

## Treatment of Class II Furcations with Autogenous Bone Grafts and e-PTFE Membranes



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*This article reports a successful clinical regimen of treatment for the Class II furcation defect. Twenty-eight patients with molar teeth demonstrating Class II furcations were treated with regenerative therapy with the goal of regenerating lost interradicular periodontium. The treatment selected included scaling and root planing, surgical flap design that would enable the flap to completely cover the surgical site, complete enucleation of granulation tissue, tetracycline root conditioning, a particulate autogenous bone graft, and an expanded polytetrafluoroethylene (e-PTFE) membrane. Of the twenty-eight consecutive patients treated, twenty-five demonstrated no postoperative clinical evidence of furcation invasion, for a success rate of 89%. Eleven sites were reopened 8 to 9 months post-surgical and presented complete furcation fill with a hard, bone-like tissue. Three teeth were judged to be failures because clinical assessment revealed persistent furcation invasion. The absence of histologic evidence precludes the presumption that complete periodontal regeneration occurred. (Int J Periodontics Restorative Dent 2000;20:233-243.)*

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This study reports the clinical results of the treatment of 28 consecutive Class II furcation defects with tetracycline root conditioning, autogenous bone grafts, and expanded polytetrafluoroethylene (e-PTFE) membranes. The authors were directed toward this therapeutic regimen after analyzing previous publications that addressed regenerative efforts when encountering Class II and III furcation invasion in mandibular and maxillary molar teeth.

Regenerative treatments can result in minimal probing depths by restoring the lost periodontium, but the success of treating furcations with regenerative procedures has been quite varied. Schallhorn et al<sup>1</sup> used iliac crest bone grafts to treat crestal defects, furcations, and one-, two-, and three-walled defects. Reentry surgery or bone sounding revealed complete furcation fill for seven of the eight treated Class II furcation defects, but few clinicians appear to be able to replicate the outstanding success rate of 87%. Therapeutic modalities proposed for the regenerative surgical treatment of mandibular Class II furcation defects have

included coronally advanced flaps with or without citric acid root conditioning,<sup>2,3</sup> bone autografts,<sup>1</sup> bone allografts,<sup>4</sup> freeze-dried bone allografts,<sup>5,6</sup> alloplasts,<sup>7</sup> nonresorbable barrier membranes,<sup>8-13</sup> resorbable barrier membranes,<sup>14-17</sup> and combination procedures of bone allografts with barrier membranes.<sup>18-21</sup>

Schallhorn and McClain<sup>18</sup> treated 62 Class II and III furcations with e-PTFE barrier membranes alone or in combination with composite bone grafts with or without citric acid root conditioning. Of the 46 furcation defects, 33 (72%) receiving combined treatment had complete furcation fill, while 5 of 16 membrane-only sites (31%) had complete furcation fill. Their 5-year data were reported for 38 of 46 graft- and membrane-treated furcation sites and all 16 membrane-only furcation sites.<sup>20</sup> There was complete furcation fill as determined by reentry surgery for 66% of the graft- and membrane sites (38 of 46), while only 12.5% (2 of 16) of the membrane-only sites had complete furcation fill. The combination-treatment sites had a decrease in horizontal probing depth of 4.0 mm, versus 2.0 mm for membrane-only sites. Reentry after 5 years demonstrated remarkable stability for the combined-treatment cohort, with 66% complete furcation fill compared to the initial report of 72%. The membrane-only sites cohort depreciated to 13% from the initial success rate of 31%.

Autogenous bone grafts alone<sup>22</sup> and combined treatment of allogenic bone grafts with barrier membranes<sup>18,20</sup> have shown improved

results compared to other available regenerative regimens for treating Class II furcation defects. This study was designed to investigate whether the combined treatment with tetracycline root conditioning, autogenous bone grafts, and e-PTFE membranes is predictable to treat Class II furcation defects. This study reports on 28 consecutive furcation defects treated in this way.

### Method and materials

Twenty-eight patients having moderate to advanced periodontitis including one Class II furcation defect consented to participate in this study. The protocol included presurgical treatment with extensive oral hygiene instruction, scaling and root planing, and preoperative recording of the probing depth, attachment levels, and the presence or absence and classification of furcation involvement using the classification system of Hamp et al.<sup>23</sup> Full-thickness mucoperiosteal flaps with sulcular incisions and vertical releases were designed to achieve primary closure over the membrane and bone graft. Meticulous root preparation was performed, and the root surface was treated with tetracycline paste for 4 minutes. Prior to graft placement, all granulation tissue was removed from the defect and bleeding was stimulated from the defect and from the periodontal ligament space. Autogenous bone grafts were harvested from the maxillary tuberosity or the mandibular retromolar region and grafted into the defects.

The e-PTFE barrier membranes (3i/WL Gore) with or without titanium reinforcement were placed over the bone grafts and stabilized with stainless steel pins and sutures as indicated in each case. Soft tissues were sutured tension free with Gore-Tex (3i/WL Gore) or silk sutures to achieve primary closure over the grafts and membranes.

Surgical dressing was placed over the surgical site for 1 to 3 weeks. Patients were examined every 2 to 4 days for the first 2 weeks and then weekly for the next 8 weeks. The surgical sites were swabbed with chlorhexidine digluconate 0.12%, and supragingival plaque was removed at each postoperative visit, with the sutures removed between 7 and 21 days. Patients were instructed to rinse with 0.12% chlorhexidine digluconate 2 times per day for 8 weeks and resumed oral hygiene after the third postoperative week. Complete-mouth prophylaxis and oral hygiene instruction were performed every 2 months for the duration of the study.

Clinical measurements were performed for all cases 8 to 9 months after the surgical procedure. Eleven patients consented to reentry surgical procedures, and the defects were classified as having either incomplete or complete bone fill.

**Table 1** Results of clinical parameters (mm)

Patient	Probing depth			Attachment level			Recession	Failure
	Initial	Postoperative	Change	Initial	Postoperative	Change		
1	4.0	2.0	2.0	5.0	2.0	3.0	1.0	
2	6.0	1.0	5.0	9.0	1.0	8.0	3.0	
3 (case 4)	12.0	3.0	9.0	13.0	4.0	9.0	0.0	
4	7.0	2.0	5.0	8.0	3.0	5.0	0.0	
5	9.0	1.0	8.0	11.0	3.0	8.0	0.0	
6	9.0	2.0	7.0	9.0	4.0	5.0	2.0	
7	6.0	2.5	3.5	6.0	3.0	3.0	0.5	
8 (case 3)	6.0	1.5	4.5	7.0	3.0	4.0	0.5	
9	11.0	1.0	10.0	10.0	3.0	7.0	3.0	
10	8.0	2.0	6.0	8.0	4.0	4.0	2.0	
11	9.0	2.0	7.0	8.0	4.0	4.0	3.0	
12 (case 2)	9.0	3.0	6.0	10.0	4.0	6.0	0.0	
13	8.0	9.0	-1.0	9.0	10.0	-1.0	0.0	X
14	7.0	2.0	5.0	9.0	4.0	5.0	0.0	
15	8.0	2.0	6.0	8.0	2.0	6.0	0.0	
16	6.0	1.0	5.0	7.0	2.0	5.0	0.0	
17	8.0	1.5	6.5	9.0	3.0	6.0	0.5	
18	8.0	1.0	7.0	10.0	3.0	7.0	0.0	
19 (case 1)	11.0	4.0	7.0	11.0	5.0	6.0	1.0	
20	9.0	2.0	7.0	10.0	3.0	7.0	0.0	
21	8.0	8.0	0.0	11.0	11.0	0.0	0.0	X
22	7.0	8.0	-1.0	7.0	9.0	-2.0	1.0	X
23	14.0	3.0	11.0	14.0	5.0	9.0	2.0	
24	6.0	2.0	4.0	7.0	3.0	4.0	0.0	
25	12.0	4.0	8.0	12.0	5.0	7.0	1.0	
26	10.0	2.0	8.0	10.0	4.0	6.0	2.0	
27	9.0	3.0	6.0	10.0	5.0	5.0	1.0	
28	8.0	4.0	4.0	8.0	4.0	4.0	0.0	
Mean	8.39	2.84	5.55	9.14	4.14	5.00	0.84	
Standard deviation	2.20	2.13	2.93	2.05	2.30	2.68	1.04	

## Results

### Clinical results

Twenty-five of the twenty-eight cases were judged to be clinically successful as evidenced by no longer having clinically detectable furcation involvement, a significant decrease in probing depth, and a significant gain in attachment level (Table 1). Three cases were classified as

failures because of continued clinically detectable Class II furcations and no positive changes in clinical measurements. All successful cases presented with no clinically detectable furcations at the 8- to 9-month reevaluation. There were no cases with intermediate results showing a change from a Class II to a Class I furcation. There was a mean decrease in probing depth of  $5.55 \pm 2.93$  mm, a mean increase in clinical

attachment of  $5.00 \pm 2.68$  mm, and a mean recession of  $0.84 \pm 1.04$  mm.

### Reentry results

Eleven patients had reentry surgery to evaluate bone fill of the furcation defects. All eleven cases showed complete fill of the furcation defects by hard, dense, bone-like tissue; four of these cases are reported.



**Fig 1a** Flap reflection reveals a Class II buccal furcation on this maxillary left first molar.



**Fig 1b** After meticulous degranulation of the defect and scaling and root planing, a tetracycline paste is applied to the root surface and the defect for approximately 4 minutes.



**Fig 1c** Autogenous bone is harvested from the maxillary tuberosity and placed to fill the defect.



**Fig 1d (left)** Titanium-reinforced Gore-Tex membrane is placed to cover the bone graft and stabilized with a bone-fixation screw and an e-PTFE suture.



**Fig 1e (right)** Eight-month postoperative reentry surgery shows the stability of the autogenous bone graft. Note that the entire defect has been successfully filled.

## Case reports

### Case 1

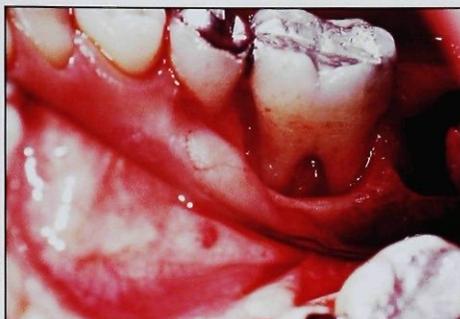
Flap reflection for a maxillary left first molar (Fig 1a) revealed a Class II buccal furcation invasion with an initial probing depth of 11 mm and attachment level of 11 mm (patient 19). After meticulous degranulation of the defect and scaling and root

planing, a tetracycline paste was applied to the root surface and the defect for approximately 4 minutes (Fig 1b). Autogenous bone was harvested from the maxillary tuberosity and grafted into the defect (Fig 1c). A titanium-reinforced Gore-Tex barrier membrane was placed to cover the bone graft and stabilized with a bone-fixation screw and an e-PTFE suture (Fig 1d). The postoperative

healing was excellent, and the barrier membrane was removed after 3 months because of exposure. The postoperative clinical evaluation revealed a probing depth of 4 mm, an attachment level of 5 mm, and recession of 1 mm. The 8-month postoperative reentry surgery showed the stability of the autogenous bone graft with complete fill of the furcation defect (Fig 1e).



**Fig 2a** Preoperative radiograph demonstrates a periodontally compromised second molar that was deemed hopeless. The first molar has Class II furcation invasion that extends to the mesial defect.



**Fig 2b** Full-thickness mucoperiosteal flap is reflected, the second molar is extracted, and the Class II furcation with a wraparound defect on the lingual aspect of the first molar is identified.



**Fig 2c** Seventeen-month postoperative reentry surgery evidences complete bone fill of the furcation defect.



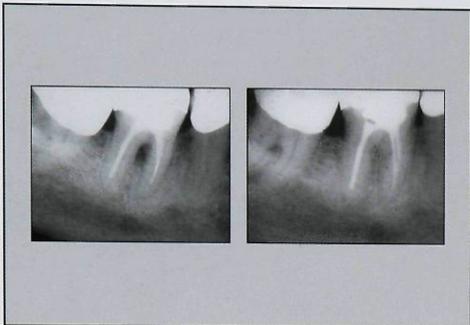
**Fig 2d** Thirty-six-month postoperative radiograph is no longer suggestive of furcation involvement, evidencing the stability of the successful graft.

## Case 2

The mandibular right first molar presented a lingual Class II furcation defect with an initial probing depth of 9 mm and an attachment level of 10 mm (patient 12). A full-thickness mucoperiosteal flap was reflected

from the second premolar to the second molar, and the second molar with radiographic bone loss beyond the apex of the distal root was extracted (Fig 2a). The Class II furcation defect on the lingual aspect of the first molar was associated with a distal wraparound intrabony

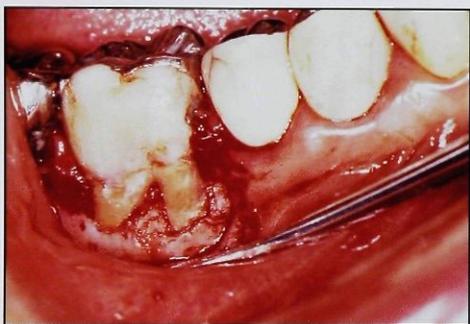
defect (Fig 2b). The defect was degranulated, and the root surfaces were meticulously scaled and planed and then treated with a tetracycline paste for 4 minutes. Autogenous bone was harvested from the region of the second molar with rongeurs, and the bone was



**Fig 3a** Preoperative radiograph is suggestive of furcation involvement for the mandibular right first molar.



**Fig 3b** Flap reflection reveals Class II furcation involvement for the first molar. Note that there is a biologic width problem that may have contributed to the etiology of the problem.



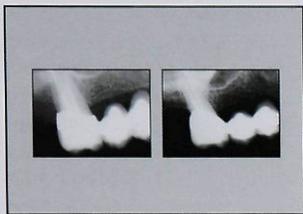
**Fig 3c** One-year reentry shows a completely integrated graft filling the furcation defect.

placed in the lingual defect on the first molar. The bone graft was then covered with a titanium-reinforced Gore-Tex membrane, and the soft tissues were sutured to obtain primary closure over the surgical site. The postoperative healing was excellent, and the membrane was removed after 2 months because of exposure at the gingival margin. The postoperative clinical evaluation

revealed probing depth of 3 mm, attachment gain of 6 mm, and recession of 0 mm. The 17-month postoperative reentry surgery evidenced complete bone fill of the furcation defect with a bone-like substance (Fig 2c). The 36-month postoperative radiograph no longer suggested furcation invasion and offered evidence of the stability of the successful treatment (Fig 2d).

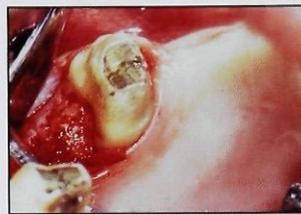
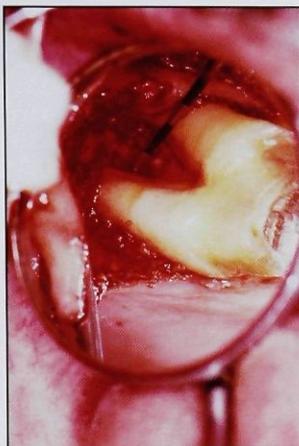
### Case 3

A mandibular right first molar had an initial probing depth of 6 mm, attachment level of 7 mm, and the preoperative radiograph suggested furcation invasion (Fig 3a) (patient 8). Flap reflection confirmed a Class II furcation involvement for this tooth, which had a biologic width problem because of a composite



**Fig 4a** Preoperative radiograph evidences an infrabony defect for the second molar associated with the distal furcation.

**Fig 4b** (right) There is a preoperative 12-mm probing depth on the distal surface of the maxillary right second molar. Flap reflection evidences the extensive bone loss on the distal surface of the second molar with a Class II furcation.



**Fig 4c** Eight-month reentry surgery after treatment with autogenous bone graft and Gore-Tex membrane shows complete bone fill of the furcation defect.

restoration encroaching upon the furcation entrance (Fig 3b). Prior to placing an autogenous bone graft and an e-PTFE (Gore-Tex) membrane, the defect was completely debrided by scaling and root planing, the restoration was reshaped to remove excess restorative material from the furcation entrance and root trunk, and tetracycline root conditioning was performed for 4 minutes. The postoperative healing was uneventful, and the membrane was removed after 2 months because of exposure at the gingival margin. The postoperative clinical evaluation revealed a probing depth of 1.5 mm, attachment gain of 4 mm, and recession of 0.5 mm. The 1-year reentry showed a completely integrated

graft filling the furcation defect (Fig 3c). The 40-month postoperative radiographic and clinical examinations suggested complete resolution of the furcation defect on this molar.

#### Case 4

There was a preoperative 12-mm probing depth and an attachment level of 13 mm on the distal surface of the maxillary right second molar (Fig 4a) (patient 3). Flap reflection evidenced extensive bone loss on the distal surface of the second molar, with a Class II furcation invasion (Fig 4b). This furcation defect received the same care as the above-described cases, with meticulous

debridement of the defect and root preparation including scaling and root planing and treatment with tetracycline paste for 4 minutes. Autogenous bone was harvested from the tuberosity, grafted to the defect site, and covered with a Gore-Tex membrane. The flap design allowed for primary closure over the graft and membrane to be easily achieved. The postoperative clinical evaluation revealed a probing depth of 3 mm, an attachment gain of 9 mm, and recession of 0 mm. The 8-month reentry surgery showed complete bone fill of the furcation defect (Fig 4c). The 2.5-year postoperative radiograph suggested regenerated bone on the distal surface of the second molar.

## Discussion

The goal of definitive furcation treatment is to achieve complete resolution of the defect to improve plaque removal. However, a Class II furcation that is unsuccessfully treated will continue to be a maintenance problem. Therefore, treatments that offer the potential for complete resolution of the furcation defect are preferred.

Lynch<sup>24</sup> evaluated the possible parameters of success of a periodontal regenerative activity. His conclusion that the most important criterion is human biopsy is validated by significant consensus meetings.<sup>25-27</sup> Recognizing the obvious limitations of procuring this level of evidence, we offer the treatment of 28 consecutive defects and the surgical reopening of 11 cases as an alternative.

Periodontics continues to seek a predictable and successful method to achieve periodontal regeneration. Autogenous bone grafts have been shown to have a substantial biologic potential to achieve periodontal regeneration, as evidenced by histologic biopsy analysis evidencing new cementum, alveolar bone, and periodontal ligament.<sup>1</sup> The role of barrier membranes is multifactorial, providing stability to the blood clot and excluding the gingival epithelium and corium, and allowing the progenitor cells from the bone and periodontal ligament to populate the surgical wound. The principle of epithelial exclusion in periodontal regeneration was first reported by Prichard<sup>28</sup> as the "intra-bony technique," in which the epithelium is

trimmed from the surgical flap that is apically positioned at a distance from the bony defect to allow the blood clot to organize unencumbered by the gingival epithelium. This concept was then reintroduced by Nyman et al<sup>29</sup> in 1982 and Gottlow et al<sup>30</sup> in 1986 as an integral factor in guided tissue regeneration (GTR).

The limits of GTR for treating maxillary Class II or III furcations have demonstrated that maxillary interproximal Class II furcations respond less favorably than buccal Class II furcations to treatment with GTR, with no improvement over open debridement alone for mesial and distal sites.<sup>31,32</sup> Maxillary Class III furcations treated with GTR do not respond more favorably than open debridement alone.

Selecting biomaterials and treatment methodology for periodontal regeneration should be an evidence-based decision. Unfortunately, methods and materials that have not been histologically proven to achieve periodontal regeneration are available and have been advocated.

The coronally advanced flap with or without citric acid root conditioning is one method suggested to achieve periodontal regeneration when treating Class II furcation invasion.<sup>2</sup> A longitudinal clinical trial including 22 buccal mandibular molar Class II furcations reported closure of the defects with bone fill following the coronally advanced flap procedure.<sup>33</sup> However, the 5-year report showed instability of the results, with 12 of 16 sites exhibiting recurrent Class II furcation invasion. Other materials, such as freeze-dried bone

grafts, have been validated through multicenter clinical trials and have been shown to consistently induce periodontal regeneration in intra-bony defects.<sup>5,34</sup> However, it is noteworthy that clinical results in Class II furcations have consistently shown improvement without complete resolution of the defects, thus the need for human histologic data.

The combination treatment of a bone graft and membrane appears to outperform bone grafts alone or membranes alone in comparative studies.<sup>19-21</sup> The advantage of establishing initial blood clot stabilization with a bone graft and membrane is that it is less likely to have dead space under the membrane. Both the mechanical handling properties and the biologic potential of graft materials must be considered. Autogenous bone has demonstrated ease of handling and biologic potential. The membrane should be made stable and passive using sutures and/or screws as needed to avoid micromovements that might interfere with the regenerative wound healing.

Eleven of the patients agreed to reentry surgery 9 months after the first surgical procedure, and all of these cases demonstrated complete hard tissue furcation fill. There is no reason to believe that the other cases that were equally successful clinically would not show similar results if they were reentered. There were no smokers enrolled in this study, as smoking has been shown to have adverse effects on both bone grafts<sup>35</sup> and GTR.<sup>36</sup> Plaque control was maintained at an optimal level

both presurgically and postsurgically. The patients were instructed to rinse with chlorhexidine digluconate for 8 weeks postoperative, and oral hygiene techniques were reviewed at each follow-up visit. At these visits, supragingival plaque removal was performed at the surgical site and the site was swabbed with chlorhexidine digluconate.

This study used autogenous bone grafts combined with barrier membranes to achieve bone regeneration in Class II furcation defects. Twenty-five of the twenty-eight cases were judged to be clinically successful as evidenced by no longer having clinically detectable furcation invasion, a significant decrease in probing depth, and a significant gain in attachment level. There was a mean decrease in probing depth of  $5.55 \pm 2.93$  mm, a mean increase in clinical attachment of  $5.00 \pm 2.68$  mm, and a mean recession of  $0.84 \pm 1.04$  mm. Three cases were classified as failures because of continued clinically detectable Class II furcations and no positive changes in clinical measurements. All successful cases presented with no clinically detectable furcations at the 8- to 9-month reevaluation. There were no cases with intermediate results demonstrating a change from a Class II to a Class I furcation. The results of this study are unique in the level of success achieved and in the fact that for the successful cases (89%) the furcation problem was completely resolved.

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