

## CLINICAL EVALUATION OF BOVINE POROUS BONE MINERAL FOR THE TREATMENT OF HUMAN PERIODONTAL DEGREE II FURCATION DEFECTS

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### ABSTRACT

The management of furcation-involved teeth is quite demanding. Degree II furcation defects, with their unique anatomy, pose a special regenerative challenge. Numerous surgical modalities have been tested in an attempt to achieve regeneration of these defects. The purpose of this study was to clinically evaluate the efficacy of bovine porous bone mineral (BPBM) for the treatment of human mandibular molar degree II furcation defects and to compare it with open flap debridement (OFD) alone. Using a split-mouth design, a total of 20 degree II mandibular molar buccal furcation defects in 10 systemically healthy patients were treated either with bovine porous bone mineral (BPBM) as test group or with open flap debridement (OFD) as control group. The clinical parameters were recorded at baseline and 6 months. At 6 months re-entry, the test group showed significantly greater pocket reduction, gain in clinical attachment, horizontal open furcation depth reduction and vertical open furcation depth reduction than the control group. Also, significant improvement was seen in bone fill and percentage gain with test group. Within limitations of the study, it was concluded that bovine porous bone mineral (BPBM) has an efficacious regenerative potential for treating degree II furcation defects.

**KEYWORDS:** Furcation, Regeneration, Bone Graft, Periodontal Therapy

### INTRODUCTION

Periodontal disease results in the destruction of the hard and soft connective tissue supporting structures around the teeth. A contemporary goal of periodontal therapy is to obtain regeneration of damaged tissues.<sup>1,2</sup>

Among periodontal defects, the furcation involvement represents one of the most challenging scenarios due to difficulty in achieving a predictable improvement regardless of the type of periodontal therapy. Moreover, the presence of furcation involvement has been demonstrated to considerably impact tooth prognosis.<sup>3</sup>

Teeth with furcation involvement undergo more extensive and rapid clinical probing attachment loss and are lost with greater frequency than are single-rooted teeth. Degree I furcations (Hamp et al, 1975)<sup>4</sup> are generally well managed with routine periodontal procedures, while degree III furcations generally require more extensive therapy. Degree II furcations present a common clinical problem that has perplexed clinicians for many years.<sup>5,6</sup>

Degree II furcation defects, with their unique anatomy, pose a special regenerative challenge. Numerous surgical modalities have been tested in an attempt to achieve regeneration of these defects. Successful regeneration of degree II furcation defects is defined clinically as the elimination of horizontal and vertical components via bone fill.<sup>7</sup>

The ideal goal of furcation therapy is to retain the tooth intact and to completely close the furcation, thereby returning the local condition to one of anatomic normalcy, facilitating long-term maintenance therapy and improving the likelihood of tooth retention. Several techniques have been proposed and promoted to treat and improve the prognosis of mandibular degree II furcation-involved molars.<sup>6,8</sup>

Procedures for the treatment of molar furcation defects range from open flap debridement, apically repositioned flap surgery, hemisection, tunnelling or extraction, to regenerative therapies using bone grafting or bone replacement grafts, guided tissue regeneration (GTR) therapy, or a combination of both.<sup>9,10</sup>

A plethora of bone substitutes are currently available for use in periodontics. Bovine porous bone mineral (BioOss® spongiosa 0.25-1mm manufactured by Geistlich Biomaterials, Switzerland) is a bone graft material recently used in periodontal regenerative procedures. This material is prepared by protein extraction of bovine bone, which results in a structure similar to human cancellous bone and has ability to enhance bone formation. Because of the widely reticulated interconnecting pores and the small crystals, the internal surface of this material covers the area similar to that of human spongy bone. This has enabled an extremely close contact with newly formed bone. Bone formation has been shown with bovine porous bone mineral in a variety of periodontal applications, including ridge augmentation, repair of vertical defects, sinus elevations, and guided bone regeneration around implants.<sup>11-13</sup>

Hence, in the present study, an attempt was made to evaluate clinically the role of bovine porous bone mineral as a bone fill in human periodontal degree II furcation defects and to compare it with open flap debridement alone in the treatment of such defects.

### Materials and methods

The sample of the study included 10 patients (6 males and 4 females) in the age range of 38 to 63 years (mean 45.8 years) with bilateral degree II furcation defects in mandibular first molars resulting from moderate to advanced adult periodontitis. Ethical clearance was obtained from Institutional Ethical Committee.

Patients selected were:

1. Systemically healthy
2. Non-smokers
3. With no history of any medications for past 6 months
4. With bilateral degree II furcation defects in mandibular first molars
5. No history of any periodontal therapy for the past 6 months
6. Without any carious tooth, mobile tooth, or non-vital tooth

In each patient, furcation defect sites were randomly assigned into test site or control site and were treated according to split mouth design method.

1. **Test site:** Treated with open flap debridement followed by placement of bovine porous bone mineral (Bio-Oss®).
2. **Control site:** Treated with open flap debridement only.

### Clinical Parameters

The following clinical parameters were recorded in a case record proforma, to the nearest millimetre on a William's periodontal probe by a single examiner for each surgical site before/at surgery (baseline) and after 6 months at the time of surgical re-entry. Naber's colour-coded probe was used only for the detection of degree II furcations (3-6 mm) as shown (Fig.1).

- I. **Gingival Index-** (Loe and Silness 1963)
- II. **Pocket probing depth (PPD):** From free gingival margin to the base of the pocket.
- III. **Clinical attachment level (CAL):** From the fixed reference point on the customized occlusal stent to the base of the pocket.
- IV. **Vertical open furcation depth (VOFD):** From the base of the furcation defect to the stent marking.
- V. **Horizontal open furcation depth (HOFD):** Horizontal distance from the depth of the furcation defect till the inner surface of the rubber stopper.

### Pre-Surgical Procedure

Following initial examination and treatment planning, all selected patients underwent Phase I therapy including oral hygiene instructions, scaling and root planing and occlusal adjustment (if necessary). Patients were re-evaluated and monitored for plaque control for a period of four weeks after initial therapy. Informed consent was obtained from all patients before surgical phase.

### Stent Fabrication

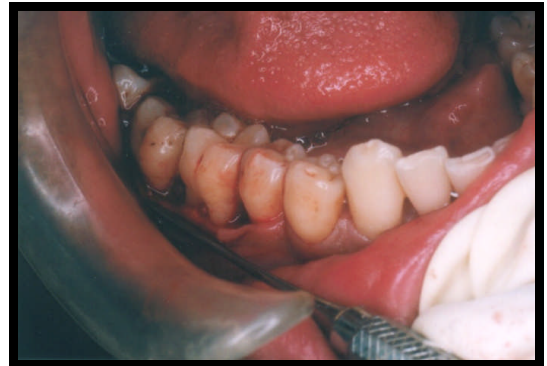
A sterile, perforated stock metal impression tray was selected for each patient accordingly. An irreversible hydrocolloid impression material (alginate) was manipulated, carried into the tray and maxillary and mandibular impressions were made. The stone cast was prepared. An occlusal stent of clear autopolymerizing resin was fabricated by sprinkle on method on both test and control sites.

### Surgical procedure

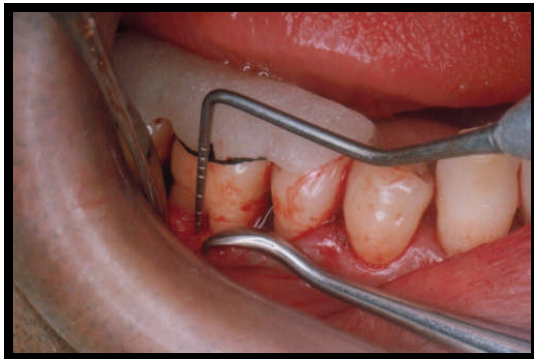
Following local anaesthesia (2% Xylocaine HCl with adrenaline 1:80,000), crevicular and inter-dental incisions were placed both buccally and lingually. The full thickness mucoperiosteal flap was then reflected by blunt dissection using a periosteal elevator. Thorough surgical debridement of both soft and hard tissues was done. After completion of root planing, the surgical site was thoroughly irrigated with normal saline (Fig.2). This ensured a clean environment, particularly at the test site for incorporation of the bone graft material. Intra-surgical clinical



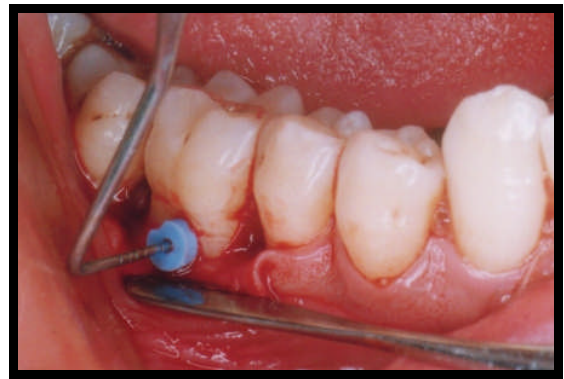
**Fig.1. Detection of furcation using Nabers' probe**



**Fig.2. Defect on test site**



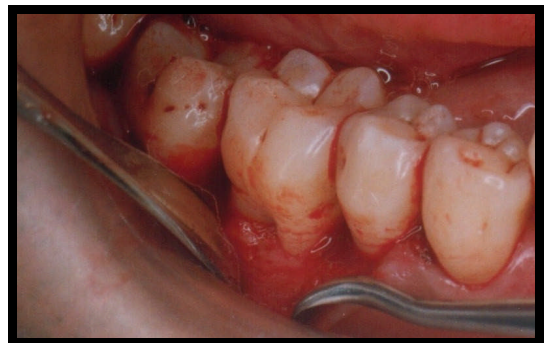
**Fig.3. Measurement of vertical open furcation depth**



**Fig.4. Measurement of horizontal open furcation depth**



**Fig.5. Placement of bone graft in the furcation defect**



**Fig.6. Surgical re-entry at 6 months at test site**

measurements such as vertical open furcation depth (VOFD) (**Fig.3**) as well as horizontal open furcation depth (HOFD) (**Fig.4**) were recorded with the help of customized occlusal stent and William's periodontal probe. The appropriate amount of the bone graft – bovine porous bone mineral (Bio-Oss®) was taken from the sterilized container, transferred into a sterilized dappen dish to which few drops of saline were added. The contents were then mixed with the blunt end of the probe and transferred to the defect at the test site with plastic filling instrument and loosely condensed to a cohesive mass (**Fig.5**). Care was taken to avoid overfilling the defect. The mucoperiosteal flaps were then repositioned. 3-0 black braided silk sutures were used to oppose the lingual and buccal flaps using interrupted sutures. Periodontal pack was placed after suturing. Apart from routine post-surgical instructions, patients were prescribed antibiotics (Amoxicillin trihydrate 500mg thrice daily for 5 days) and non-steroidal anti-inflammatory drug (Ibuprofen 400 mg thrice daily for 3 days). Also, 0.2% chlorhexidine gluconate mouthwash was advised twice daily for one week. Patients were recalled after one week when the periodontal pack and sutures were removed and the area was irrigated with saline. Patients were instructed to gently brush the area with a super-soft bristle toothbrush. Patients were recalled every month and motivated to maintain strict plaque control.

At six months, surgical re-entry was performed to get a clinical evaluation of the site for measurements. For re-entry procedure, the area was sterilized using povidone iodine solution and anesthetized. A crevicular incision was made extending from the mandibular second premolar to the second molar and the flap was then gently reflected exposing the defect site (**Fig.6**). Care was taken so as not to disturb the underlying hard tissue matrix. All the intra-surgical measurements taken at baseline were repeated. The flap was sutured back into place ensuring a snug fit against the tooth surface using interrupted sutures. Periodontal pack was placed after suturing. Post-surgical instructions were repeated. Suture removal was done after one week.

The data of all clinical parameters recorded at baseline and at re-entry were evaluated and the results of the study were subjected to statistical analysis.

## RESULTS

Patient compliance was excellent as all ten patients followed up and consented to re-entry procedure. Healing was uneventful for both the groups.

The mean gingival index scores at baseline and at the end of 6 months were 0.99 and 0.56 respectively; with statistically significant difference at 1% level between the two scores (**Table.1**) Changes in measurements of clinical parameters for test and control groups at the end of 6

months are presented (**Table.2and3**). The mean horizontal defect fill percentage values at the end of 6 months ranged from 34.33% for the control group and 60.16% for the test group (**Fig.11**). No complete defect fill was observed.

## DISCUSSION

Bovine porous bone mineral is a type of natural bone substitute (xenograft), considered to have a high degree of biocompatibility, high degree of osteoconductivity, capacity to stabilize blood coagulation, and ability to integrate in the natural remodeling processes of the bone. It has also demonstrated the potential to stabilize the regenerated bone thus preventing rapid resorption of new bone as shown by Artzi et al, Richardson et al, Camelo et al.<sup>10,11,14,15</sup>

The present split-mouth study included only buccal mandibular first molar degree II furcation defects as in other studies by Gantes et al, Bouchard et al.<sup>16,17</sup> This provided a proper standardization for treatment of all the furcations included in the study.

The clinical assessment used for this study included soft tissue as well as hard tissue parameters. Soft tissue parameters included pocket probing depth and clinical attachment level whereas hard tissue measurements included horizontal open furcation depth and vertical open furcation depth. All measurements were made using William's periodontal probe. In addition, vertical open furcation depth was measured with the help of a custom-made acrylic occlusal stent, which served as a fixed reference point. Hassel et al<sup>18</sup> reported that the accuracy of probing might suffer if the site and the direction of probing were not consistent. The fabrication of groove in the stent guided the probe to an exact location with a proper orientation. The stent was also used in studies by Lekovic et al, Camargo et al.<sup>19, 20, 21</sup>

Surgical re-entry at 6 months at both test and control sites was performed to assess the efficacy of respective treatments. It also served to analyze the incorporation of implanted bone graft material with surrounding bone at test sites. This is in accordance with studies by Yukna et al, Bouchard et al, Camelo et al, and Houser et al.<sup>6,15,17</sup> At re-entry, the regenerated tissue had the consistency of "rubber" and was resistant to the probe as shown by Becker et al.<sup>22</sup>

In the present study, healing was uneventful and no adverse tissue responses such as flap dehiscence or infection or unusual patient experiences were observed in any of the treated cases. This fact suggests that the use of this bone graft material is well tolerated by oral tissues and is safe in clinical practice as shown by Houser et al, Camelo et al, Richardson et al, Lekovic et al, Camargo et al, and Artzi et al.<sup>12,14,15,20,21</sup>

**Table.1 Mean gingival index scores at baseline and at the end of 6 months**

Time	Mean (mm)	S.D.	t value	p value
Baseline	0.994	0.32	8.557	< 0.001
6 months	0.563	0.19		

**Table.2 Pre-operative and post-operative comparison of clinical parameters between test and control groups**

Parameter	TEST				CONTROL			
	Baseline	6 months	P value	change	Baseline	6 months	P value	change
PPD	4.5±0.71	1.8±0.63	0.0001	2.7±0.81	4.6±0.69	2.9±0.32	0.0001	1.7±0.32
CAL	4.3±0.48	2.4±0.52	0.0001	1.9±0.40	4.2±0.42	3.5±0.53	0.0013	0.7±0.54
VOFD	9.7±0.48	8.5±0.71	0.002	1.2±0.16	9.6±0.51	9.3±0.67	0.0811	0.3±0.10
HOFD	3.7±0.67	1.5±0.53	0.001	2.2±0.54	3.8±0.79	2.5±0.71	0.0001	1.3±0.19

PPD = pocket probing depth  
CAL = clinical attachment level  
VOFD = vertical open furcation depth  
HOFD = horizontal open furcation depth

**Table.3 Intergroup comparison of clinical parameters**

PARAMETER	TEST	CONTROL	P value
PPD	1.8±0.63	2.9±0.32	0.0001
CAL	2.4±0.52	3.5±0.53	0.0002
VOFD	8.5±0.71	9.3±0.67	0.0016
HOFD	1.5±0.53	2.5±0.71	0.0021

PPD = pocket probing depth  
CAL = clinical attachment level  
VOFD = vertical open furcation depth  
HOFD = horizontal open furcation depth

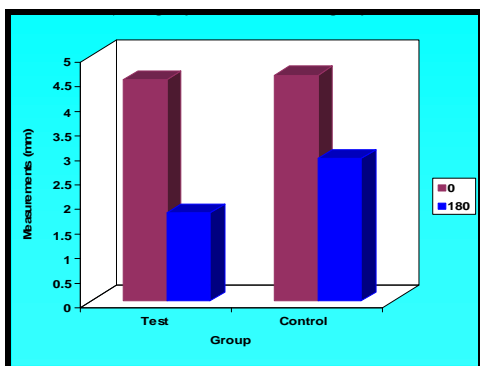


Fig.7. Comparison of mean changes in pocket probing depth

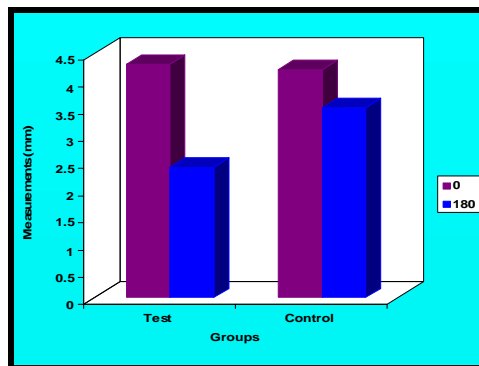


Fig.8. Comparison of mean changes in clinical attachment level

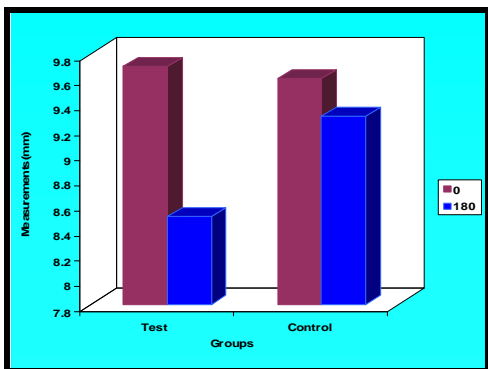


Fig.9. Comparison of mean changes in vertical open furcation depth

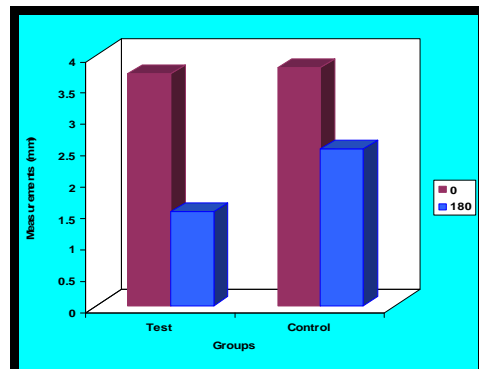


Fig.10. Comparison of mean changes in horizontal open furcation depth

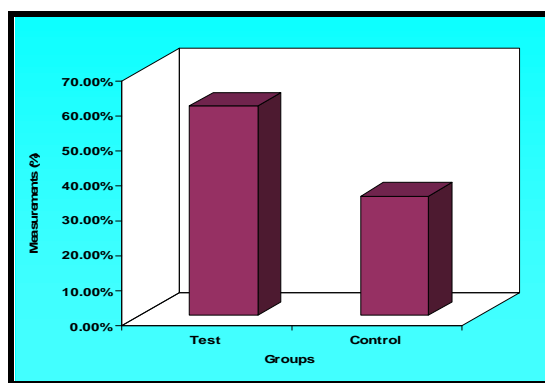


Fig.11. Comparison of horizontal defect fill percentage at the end of 6 months

This study demonstrated that the differences between the baseline and 6 month measurements were clinically and statistically significant for all the recorded clinical parameters. Probing depth reduction is a parameter commonly used for decision making in the patient care scenario since it directly relates to the ability of the patient to maintain plaque control. Both test and control groups showed comparable results with pocket probing depth reduction. The mean pocket probing depth reduction in the test group was 2.7mm as compared to 1.7mm in the control group. There was statistical difference between the two groups at 1% level. This was in accordance to studies by Houser et al, Pontoriero et al, Yukna et al.<sup>6,12,23</sup>

The mean gain in clinical attachment level in the test group was 1.9mm as compared to 0.7mm in the control group. This was found to be statistically significant at 1% level. This could be probably due to tissue repair and the formation of a long junctional epithelium. Our findings were in agreement with studies by Houser et al, Becker et al, Camelo et al and Pontoriero et al.<sup>12,15,22,23</sup>

The mean gain in the vertical open furcation depth in the test group was 1.2mm as compared to 0.3mm in the control group. This was also found to be statistically significant. These findings were in accordance with studies by Houser et al and Yukna et al.<sup>6, 12</sup> The mean gain in horizontal open furcation depth in the test group was 2.2mm as compared to 1.3mm in the control group. There was a statistically significant difference between the two groups at 1% level. The test group exhibited 25.83% greater horizontal bone fill than that demonstrated by the control group. The bone fill was due to the dot stabilization and osteoconductive properties of the graft material. These findings corroborated with those of Houser et al., Yukna et al, Leonardis et al.<sup>3, 6, 12</sup>

The present study revealed that no complete furcation closure was achieved in any of the defect sites. There was a considerable change from degree II to degree I in all of the defects studied. Another important point to be noted is that none of the furcations treated became degree III. It may be suggested that partial results in degree II furcations may improve the prognosis of the tooth. This is in agreement with studies by Yukna et al and Leonardis et al.<sup>3,6,24,25</sup> This result confirms that many variables may render the treatment of degree II furcation defects unpredictable. Among these factors, the morphology of the bony defect, the anatomy of the roots and the radicular trunk and the amount of remaining periodontium may play a major role. This finding is in accordance with that of Leonardis et al, and Yukna et al who failed to achieve degree II defect closure.<sup>3, 6,7,16</sup> The clinical outcomes obtained in this study are comparable with that of Houser et al and thus confirm that treatment of degree II furcations with porous bovine bone mineral results in clinically and statistically significant improvements.<sup>12</sup>

A possible explanation for the superiority demonstrated by the test group in the present study may be related to the physical properties of bovine porous bone mineral by aiding in blood clot stabilization and isolating gingival epithelial and connective tissue cells from the defect area and from the root surface. Also, it is possible that regenerated tissues in areas treated with bovine porous bone mineral are denser and therefore more resistant to the penetration of the probe (Houser et al, Camelo et al)<sup>12,15,19</sup>. As noted by Richardson et al<sup>10</sup>, clinical experience with this graft material has been shown to have a very favourable handling properties which included:

1. ease of delivery to the site
2. ease of packing the material into the defect
3. ability of the material to demonstrate an adhesion once placed into the defect, even with significant haemorrhage of the wound site, providing a stable graft and
4. ability to maintain space once soft tissue closure was achieved.

The above characteristics were later confirmed by Houser et al.<sup>12</sup> Although the ultimate test for regeneration is histological assessment, this measurement is often prevented in human trials by ethical considerations and patient comfort. This is a limitation of several studies in periodontal regeneration including the present one, as it is not possible to assess the histologic characteristics of the regenerated tissues and most importantly the nature of the attachment between the regenerated tissues and the previously diseased root surface.

## CONCLUSION

Within the limitations of the present study, it may be concluded that the use of bovine porous bone mineral resulted in greater clinically and statistically significant improvements in parameters such as probing depth, clinical attachment level, vertical open furcation depth, horizontal open furcation depth when compared to open flap debridement alone for the treatment of human periodontal degree II furcation defects. Bovine porous bone mineral is an effective bone substitute having the potential to result in substantial osseous defect fill over a short period of time. However, future studies involving larger sample size and a longer follow-up are recommended.

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