Effect of Removing an Impacted Mandibular Third Molar on the Periodontal Status of the Mandibular Second Molar

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Purpose: The aim of this study was to evaluate the change in the periodontal status of mandibular second molars after surgical extraction of adjacent impacted lower third molars.

Materials and Methods: The study was based on a 1-year follow-up of 48 patients (20 men and 28 women) recruited consecutively after the extraction of an impacted lower third molar. Panoramic radiographs were obtained and clinical examinations were carried out at baseline to determine the periodontal status (probing depth and dental plaque and gingival indices) both for the second molar and for the 4 posterior sextants. After surgical removal of the impacted mandibular third molars, all patients were assessed at 3, 6, 9, and 12 months for changes in periodontal status.

Results: The periodontal health of the second molar was found to improve gradually after third molar surgery in all clinical parameters. Probing depth was gradually reduced by about 0.6 mm quarterly, until a final depth of 2.6 ± 0.8 mm was attained. The relative risk of having a plaque index and gingival index coded as 0 (healthy) or 1 (minor problems) was about 10 times higher at the end of the follow-up than at baseline for both indices. The periodontal status of the 4 posterior sextants also improved gradually. Molar depth, according to the Pell and Gregory classes and types, seemed to be the main factor modulating both the baseline probing depth and the change in probing depth during follow-up.

Conclusions: Our results suggest that the initial periodontal breakdown established on the distal surfaces of the second molars and in the periodontal health of the 4 posterior sextants can be significantly improved 1 year after surgical removal of the ipsilateral lower third molar.

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Third molars, the last teeth to erupt into the human dental arch, have been shown to be the most frequently impacted teeth in all human ethnicities.[1] The main factors contributing to impaction are an inadequate dental arch space[2] and erratic eruption paths.[3,4]

Impacted third molars, like other impacted teeth, can predispose the remaining dentition to an array of problems, such as pericoronitis and/or orofacial infection, caries and/or periodontitis of the adjacent tooth, root resorption of the adjacent tooth, cystic or neoplastic changes, orthodontic or prosthetic problems, or even temporomandibular joint symptoms.[5,6] Above all, third molar symptoms seriously impinge on the quality of life.[7,8]

By contrast, some lesions associated with impacted mandibular third molars may sometimes be asymptomatic.[9] An example is when there is a localized periodontal problem on the adjacent second molar that is associated with an impacted partially erupted mandibular third molar.[10]

The indications and contraindications for the removal of impacted third molars have been discussed elsewhere.[6] In all cases surgical extraction of the third molar must attempt to conserve or even lead to the regeneration of the periodontal tissues on the distal surface of the adjacent second molar. However, the regeneration of such periodontal tissues seems difficult to achieve, because it represents a complex biologic process that is affected by local oral conditions, such as plaque accumulation, the inflammation of

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periodontal tissue, and the angulation of the third molar and its positional relationship with the adjacent second molar.[10]

Since the 1980s, several studies have focused on the relationship between impacted third molars and periodontal health, as well as the effect of removing impacted third molars, on the health of the periodontium.[10,11]

Some authors have concluded that the extraction of impacted mandibular third molars may cause multiple periodontal defects at the distal root of the second molar, such lesions being more frequent in older patients and when there are preoperative periodontal defects on the distal surface of the second molar before extraction of the impacted third molar.[10] Despite these findings, the same authors reported that early removal of impacted lower third molars with a large angulation and a close positional relationship to the adjacent second molar proved to have a beneficial effect on periodontal health.[12]

Because there is still a lack of consensus in the scientific literature addressing the effect of the extraction of lower third molars on adjacent second molars and on periodontal health, the aim of this study was to evaluate the periodontal conditions of mandibular second molars after surgical extraction of adjacent impacted mandibular third molars, in a prospective study.

Materials and Methods

SAMPLING

Patients requesting mandibular third molar extractions were recruited consecutively at the School of Dentistry, University of Granada, Granada, Spain, during 2005-2006. All participants were above legal age (18 years) and provided specific informed consent to participate in this study. To record baseline periodontal scores, it was previously ascertained that none of the patients were undergoing active periodontal treatment. The study protocol was approved by the ethical committee of the university.

A panoramic radiograph was taken at baseline to evaluate the position of the third molar according to the classifications of Pell and Gregory[13] with respect to the ascending ramus (classes I, II, and III) and with respect to the occlusal plane (types A, B, and C). Classes I, II, and III mean that the space between the anterior part of the ascending ramus and the distal surface of the second molar is sufficient, less than sufficient, and inexistent, respectively, to accommodate the mesiodistal diameter of the crown of the third molar. Position type A means that the highest portion of the tooth is level with or above the occlusal plane. Position type B means that the highest portion of the tooth is below the occlusal plane but above the cervical line of the second molar. Position type C means that the highest portion of the tooth is below the cervical line of the second molar.

Moreover, third molar impaction depth was calculated by aggregating the total scores of the Pell and Gregory classification[13] (ie, class I and type A were coded as 0, class II and type B were coded as 1, and class III and type C were coded as 2). Thus third molars were dichotomized as "shallow molars" (total aggregated score ≤ 1) or "deep molars" (total aggregated score ≥ 2). We also gathered surgical data on the extent of osteotomy (in millimeters) around the perimeter of the third molar, the type of suture, and the type of mucoperiosteal flap (with or without vertical discharge).

SURGICAL TECHNIQUE

All lower third molars were extracted by the same surgeon with patients under local anesthesia, generally with articaine in a 4% solution with epinephrine at 1:100,000 (Ultracain; Hoechst, Barcelona, Spain). The surgical field and all surgical materials were sterile. The surgeon raised a full-thickness flap, which was protected by a Langenbeck retractor. Lingual flap retraction with a Freer periosteal elevator was performed only when necessary. Sterile low-speed (20,000 rpm) handpieces and sterile saline solution were used for ostectomy and tooth sectioning when necessary. To close the wound, No. 3-0 silk suture was used (Aragó; Laboratorio Aragó, Barcelona, Spain). After 7 days, the suture was removed. The surgical technique used was similar to that described elsewhere.[14]

In the short-term follow-up, healing and soft-tissue regeneration were spontaneous without the requirement of any biomaterial or membranes. After the operation, an antibiotic was prescribed (usually 1 g of amoxicillin every 8 hours for 7 days [Clamoxyl; GlaxoSmithKline, Madrid, Spain]), in addition to an anti-inflammatory agent (eg, 600 mg of ibuprofen every 8 hours for 7 days [Saetil; Robapharm, Barcelona, Spain]), an analgesic (usually 575 mg of metamizol every 8 hours for 4 days [Nolotil; Boehringer Ingelheim, Sant Cugat del Vallés, Spain]), and a mouth rinse (0.12% chlorhexidine digluconate every 12 hours for 8 to 10 days [Clorhexidina Lacer; Lacer SA, Barcelona, Spain]). All the postoperative instructions were explained to the patients by the surgeon and were also printed on a paper sheet that was given to the patients. All patients were reminded to perform their regular oral hygiene care, except in the region of the surgical wound, 1 day after surgery. These instructions for proper oral hygiene were also explained during the 4 follow-up visits.

PERIODONTAL EVALUATION AND FOLLOW-UP

The plaque index (PI)[15] and the gingival index (GI)[16] were measured on the facial, lingual, mesial, and distal surfaces of all the teeth of the 4 posterior sextants, excluding the third molars. However, we

only recorded the highest score of both the PI and GI of the 4 quadrants at baseline and at 3, 6, 9, and 12 months after third molar surgery.

The PI[15] was coded as follows: 0, no visible plaque; 1, a thin film of plaque at the gingival margin, visible only when scraped off the tooth with a probe; 2, a moderate amount of plaque along the gingival margin, which could be seen with the naked eye; and 3, a heavy accumulation of plaque at the gingival margin, as well as interdental spaces grossly filled with plaque.

The GI[16] was scored as follows: 0, no visible inflammation (healthy gingiva); 1, gingival inflammation noted by direct observation as a slight color change or mild alteration of the gingival surface, with no bleeding (minor inflammation); 2, moderate inflammation, erythema, and swelling, with bleeding on probing or when pressure is applied; and 3, severe inflammation, erythema, and swelling, with a tendency for spontaneous bleeding and perhaps ulceration.

Furthermore, 3 sites around the second molar—the distolingual, mid-distal, and distobuccal sites—were also considered in the clinical evaluation of the regional periodontal health of the patients. These regions were also explored by the same examiner at baseline and at 3, 6, 9, and 12 months after surgery to quantify the periodontal healing around the distal faces of the second molar, including probing depth (PD), PI, and GI. PD was measured with a Michigan periodontal probe with Williams markings. The probe tip was inserted into the gingival sulcus parallel to the long axis of the tooth until a slight resistance was met. All measurements were recorded to the nearest millimeter.

STATISTICAL ANALYSIS

To evaluate changes in periodontal depth during the follow-up period, we used analysis of variance and the Student *t* test. Changes in the prevalence of periodontal conditions were analyzed with χ^2 tests. The same tests were used to analyze the influence of some surgical factors on periodontal status, as well as changes in it. All analyses were performed with SPSS software, version 15 (SPSS, Chicago, IL). Differences were considered statistically significant at $P < .05$.

Results

This study included 48 patients (20 men and 28 woman) aged between 18 and 29 years, with a mean age at baseline of 23.1 ± 6.1 years. The reasons for the mandibular third molar extraction were pain, infection, follicular cyst, and orthodontic indications. Most of the third molars extracted were classified as deep molars (64.6%), mainly belonging to class II (60.4%) and type B (54.2%) according to the Pell and Gregory classification[13] (Table 1). In most cases the wound was closed with a single suture. Table 1 shows the progressive improvement of the GI and PI in the 4 posterior sextants during the follow-up period.

The periodontal health of the second molar was also found to improve after third molar surgery. Table 2 shows the progressive decrease in PD during the follow-up period, with a final mean PD of 2.6 ± 0.8 mm. The differences between PD values for each observation period showed a significant improvement, with PD being reduced by about 0.6 mm quarterly. The PI and GI scores of the second molar adjacent to the sites of surgery were found to improve gradually during the follow-up period. The relative risk (RR) of having a PI and GI coded as 0 (healthy) or 1 (minor problems) was about 10 times higher at the end of the follow-up than at baseline for both indices (RR of 0.34 [95% confidence interval (CI), 0.22-0.54] for PI at baseline and 3.7 [95% CI, 2.0-7.1] for PI at 12 months and RR of 0.38 [95% CI, 0.24-0.58] for GI at baseline and 3.4 [95% CI, 1.8-6.5] for GI at 12 months).

According to the Pell and Gregory classes and types[13] and the aggregated total scores obtained in our study, molar depth seemed to be the main modulating factor in both the baseline PD and the change in PD during follow-up (Table 3). The deeper the molars, the higher the baseline probing but also the greater the change. The mean change in the distolingual site was significantly greater in the molars extracted with vertical flap discharge than those extracted without discharge.

The gradual improvement in all clinical parameters of periodontal health was statistically significant when we performed comparisons between successive test times (results not shown) by use of repeated analysis of variance. This trend is depicted in Figures 1 and 2. On average, normal values of periodontal health were obtained at 9 to 12 months after surgery.

Discussion

The extraction of mesioangular impacted mandibular third molars when they cause periodontal damage at the distal root of the adjacent second molar has been practiced on a routine basis for some time.[11] The surgical treatment of symptomatic cases of third molar impaction coursing with pain, swelling, infections, and so on is an obvious option to provide the patients with some benefit.[17] However, there is still a lack of consensus in the scientific literature concerning the clinical management of asymptomatic third molars because of the impact of surgical procedures on the periodontal status of the adjacent second molar. In the surgical removal of impacted mandibular third molars, it is important to preserve the integrity of the adjacent second molar.

This study involved quarterly explorations over a 1-year period, focusing on the periodontal conditions at 3 distal sites of mandibular second molars and on the GI and PI after routine surgical extraction of impacted

Table 1. CHARACTERISTICS OF STUDY SAMPLE (N = 48)

Characteristic	n	%	Baseline n	Baseline %	3 mo n	3 mo %	6 mo n	6 mo %	9 mo n	9 mo %	12 mo n	12 mo %
Surgical variables												
Ascending mandibular ramus–related depth*												
I	15	31.3										
II	29	60.4										
III	4	8.3										
Occlusal plane–related depth*												
A	13	27.1										
B	26	54.2										
C	9	18.8										
Osteotomy grade												
None	16	33.3										
1 mm of osteotomy	12	25.0										
2 mm of osteotomy	11	22.9										
3 mm of osteotomy	9	18.8										
Third molar impaction depth†												
Shallow molars	17	35.4										
Deep molars	31	64.6										
Type of suture												
Simple	30	62.5										
Suspended	18	37.5										
Vertically released flap												
Yes	22	45.8										
No	26	54.2										
General periodontal health												
GI												
Healthy			2	4.2	10	20.8	14	29.2	14	29.2	14	29.2
Minor inflammation			20	41.7	12	25.0	12	25.0	20	41.7	21	43.8
Moderate inflammation			16	33.3	26	54.2	22	45.8	14	29.2	13	27.1
Severe inflammation			10	20.8	0	0.0	0	0.0	0	0.0	0	0.0
PI												
0 (no plaque)			0	0.0	6	12.5	8	16.7	10	20.8	14	29.2
1 (thin plaque)			14	29.2	16	33.3	18	37.5	22	45.8	18	37.5
2 (visible plaque)			20	41.7	18	37.5	16	33.3	8	16.7	8	16.7
3 (heavy plaque)			14	29.2	8	16.7	6	12.5	8	16.7	8	16.7

*Pell and Gregory classification.[13]

†Arbitrary classification based on the aggregated scores of both the mandibular ramus–related and occlusal plane–related depths.

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lower third molars. The results of this study show gradual but significant improvements in all the periodontal parameters evaluated (PD, GI, and PI) from baseline to the final evaluation 1 year after the extraction. This improvement was much higher at adjacent second molar sites than the mean values recorded for the 4 posterior sextants (Tables 1 and 2). These improvements would also partially stem from the better plaque control and dental hygiene performed by the subject after third molar removal. Autoclysis was also clearly improved after third molar removal. Moreover, we are well aware that the quarterly checkup visits could have positively influenced the oral health patterns of the patients, and thus the positive effect of third molar removal on the periodontal indices could have been overestimated. The effect of the maintenance of proper oral hygiene after the removal of impacted lower third molars has been reported elsewhere.[1]

The results of many studies support our findings. Blakey et al[18] concluded that removal of mandibular third molars significantly improved the periodontal status of the distal surfaces of the second molars and was also positive in terms of overall periodontal health. Along the same lines, Krausz et al[19] reported that extraction of an impacted lower third molar resulted in a significant gain of alveolar bone height on the distal aspect of the adjacent second molar on the test side, whereas a slight degree of bone loss was noted on the control side.

In contrast, other studies have shown that periodontal breakdown, beginning and becoming established on the distal surface of a mandibular second molar in close contact with a mesioangular impacted

Table 2. PERIODONTAL HEALTH OF SECOND MOLAR AT BASELINE AND DURING FOLLOW-UP PERIOD (N = 48)

	Baseline				3 mo				6 mo				9 mo				12 mo			
	Mean	SD	n	%	Mean	SD	n	%	Mean	SD	n	%	Mean	SD	n	%	Mean	SD	n	%
PD (mm)																				
Distolingual	5.0	1.8			4.4	1.5			3.8	1.3			3.0	1.1			2.5	0.8		
Mid-distal	5.5	2.1			4.5	1.5			4.1	1.4			3.2	0.9			2.6	0.8		
Distobuccal	5.6	1.9			4.8	1.6			3.8	1.3			3.2	1.0			2.7	0.8		
Change in PD during follow-up (mm)																				
Distolingual	0.0	0.0			0.6	0.6			1.3	0.8			2.0	1.0			2.6	1.3		
Mid-distal	0.0	0.0			1.0	0.9			1.5	1.2			2.3	1.5			2.9	1.8		
Distobuccal	0.0	0.0			0.9	0.7			1.8	1.0			2.4	1.4			3.0	1.5		
Second molar GI																				
Healthy			5	10.4			11	22.9			18	37.5			22	45.8			28	58.3
Minor inflammation			12	25.0			22	45.8			17	35.4			16	33.3			12	25.0
Moderate inflammation			19	39.6			11	22.9			9	18.8			7	14.6			4	8.3
Severe inflammation			12	25.0			4	8.3			4	8.3			3	6.3			4	8.3
Second molar PI																				
0 (no plaque)			4	8.3			11	22.9			14	29.2			21	43.8			27	56.3
1 (thin plaque)			11	22.9			19	39.6			21	43.8			18	37.5			13	27.1
2 (visible plaque)			19	39.6			13	27.1			8	16.7			5	10.4			3	6.3
3 (heavy plaque)			14	29.2			5	10.4			5	10.4			4	8.3			5	10.4

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third molar (as evidenced by pre-extraction crestal radiolucency) in association with inadequate plaque control, can predispose patients to a persistent localized periodontal problem after extraction.[20] According to several authors, the risk of worsening the attachment level is a rationale for carefully evaluating the indication for third molar removal.[21,22]

Many authors have pointed out some potentially confounding factors such as preoperative intraosseous defects, age, the size of the contact region between the second and third molars, the inclination of the third molar, and previous root resorption.[23] The main factors modulating the periodontal status of adjacent second molars are older age, a lower level of education, irregular dental visits, and smoking.[23-25]

Our results suggest that the depth of the third molar is strongly correlated with both baseline periodontal probing and the change occurring during follow-up, in

Table 3. FACTORS INFLUENCING PERIODONTAL PD AT BASELINE AND CHANGE IN DEPTH 1 YEAR AFTER SURGERY AT 3 PERIODONTAL SITES

	Baseline PD (mm)						Changes in PD (mm)					
	Distolingual		Mid-Distal		Distobuccal		Distolingual		Mid-Distal		Distobuccal	
Modulating Factors	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Ascending mandibular ramus–related depth												
Class I	3.5	0.7	3.7	0.9	4.2	0.9	1.5	0.5	1.5	1.3	2.2	0.8
Class II	5.6	1.7	6.2	2.1	6.2	2.0	2.9	1.2	3.5	1.7	3.3	1.7
Class III	6.5	1.7	7.0	1.2	6.5	1.7	4.0	1.2	3.5	0.6	3.5	0.6
Intergroup comparisons	$P < .001$		$P < .001$		$P = .001$		$P < .001$		$P = .001$		$P = .053$	
Occlusal plane–related depth												
Type A	4.4	1.8	4.5	1.7	5.0	2.6	2.4	1.3	2.1	1.3	2.4	1.6
Type B	4.6	1.2	5.5	2.1	5.5	1.5	2.2	0.9	2.9	1.8	2.9	1.5
Type C	7.2	1.7	7.0	1.7	6.9	1.6	3.9	1.3	4.1	1.5	4.0	1.0
Intergroup comparisons	$P < .001$		$P = .016$		$P = .067$		$P = .001$		$P = .024$		$P = .037$	
Vertical released flap												
Yes	5.5	2.0	5.5	2.0	5.7	1.6	3.0	1.3	3.0	1.8	3.1	1.1
No	4.7	1.6	5.5	2.2	5.5	2.2	2.2	1.2	2.8	1.8	2.8	1.7
Intergroup comparisons	NS		NS		NS		$P = .045$		NS		NS	
Total molar depth												
Shallow molars	3.6	0.7	3.8	0.8	4.5	1.9	1.7	0.7	1.5	1.1	2.3	1.3
Deep molars	5.8	1.7	6.5	1.9	6.2	1.7	3.0	1.3	3.7	1.6	3.3	1.5
Intergroup comparisons	$P < .001$		$P < .001$		$P = .003$		$P < .001$		$P < .001$		$P = .053$	

Abbreviation: NS, not significant.

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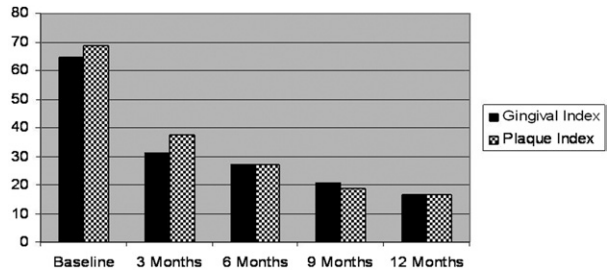

FIGURE 1. Evolution of GI and PI during follow-up.

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agreement with other authors.[12,23] However, because Kugelberg et al[12] postulated that the effects of age on decreasing cellular immunity to dental plaque might underlie the discrepancies found between younger and older patients with regard to their periodontal responses after third molar removal, our results should be considered with caution because of the young age of our patients (mean, 23.1 ± 6.1 years). The importance of age in periodontal healing was confirmed in a study by Kaminishi et al,[26] who stated that patients aged 40 years or older have an increased risk of periodontal problems after the removal of third molars.

The clinical assumption that removing symptomatic partially erupted third molars will improve the gingival health status and plaque level of patients could independently derive from the fact that third molar symptoms influence patients' ability to perform proper oral hygiene, but also influence the capacity of the oral tissues to perform self-cleaning because patients tend to use the contralateral side for chewing. Some authors have concluded that removing partially erupted third molars is significantly associated with a reduction in plaque level in both symptomatic and asymptomatic study groups in comparison to a control group.[27] The same authors reported that the PI and GI were worse in the presence of impacted third molars, except when an osseous wall between the adjacent molars was present. Moreover, it has been suggested that among young adults, the initiation of periodontitis may be due to certain microbial changes occurring in the third molar region.[28] In fact, during pregnancy, third molar periodontal pathology appears to be a significant risk indicator for the progression of periodontal disease.[29]

Again, this fact could be modulated by the patient's age, because some authors have reported that the presence of visible plaque, bleeding on probing, and deep PDs on the distal surface of the second molar do not seem to affect the healing process in younger patients.[23] However, older patients, mainly those with high plaque scores and deep pockets, show significantly deeper intraosseous defects than patients with no preoperative plaque or deep pockets.

Several authors have proposed that the presence of trapped food particles in a region that is difficult to keep clean, together with plaque accumulation in the interproximal space between a second and third molar, may result in inflammation, redness, suppuration, and changes in the gingival tissue not only in the region of the third molar but also in the posterior sextants.[18,28] This has also been confirmed in older samples, in which the presence of a visible third molar was significantly associated with more severe periodontal disease on the adjacent teeth of the sextant, as compared with those subjects with no visible third molars.[29]

The finding of more severe periodontal conditions associated with visible third molars in these middle-aged and older adults indicates that third molars may continue to have a negative impact on periodontal health well into later life.[30]

Our results suggest that proper oral education after the removal of an impacted third molar seems to be enough to improve periodontal health in young, non-periodontal patients. In other studies several different treatment strategies have been proposed to decrease periodontal defects after mandibular third molar extraction. Root planing has been suggested for promoting periodontal healing after third molar removal.[1,31,32] Nevertheless, inconsistent results, including equal and better periodontal healing, have been observed in patients who received root planing after surgical extraction.[1,31,32] The effects of aging and the influence of recall frequency during follow-up have been proposed to explain such inconsistency.[1,31]

Dodson[33] estimated that the use of a demineralized bone powder or guided tissue regeneration therapy after third molar extraction did not offer predictable benefits over no treatment at all. Despite this, some clinicians have reported the efficacy of autologous platelet-rich plasma in bone regeneration to prevent periodontal complications at the roots of mandibular second molars after extraction of a mesioangular impacted third molar, finding that as early as 12 weeks after surgery, this method affords a satisfactory reduction in PD and a gain in attachment, as well as the formation of new bone tissue in the bone defect.[34] However, long-term evalua-

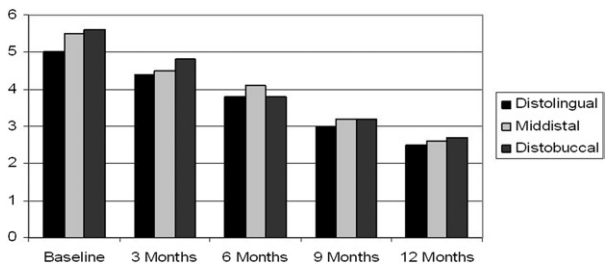

FIGURE 2. Evolution of PD at 3 distal sites during follow-up.

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tion of periodontal health after extraction of impacted mandibular third molars is necessary. We found a clear gradual periodontal improvement without performing any periodontal treatment on the second molar or using guided tissue regeneration techniques, as suggested elsewhere.[31] Indeed, other authors have also found these advanced techniques to be unnecessary.[32] Some authors consider that bone regeneration techniques with bone graft should only be recommended in cases of prior periodontal defects distal to second molars.[35]

According to our results, flap design does not clearly influence the PD or the attachment level on the distal aspect of the second molar after third molar surgery, as reported elsewhere.[35] However, the design and extent of the osteotomy and some tooth-division techniques have been proposed for protecting the distal surface of the second molar.[25]

The removal of a mandibular impacted third molar in young patients improves the initial periodontal PD at the 3 distal sites of the adjacent second molar and in all the posterior sextants. The depth of the third molar is correlated with both the baseline periodontal probing and the change occurring in it during 1 year of follow-up. At 9 to 12 months after the surgical procedure, the periodontal status reached normal values for PI, GI, and PD.

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