Clin Oral Invest (2007) 11:385–389
DOI 10.1007/s00784-007-0134-z

ORIGINAL ARTICLE

Efficacy of open flap debridement with and without enamel matrix derivatives in the treatment of mandibular degree II furcation involvement

Mohammad Taghi Chitsazi · Ramin Mostofi Zadeh Farahani · Mohammadreza Pourabbas · Nasim Bahaeddin

Received: 14 September 2006 / Accepted: 13 June 2007 / Published online: 11 July 2007

Abstract The aim of the present study was the evaluation of the efficacy of open flap debridement (OFD) with and without enamel matrix derivatives (EMD) in the management of class II furcation involvement. Twenty similar bilateral class II furcation defects in ten healthy nonsmoker patients were selected. One defect in each subject was treated with OFD alone (OFD group) and the contralateral one with OFD and simultaneous application of enamel matrix derivatives (EMD group). Clinical probing depth, vertical clinical attachment level, horizontal clinical attachment level, and the location of the gingival margin, horizontal probing depth of bony defect (E-HPD), vertical depth of bone crest, vertical depth of the base of bony defect (V-DBD), and length of the intrabony defect were measured at baseline and during reentry surgery after 6 months. Wilcoxon signed-rank test and Mann–Whitney *U* test were used to analyze the data. Among soft tissue parameters, only horizontal attachment gain in EMD was significantly more than OFD ($P=0.002$). Application of EMD significantly enhanced the horizontal (E-HPD) and vertical (V-DBD) resolution of the bony defect ($P<0.05$). In conclusion, it seems that the adjunctive use of EMD enhances the efficiency of OFD in the management of mandibular class II furcation defects.

M. T. Chitsazi · M. Pourabbas · N. Bahaeddin
Department of Periodontics, School of Dentistry,
Tabriz University of Medical Sciences,
Tabriz, Iran

R. Mostofi Zadeh Farahani (✉)
School of Dentistry, Tabriz University of Medical Sciences,
Golgasht St., Daneshgah St.,
Tabriz, Iran
e-mail: r.mostofi@gmail.com

Keywords Furcation involvement · Enamel matrix proteins · Open flap debridement

Introduction

Enamel matrix derivative (EMD) is a preparation of matrix proteins derived from developing porcine teeth [9]. This material—and especially amelogenin fraction of EMD—has been suggested to induce formation of acellular cementum [23] and contribute to the regeneration of the periodontal tissues [1] by stimulating proliferation of mesenchymal cells, inhibiting proliferation of epithelial cells and promoting the secretion of certain growth factors such as TGF-β1 by periodontal ligament cells [15]. The regeneration of buccal dehiscence in animal model [10] and also effective resolution of periodontal intrabony defects [21] after the application of EMD has been suggested. In addition, clinical attachment gain in intrabony defects through the use of EMD has been demonstrated [11]. Initial differentiation of cementoblast precursors is guided through deposited dentine matrix, implicating the important role of these proteins in tissue regeneration [3]. Moreover, application of EMD to the artificial periodontal intrabony defects led to de novo formation of cementum and bone on denuded root surfaces [10]. EMD-mediated formation of cementum has been demonstrated in human studies [19].

While various biomaterials have been used for treatment of furcation defects [17], EMD has provided a promising envision for treatment of intrabony defects [14]. In a histological study, it was found that both EMD and bioresorbable membrane are capable of inducing cementum in class II furcation defects [2]. However, only in the

presence of EMD, acellular cementum was formed. In addition, it has been shown that EMD, guided tissue regeneration (GTR), and the simultaneous use of EMD and GTR may lead to the periodontal regeneration significantly more than coronally advanced flap alone [4, 12]. Donos et al. [6] evaluated the clinical efficacy of EMD, GTR, and EMD+GTR in the treatment of class III furcation involvement. The researchers attributed the lack of significant difference between these three methods to the smaller sample size. Jepsen et al. [13] studied the use of EMD and GTR in the treatment of buccal class II furcation defects using surgical reentry. They concluded that treatment with EMD was associated with the reduction in horizontal depth of furcation significantly more than GTR. Furthermore, postsurgical inflammation and pain in the EMD-treated teeth occurred less than in the GTR-treated teeth. However, there were no significant differences between clinical efficacy of EMD and GTR with reference to secondary healing outcomes, i.e., changes of the hard tissue boundaries, in the treatment of class II furcation involvement [16]. Histological studies demonstrated that EMD treatment leads to periodontal regeneration [18]. Nonetheless, combination of EMD and GTR does not enhance the periodontal regeneration.

In vivo assessment of efficacy of EMD in the management of furcation involvement necessitates more meticulous postoperative evaluation of defect topography. Exposing the furcation area, using reentry surgery, may eliminate most of the extraneous variables compromising the internal validity of findings. The aim of the present study was the investigation of efficiency of adjunctive use of enamel matrix derivatives (OMD) with open flap debridement (OFD) in the management of mandibular degree II furcation involvement.

Materials and methods

Study population

A total of ten nonsmoker patients (seven females and three males) afflicted by chronic moderate to severe periodontitis participated in the present controlled, randomized clinical trial. A history of the following items was ruled out: existence of any systemic or debilitating diseases, which could affect the viability of periodontal tissues, antibiotic therapy during the past 6 months, presence of restorations in the gingival third of the selected teeth, smoking, and pregnancy. Twenty similar bilateral class II furcation defects in mandibular molars (Glickman's classification [8]) were selected in the aforementioned subjects. Clinical and radiographic examinations were performed. Horizontal probing depths (HPD) of the defects were more than 3 mm in all subjects. The upper level of interproximal bone was located higher than the entrance of the furcation. Gingival margin was a minimum of 2 mm coronal to the entrance of the furcation. Sufficient divergence of the roots and vitality of the teeth were among the inclusion criteria. The whole study was explained to the patients, and a written consent form was signed by them. The study was approved by the ethics and the research committees of the Tabriz University of Medical Sciences.

Preoperative procedures

The primary preoperative phase comprised of oral hygienic instructions followed by scaling and root planing and the necessary occlusal adjustments. Fissured acrylic templates were fabricated for all the subjects for maintaining the reliability of the repetitive measurements. Clinical parameters related to soft tissue were measured immediately before surgery (baseline) and 6 months postoperatively. These parameters included clinical probing depth (CPD), vertical clinical attachment level (v-CAL), horizontal clinical attachment level (h-CAL), and the location of the gingival margin. Measurement of the clinical parameters was performed in the mid-facial aspect of the studied teeth. These parameters were measured using William's periodontal probe preoperatively, after 6 months. Measurements were accomplished by a single examiner blind to the method of the study. Repeated measurement of some parameters revealed a high intraexaminer agreement of data.

Surgical procedures

The defects in each patient were randomly allocated to the test and the control groups through simple method of dropping a metal coin. OFD was performed for the control group. A single surgeon performed all operations. In the test group, EMD was utilized as an adjunct to OFD. After anesthetizing the surgical area, a sulcular incision was started from the distal aspect of the teeth posterior to the affected site and continued anteriorly past the mesial border of the second teeth anterior to the involved region. A mucoperiosteal flap was separated and the granulation tissue was removed. Afterwards, scaling of the root surfaces and the furcation and root planing were performed. Any existing enamel projections and pearls were removed using high-speed burs. Supporting bone of the teeth was left intact. Then measurements of the hard tissue parameters were accomplished using the fissured acrylic template and the periodontal probe. These parameters included:

1. Surgically exposed HPD of bony defect (E-HPD): the horizontal distance between deepest probed region of defects and the rubber stop contacting the root convexity while the probe is perpendicular to the long axis of tooth.

2. Vertical depth of bone crest: the vertical distance between lower border of template and alveolar crest.
3. Vertical depth of the base of bony defect (V-DBD): the vertical distance between lower border of template and base of bony defect.
4. Length of the intrabony defect (LID): the vertical distance between alveolar crest and base of bony defect.

On a random basis, one side was treated with OFD and the contralateral side was treated with a combination of EMD and OFD. Randomized allocation of OFD and EMD sites was accomplished before the first operation by dropping a metal coin. In EMD site, ethylenediamine tetraacetic acid (EDTA; 24%) was applied to the root surface for 2 min as a root conditioner. The root surface was thoroughly rinsed with sterile saline. After injection of EMD gel to the furcation area, the flap was returned to its place immediately and sutured. Treatment protocol for OFD site was like EMD site but EDTA and EMD were not utilized. Time interval between the two operations was 3 weeks. The patients were checked each week during the first month and thereafter monthly till the sixth month.

Six months after the primary surgery, a reentry surgery was performed. The reentry procedure was aimed at correction of any probable remaining defects and also evaluation of the results of the treatment with reference to the soft and the hard tissue parameters. During reentry surgery, a mucoperiosteal flap was elevated without removing the soft tissue from furcation, except in cases where remaining defects were observed. The method of reentry measurements was similar to primary measurements.

Statistical analysis

The variables are presented as mean±standard deviation. The between-group postoperative differences of the defects, before and after the treatment, were compared based on the Wilcoxon test. In addition, Mann–Whitney *U* test was used for the comparison of the within-group differences at baseline and 6 months postoperatively. In the present study, $P< 0.05$ was considered to indicate statistical significance.

Results

Seven male and three female patients aged 32 to 48 years (mean, 40) participated in the present study. All of the patients completed the study course without any serious consequence. Plaque index and gingival index did not show any significant difference from the baseline values ($P>0.05$).

Soft tissue parameters

Soft tissue parameters are presented in Table 1. V-CAL in both groups improved significantly with reference to the baseline values. Vertical attachment gain in EMD was 13% ($P=0.007$) and in OFD was 8.3% ($P=0.009$). However, the between-group differences after 6 months were not statistically significant ($P=0.164$). The horizontal attachment gain in EMD was 1.9 mm (40%) and in OFD was 0.6 mm (13%). Both of the within-group differences were significant ($P< 0.05$). The assessment of soft tissue parameters revealed that the addition of EMD improved the horizontal attachment gain considerably. The horizontal attachment gain in EMD was 1.2 mm (30%) more than OFD ($P=0.002$).

The initial probing depths were not statistically different ($P>0.05$). The decrease in CPD after 6 months was 41% in EMD ($P=0.005$) and 33% in OFD ($P=0.005$). Nonetheless, the between-group difference of CPD (9.6%) did not reach statistical difference ($P=0.317$). The postoperative recession equaled 0.5 mm in EMD ($P=0.15$) and 0.75 mm in OFD ($P=0.317$). The postoperative recession was not affected by the treatment protocol ($P=0.462$).

Hard tissue parameters

Hard tissue parameters are presented in Table 2. Initial HPDs of the defects in EMD and OFD were not significantly different ($P>0.05$). E-HPD reduced by 2 mm (40%) in EMD and 0.8 mm (16.7%) in OFD. The horizontal resolution of the defect through adjunctive use of EMD was 1.2 mm more than OFD ($P=0.006$). V-DBD diminished by 1.25 mm in EMD ($P=0.007$) and 0.85 mm

Table 1 Soft tissue parameters at the baseline and after 6 months

Variable	Group	Baseline value (mm)	Reentry value (mm)	Within-group comparison	Between-group comparison
CPD	EMD	4.75	2.80	$P=0.005$*	$P=0.317$
	OFD	4.65	3.10	$P=0.005$*	
v-CAL	EMD	10.8	9.35	$P=0.007$*	$P=0.164$
	OFD	10.9	10.00	$P=0.009$*	
LGM	EMD	6.05	6.55	$P=0.15$	$P=0.462$
	OFD	6.25	6.90	$P=0.317$	
h-CAL	EMD	4.70	2.80	$P=0.005$*	$P=0.002$*
	OFD	4.60	4.00	$P=0.010$*	

Asterisk indicates statistical significance based on $P<0.05$.

Table 2 Hard tissue parameters at the baseline and after 6 months

Variable	Group	Baseline value (mm)	Reentry value (mm)	Wilcoxon test	Mann–Whitney *U* test
E-HPD	EMD	4.90	2.90	P=0.007*	P=0.006*
	OFD	4.80	4.00	P=0.007*	
V-DBC	EMD	10.65	11.05	P=0.23	P=0.142
	OFD	10.80	11.15	P=0.38	
V-DBD	EMD	12.65	11.40	P=0.007*	P=0.013*
	OFD	12.85	12.00	P=0.004*	
LID	EMD	2.00	0.35	P=0.005*	P=0.045*
	OFD	2.05	0.85	P=0.005	

Asterisk indicates statistical significance based on $P<0.05$.

in OFD (P=0.004). This reduction in V-DBD in EMD was 1.47 times (32%) more than in OFD (P=0.013).

The initial level of bone crest was not statistically different at baseline ($P>0.05$). V-DBD reduced by 0.4 mm in EMD and 0.35 mm in OFD. However, both the within-group and the between-group differences did not reach statistical difference ($P>0.05$).

The LID, which is an indicator of new bone formation, decreased substantially at 6 months postoperatively in both groups. LID resolution equaled to 1.65 mm in EMD (P=0.005) and 1.20 mm in OFD (P=0.005). The between-group difference of EMD and OFD was 27% (0.45 mm), which was statistically significant (P=0.045). Furthermore, one of the defects in the EMD demonstrated complete resolution. However, a similar finding was not observed in the OFD.

Discussion

The aim of the present study was the evaluation of the efficacy of OFD with and without OMD in the management of mandibular class II furcation involvement. Both treatment protocols were effective in enhancement of the clinical parameters of the soft tissue healing. However, EMD application resulted in a more efficient healing of the periodontal hard tissues with reference to the vertical and horizontal defect resolution.

Vertical decrease in the CAL in the EMD and OFD groups were 1.45 mm and 0.9 mm, respectively. The postoperative gingival recession was not significant in both groups (P=0.22). Moreover, the probing depth reduced by 1.95 mm in the EMD site and 0.9 mm in the OFD site, suggesting that the gain in attachment is the major contributor to the reduction in the probing depth. In agreement with the results of the present study, Donos et al. [5] reported a 1.35-mm gain in the vertical attachment after the application of EMD in the mandibular furcation. However, in another study the mean vertical attachment gain was reported to be 2.3 mm [6]. This new attachment may originate from true periodontal regeneration or new connective tissue attachment or long junctional epithelium. In a study by Yukna et al. [22], three out of ten intrabony defects treated using EMD demonstrated the regeneration of periodontal tissues. Three cases were repaired with connective tissue attachment and the rest of them with long junctional epithelium [22].

Horizontal attachment gain in the EMD and OFD groups were 1.9 m and 0.6 mm, respectively. Both within-group and between-group differences were significant. Donos et al. [5] found that the amount of h-CAL averaged 1.4 mm in the buccal furcations and 0.5 mm in the lingual furcations. This relative disagreement may partially reflect the difference in the evaluation criteria, case selection, and the study method.

Through the surgical approach (reentry surgery), the formation of bone was evaluated. The amount of bone formation as evidenced by filling of the defect with new bone was 1.25 mm in the EMD site and 0.85 mm in the OFD site. Regarding the mean primary depth of the defects in the EMD group (2 mm), 62.5% of the defects were repaired with bone formation. Velasquez et al. [20] achieved a 63.2% bone fill in the intrabony defects treated with EMD. Froum et al. [7] detected a 68% bone fill using the same method.

Crestal bone resorption equaled 0.4 mm in the EMD site and 0.35 mm in the OFD site. These values are in accordance with the findings of Froum et al. [7], who measured a 0.46-mm resorption of crestal bone. However, Velasquez-Plata et al. [20] detected a 0.6-mm resorption. The intrabony component of the defect in the present study decreased by an average of 1.65 and 1.2 mm in the EMD and the OFD groups, respectively. Both the within-group and the between-group differences at 6 months postoperatively were significant. Because the amount of crestal bone resorption was minimal, these changes mostly reflect the filling of the intrabony defect. HPD of the defect with open access examination showed a reduction of 2 mm in the EMD and 0.8 mm in OFD groups. This fact is suggestive of the efficiency of EMD in the resolution of the horizontal components of the furcation defects. Jepsen et al. [13] evaluated the changes in HPD after the treatment of degree

II furcation involvement using open access. They observed a 2.6-mm decrease in E-HDD, which is more than the values detected in the present study. In addition, the newly formed tissue in the furcation had a rubbery consistency resisting the entrance of the periodontal probe. Complete closure of furcation was observed in one out of ten defects treated using EMD. Jepsen et al. [13] observed the complete furcation closure in 17% of the cases treated with EMD. On the contrary, Donos et al. [5] did not find any complete closure of furcation through application of EMD.

The future research may be directed toward the ultrastructural assessment of the mechanisms underlying the clinical events. In addition, the investigation of the simultaneous healing procedure of the periodontal soft and hard tissues affected by the EMD and the mutual interactions of these two with reference to the mediator molecules and other regional factors seems interesting.

Admittedly, both treatment protocols were effective in promoting the healing procedure of the class II furcation defects. However, application of EMD resulted in greater enhancement of the h-CAL and, in addition, more efficient formation of new bone both vertically and horizontally.

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