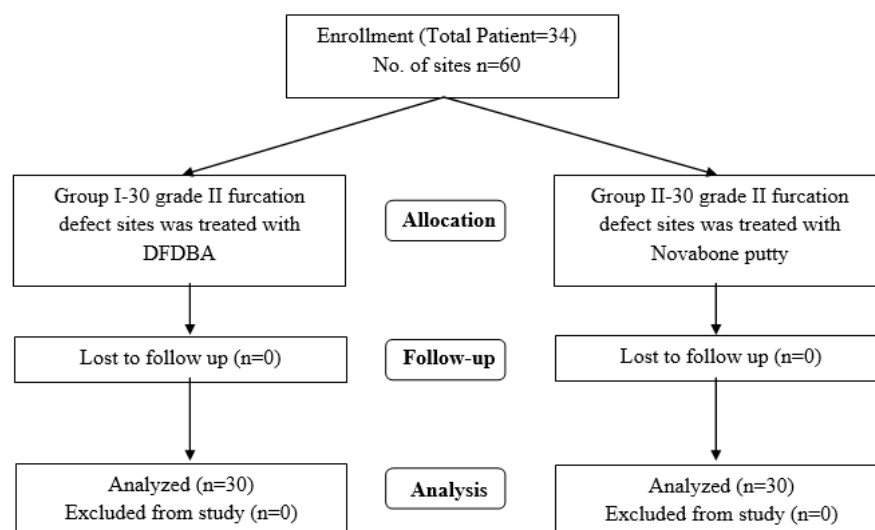


Figure 1: Flowchart of the study.

Presurgical procedure

Full mouth supra gingival and subgingival scaling and root planning was carried out in all the selected patients. Detailed instruction about regular plaque control

measure was given. 6 to 8 weeks following phase I therapy periodontal evaluation was performed to confirm the suitability of the sites for the study [10]. The selected sites were randomly divided into group I and

group II according to the type of treatment rendered to them at an interval of 1 week. Group I consisted of 30 mandibular grade II furcation defects treated using open flap debridement with DFDBA (TATA memorial tissue bank, Mumbai, India). Group II consisted of 30 mandibular grade II furcation defects treated using open flap debridement with Bioactive glass putty (Novabone putty®, Alachua, Florida, USA).

Surgical Procedure

Following administration of local anaesthesia, buccal and lingual crevicular incisions were made and mucoperiosteal flap was elevated, taking care to preserve the interproximal soft tissue. Meticulous defect debridement and root planning was

carried out using curettes. Pre suturing was done to avoid displacement of the graft. In group I the defect was treated using DFDBA granules which were condensed slightly until the defect was filled (Figure 2), while in group II Novabone putty was placed into the defect and condensed slightly (Figure 3).

The mucoperiosteal flaps were repositioned and secured in place using 3-0 non-resorbable sutures. The area was protected using periodontal dressing. (Coe-Pak, GC, America). Systemic antibiotics (amoxicillin 500mg every 8 hours for 5 days), analgesics and anti-inflammatory drugs were prescribed. 0.2% chlorhexidine rinse was prescribed for 2 weeks [11]. Single operator performed all the surgical procedures.

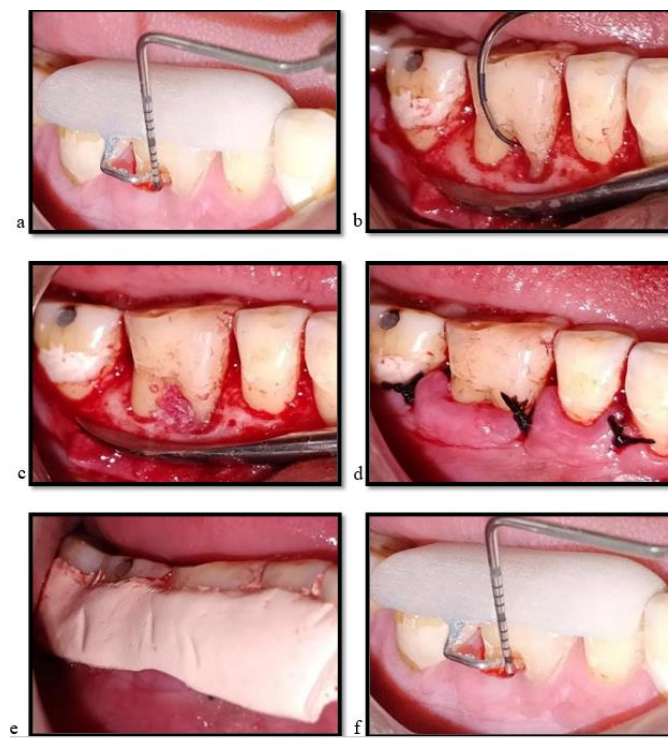


Figure 2: (a) Pre-operative image of a mandibular right first molar with a stent showing relative vertical probing depth of 7 mm. (b) Full thickness mucoperiosteal flap reflected and Nabers probe showing grade II furcation defect. (c) DFDBA placed into the defect. (d) Flap repositioned and sutured using 3-0 non-resorbable suture. (e) Periodontal dressing Coe-Pak placed. (f) Post- operative image showing relative vertical probing depth of 5 mm after 6 months.

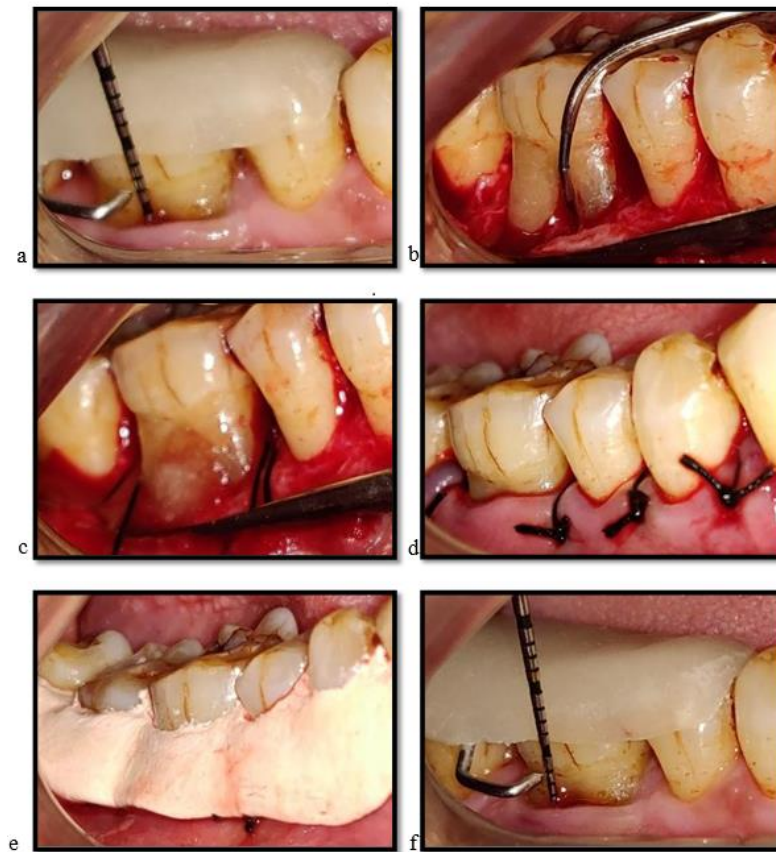


Figure 3: (a) Pre-operative image of a mandibular right first molar with a stent showing relative vertical probing depth of 6 mm. (b) Full thickness mucoperiosteal flap reflected and Nabers probe showing grade II furcation defect. (c) Novabone putty placed into the defect. (d) Flap repositioned and sutured using 3-0 non-resorbable suture. (e) Periodontal dressing Coe-Pak placed. (f) Post-operative image showing relative vertical probing depth of 4 mm after 6 months.

Post Operative Care

After 10-12 days of surgery, periodontal dressing and sutures were removed. After cleaning the wound with 0.2% chlorhexidine, and patients were instructed to rinse with 0.2% chlorhexidine for another week.

There after gentle brushing with a soft brush was recommended. Patients were examined weekly for one month then at 3- and 6-months clinical parameters were recorded. At each visit oral hygiene instructions were reinforced.

Clinical measurements

Customized acrylic stent with 20 gauge orthodontic wire incorporated in it were fabricated and stored on the study cast to ensure a reproducible placement of the probe. The clinical parameters used for assessment at baseline, 3 months and 6 months after surgical procedures: Plaque index, Gingival index, Probing pocket depth (PPD): measured from the crest of the gingival margin to base of the pocket (BOP) using a UNC-15 probe, Relative vertical attachment level (RVAL): measured from a fixed reference point on acrylic stent to the base of the pocket using UNC-15 probe,

Horizontal furcation depth was measured at the furcation fornix using a Nabers probe (Q₂N, Hu-Friedy) and recorded as relative horizontal attachment level (RHAL) [12,13].

Radiographic measurements

The radiographic parameters used for assess changes in furcation defect at baseline and 6-month post-surgery were:

1. Defect depth (calculated as linear measurement from the furcation fornix to base of the defect),

2. Bone density (measured in gray scale levels) using image J software [14].

Digital Radiovisiography (RVG) was taken for all the sites at baseline and at 6 months post-surgery. Radiographs were standardized by using paralleling technique. The interpretation of radiographs was carried out by means of Kodak dental imaging software. The distance was then measured in millimetres (mm) using a measuring tool (Figure 4).

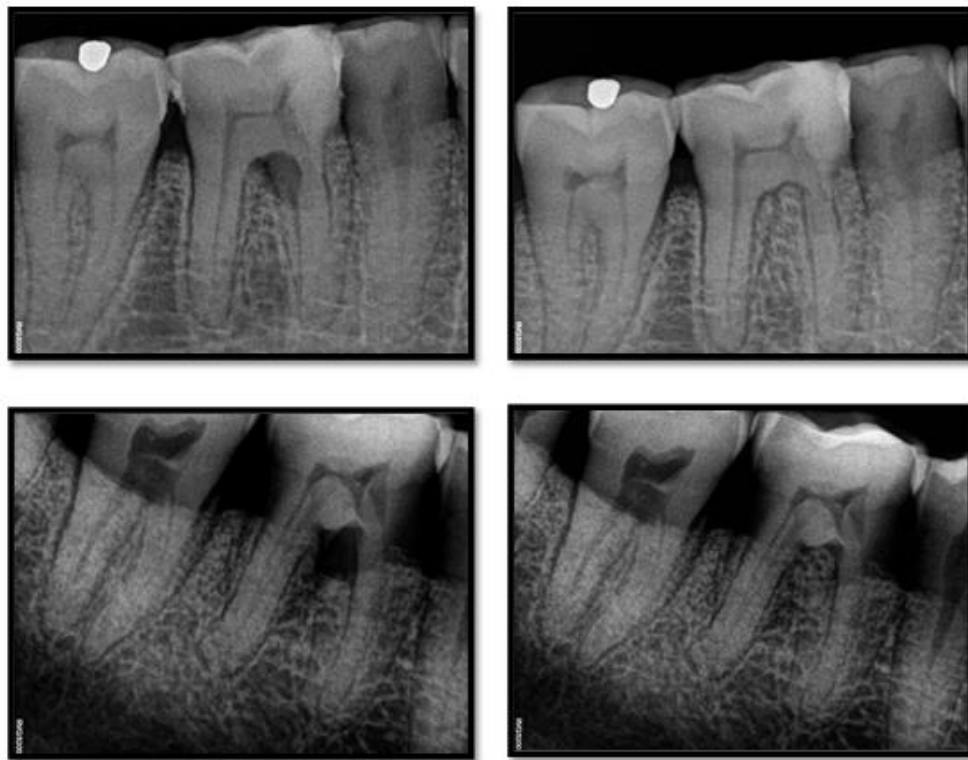


Figure 4: (a) Pre-operative image of a mandibular right first molar. (b) 6 months post-operative image after treatment with DFDBA. (c) Pre-operative image of a mandibular right first molar. (d) 6 months post-operative after treatment with Novabone putty.

Statistical Analysis

The data obtained was subjected to statistical analysis using Statistical Package for the Social Sciences (SPSS) version 19.0 for windows. Descriptive statistics and

following statistical tests was applied: The data for each parameter was analysed for difference by use of One-way Analysis of Variance (ANOVA) to determine mean differences, Tukey's post-hoc test was performed for intragroup comparisons at

different time intervals. Intergroup comparison was done using independent sample 't' test.

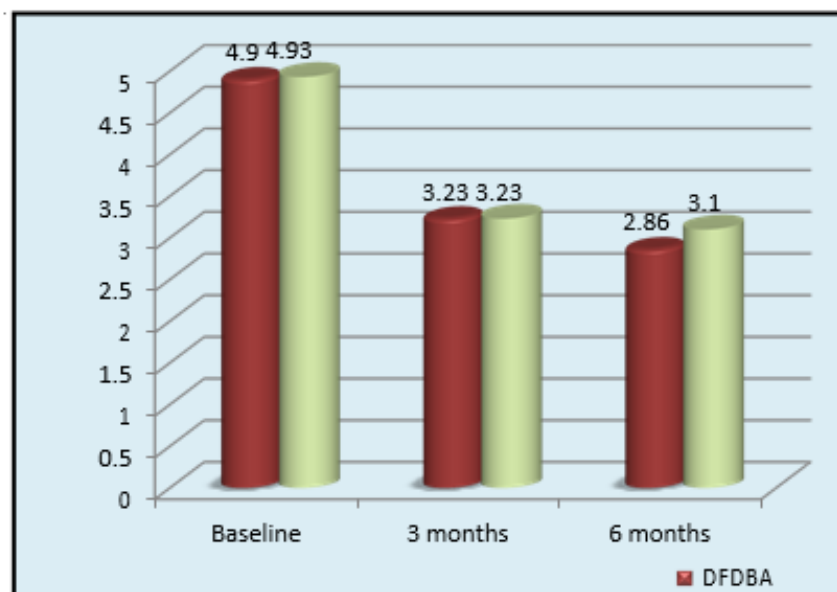
Results

All patients treated according to the study protocol were monitored for the complete study period. No drop-outs were encountered.

Statistical test using ANOVA showed significant differences in PI and GI levels when baseline values were compared to 6 months in both the groups. Both the groups showed a significant difference in PPD when baseline values were compared with 3 and 6 months post operative scores using ANOVA (Table 1). However, group I (DFDBA) showed a greater reduction in PPD (Graph 1).

	Group I			Group II		
	PI	GI	PPD	PI	GI	PPD
Baseline	2.18 ± 0.228	2.04 ± 0.190	4.90 ± 1.12	2.41 ± 0.209	2.02 ± 0.271	4.93 ± 0.78
3 months	1.40 ± 0.217	0.98 ± 0.193	3.23 ± 0.43	1.44 ± 0.184	0.95 ± 0.221	3.23 ± 0.43
6 months	0.70 ± 0.129	0.57 ± 0.103	2.86 ± 0.34	0.68 ± 0.111	0.59 ± 0.119	3.10 ± 0.48
f value	240.413	424.436	67.32	424.436	347.735	91.101
P value	0.001	0.001	0.001	0.001	0.001	0.001
	H.S	H.S	H.S	H.S	H.S	H.S

Table 1: Mean comparison of PI, GI, PPD at Baseline, 3 months and 6 months in group I and group II. Statistical test: ANOVA; (p<0.05 significant, CI=95%), H.S-Highly Significant



Graph 1: Comparison of mean PPD between group I and group II at baseline, 3 months and 6 months.

The clinical parameters of these defects are given in Table 2. A statistically significant ($P \leq 0.05$) gain in RVAL as well as RHAL was observed in grade II furcation defects of both groups. On Intragroup comparison

(Table 3) a statistically significant change in furcation defect was observed from baseline to 6 months, whereas no statistically significant difference was observed between 3 and 6 months.

	Group I		Group II	
	RVAL	RHAL	RVAL	RHAL
Baseline	6.56 ± 1.22	7.50 ± 1.33	6.56 ± 1.45	7.60 ± 1.49
3 months	4.80 ± 1.03	5.20 ± 1.12	4.80 ± 1.24	5.13 ± 1.05
6 months	4.26 ± 0.86	4.90 ± 1.18	4.50 ± 1.33	4.73 ± 1.14
f value	39.388	40.937	20.643	40.19
P value	0.001	0.001	0.001	0.001
	H.S	H.S	H.S	H.S

Table 2: Mean RVAL and RHAL at Baseline, 3 months and 6 months in group I and group II.
Statistical test: ANOVA; (p<0.05-significant, CI=95%), H.S-Highly Significant.

	Group I				Group II			
	RVAL		RHAL		RVAL		RHAL	
Intragroup comparison	Mean difference	p-value	Mean difference	p-value	Mean difference	p-value	Mean difference	p-value
Baseline – 3 months	1.766 ± 0.19mm	0.001 H.S	2.30 ± 0.21mm	0.001 H.S	1.76 ± 0.21mm	0.001	2.466 ± 0.44mm	0.001 H.S
Baseline – 6 months	2.300 ± 0.36mm	0.001 H.S	2.60 ± 0.15mm	0.001 H.S	2.06 ± 0.12mm	0.001	2.866 ± 0.35mm	0.001 H.S
3 months- 6 months	0.533 ± 0.17mm	0.127 N.S	0.30 ± 0.06mm	0.608 N.S	0.30 ± 0.09mm	0.654 N.S	0.400 ± 0.09mm	0.45 N.S

Table 3: Mean difference in RVAL and RHAL in group I and II at different time intervals.
Statistical test: Tukey's post-hoc test; (p<0.05-significant, CI=95%), H.S-Highly Significant, N.S- not significant.

There were no differences in initial defect depth radiographically between the two groups Table 4. Average defect fills in group I was 1.78 ± 0.41 mm at 6 months while group II demonstrated 1.73 ± 0.32 mm at 6 months. Similarly, no difference was observed in bone density (gray scale) between to two

groups initially. There was increase in bone density of 47.65 ± 6.2 and 46.88 ± 1.35 in group I and group II respectively at 6 months. Statistical findings revealed similar results between two groups. But a statistically significant result can be seen in defect fill and bone density between two groups at 6 months.

	Group I (DFDBA)		Group II (Novabone putty)	
	Defect depth	Bone density	Defect depth	Bone density
Baseline	2.36 ± 0.69	33.06 ± 17.15	2.41 ± 0.59	33.49 ± 17.82
6 months	0.57 ± 0.28	80.72 ± 23.35	0.68 ± 0.27	80.37 ± 19.17
Change	1.783 ± 0.41 mm	47.65 ± 6.2	1.733 ± 0.32 mm	46.88 ± 1.35
P-value	0.001 H.S	0.001 H.S	0.001 H.S	0.001 H.S

Table 4: Mean comparison of radiographic defect depth and radiographic bone density at Baseline, 3 months and 6 months in group I and group II. Statistical test: Independent Sample t test; (p<0.05-significant, CI=95%), H.S-Highly Significant, N.S-Not significant.

Discussion

Grade I furcations are usually managed with routine periodontal procedures while grade III furcation have to be treated using more extensive therapy such as tunneling, root amputation, hemi section or extraction [15]. Grade II furcations found more commonly has perplexed clinicians for many years [15-17]. Several techniques have been proposed and promoted to treat and improve the prognosis of mandibular grade II furcation defects.

Demineralized freeze-dried bone allograft (DFDBA) has been used in periodontal therapy for more than 2 decades [18]. DFDBA provides osteoconductive surface and in addition it also acts as a source of osteoinductive factors [19]. Healing following the use of DFDBA follows a highly regulated cascade of events, ultimately resulting in cellular migration, differentiation and synthesis of bone. Although the precise origin of these progenitor cells remains unknown, it is clear that they have capacity to migrate and differentiate into synthetically specialized cell type in response to signals, such as bone morphogenic proteins present within DFDBA [20].

Particle size also surfaces to be an important variable for the success DFDBA as a bone inductive material. Particles in the range of 125 to 1000µm possess a higher osteogenic potential than do particles below 125 microns [21]. In view of this, our study used DFDBA with particle size having a range of 500 – 1040µm.

As there are extensive literature available reporting statistically significant results in

favor of bone replacement grafts as compared to non-graft site, our study excluded non-graft site as control [22,23].

The most important outcome of periodontal procedure, including periodontal regeneration is reduction in probing pocket depth because it directly affects the ability of a clinician to maintain a treated site [24].

Significant reduction of PPD was found when comparing baseline values to 6 months post treatment results in DFDBA and novabone putty groups. However, DFDBA group showed a greater reduction in PPD compared to novabone putty group. Wallace SC, et al. in his study using ePTFE with and without DFDBA found that there was significant reduction in probing depths [25]. Guillemin, et al. reported that DFDBA alone and DFDBA with ePTFE, resulted in reduction in probing depths [26]. However, there was no significant difference in probing depths between the groups. Alternatively, Anderegg, et al. observed reduction in probing depth of 3.27mm at 6 months with bioactive glass particulate bone replacement graft in mandibular class II furcation defects [27]. Changes in probing depth are also not specific to periodontitis since they may just reflect changes in the inflammatory status of the periodontal tissues, and therefore may not represent the best clinical outcome measurement to evaluate success after regenerative surgery [28].

Clinical attachment levels using a fixed reference point (such as the cemento-enamel junction) reflect more clearly the histological status of the tooth's attachment apparatus and are widely accepted as one of the primary clinical outcomes to evaluate success after regenerative surgery. A near

perfect correlation between the gain in clinical attachment level and bone height has been observed by Tonetti, et al. [29]. For outcomes relating to clinical regeneration of furcation treated site (Yukna CN, et al., Eickholz P, et al. reported that it is necessary to measure attachment gain in both vertical and horizontal direction [30,31].

In our study, both group I (DFDBA) and group II (Novabone) have resulted in significant gain in relative vertical attachment level of 2.300 ± 0.36 mm and 2.06 ± 0.012 mm at 6 months. However intergroup comparison of vertical attachment level was found to be non-significant. Anderegg, et al. found significant gain in vertical attachment level of 3.1mm and 1.4mm using PTFE and DFDBA and ePTFE alone respectively [27]. Leonardis, et al. observed gain in vertical attachment level of 5.9mm and 5.6mm using GTR alone and GTR with DFDBA respectively at 12 months [32]. However, there was no significant difference between the groups when evaluated at 12 months.

In the present study the mean gain of RHAL amounted to 2.60 ± 0.15 mm and 2.866 ± 0.35 mm at 6 months in group I (DFDBA) and group II (Novabone) respectively. Intergroup comparison showed no significant difference between the groups. Luepke, et al. found decrease in horizontal furcation depth of 1.13 ± 1.08 and 1.70 ± 1.22 at 6 months with barrier alone and barrier with DFDBA respectively [33].

Yukna, et al. from their study using bioactive glass bone replacement graft material and ePTFE barrier material showed that both treatments gained about 0.3 to 0.4 mm of vertical clinical probing attachment

level and 1.3 to 1.5mm of horizontal clinical probing attachment level [30]. However, comparison with other studies is difficult to make because of a number of differences in study design (manual/pressure sensitive probes, probing forces, blinded evaluation or not, difference in original defect depth, parameters investigated, etc.) as well as the way the results are reported. Complete closure of the furcation could not be achieved in any of the sites in our study; inconsistency of complete closure is also reported by Becker, et al., Machtei and Schallhor; Evans, et al. [16, 34,35]

Defect fill is a desirable outcome of any periodontal regenerative therapy. Kothiwale SV, et al. radiographically calculated defect fill by linear measurement from furcation fornix to base of the defect and found 1.40 ± 0.616 and 0.598 ± 0.195 at 6 months and 9 months respectively in DFDBA+AM whereas in BDX+AM showed 1.10 ± 0.448 and 0.528 ± 0.268 at 6 months and 9 months respectively [36]. Similarly, we found defect fill of 1.78 ± 0.41 mm at 6 months in group I and 1.73 ± 0.32 at 6 months in group II. Also, change in bone density (grayscale unit) 47.65 ± 6.2 and 46.88 ± 1.35 at 6 months was observed at the defect sites in group I and group II and was statistically significant at 6 months. EL-Haddad. et al, found similar results in gray levels in all three groups 28 ± 12.67 , 30 ± 10.14 and 9 ± 35.91 with bony glass, autogenous bone and only flap respectively at 6 months [37].

Thus, in the present study novabone putty showed comparable results to that of DFDBA, in the terms of post treatment gain in height and density of alveolar bone. Lovelace, et al. found that bioactive glass particles were not completely integrated at

6 months and flap management technique, which positions the wound margin away from the entrance to the healing defects, is most essential for successful outcome of regenerative therapy in furcation defects [27,38]

In our study the regenerative outcome was measured at 6 months and flap was coronal placed as to completely cover the furcation defect which could influence the result. Moreover, patient compliance's another major determinant factor. Difference in results between individuals and studies in the treatment of grade II furcation defects can be attributed to selection of defects, surgical procedure, maintenance program and most importantly patient compliance with plaque control.

Limitations of the present study

Split mouth design having the advantage of removing the variables, increasing the statistical power could have provided a greater difference in the clinical and radiographic parameters recorded between the groups. The results of therapy in the present study were assessed using clinical and radiographic means. Though surgical re-entry could have provided direct

evidence of bone regeneration, the same was not considered due to ethical concerns and difficulty in obtaining patients acceptance. Present study was carried out in grade II furcation defects in mandibular molars. The treatment results are easier to assess and evaluate in mandibular molars due to presence of single furcation. Application of these results to maxillary molar furcation defects may not be totally valid due to anatomic differences. A similar study in maxillary furcation defects would address this issue.

Conclusion

Results of this study demonstrated that the use of bioactive glass putty and DFDBA significantly regenerated mandibular grade II furcation defect with uneventful healing of the sites. It can be concluded that bioactive glass putty seems to have comparable regenerative property to that of DFDBA when used for the treatment of mandibular grade II furcation defects and it could be a material of great choice in future. Long term randomized controlled clinical trials along with histologic evidence are required to further explore the potential of bioactive glass putty as a periodontal regenerative material.

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