J Clin Periodontol 2004; 31: 79–84
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Journal of Clinical Periodontology

Reconstruction of the maxillary midline papilla following a combined orthodontic–periodontic treatment in adult periodontal patients

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Cardaropoli D, Re S, Corrente G, Abundo R: Reconstruction of the maxillary midline papilla following a combined orthodontic–periodontic treatment in adult periodontal patients. J Clin Periodontol 2004; 31: 79–84. © Blackwell Munksgaard, 2004.

Abstract

Objective: The aim of the present study was to evaluate the role of a combined orthodontic–periodontic treatment in determining the reconstruction of midline papilla lost following periodontitis.

Material and Methods: Twenty-eight patients, with infrabony defect and extrusion of one maxillary central incisor, were treated. At baseline, all patients presented opening of the interdental diastema and loss of the papilla. At 7–10 days after open-flap surgery, the intrusive movement started. For each patient, probing pocket depth (PPD), clinical attachment level (CAL) and papilla presence index (PI) were assessed at baseline, end of treatment and after 1 year. PI was also evaluated independently in patients with narrow or wide periodontal biotype (NPB–WPB).

Results: All parameters showed statistical improvement between the initial and final measurements, and showed no changes at follow-up time. The mean residual PPD was 2.50 mm, with a decrease of 4.29 mm, while the mean CAL gain was 5.93 mm. Twenty-three out of 28 patients improved the PI score at the end of therapy. No statistical difference was recorded in PI values between groups NPB and WPB.

Conclusion: The presented clinical protocol resulted in the improvement of all parameters examined. At the end of orthodontic treatment, a predictable reconstruction of the interdental papilla was reported, both in patients with thin or wide gingiva.

Key words: interproximal papilla; midline papilla; orthodontic intrusion; orthodontic–periodontic treatment; periodontal therapy

Accepted for publication 25 March 2003

The presence of interproximal papilla is a topic of concern both for clinicians and patients. Opening of interproximal spaces can produce severe esthetic abnormalities and phonetic problems. Often, the absence of papillary height is the sequela of periodontal disease as well as the response to periodontal treatment, especially after surgical therapy. As a consequential need, soft-tissue augmentation procedures are developing to regenerate lost dental papillae. Unfortunately, while in the literature there are only case reports of papilla reconstruction, no studies are available indicating that papilla regeneration is a predictable result. Several techniques have been proposed to rebuild an atrophied papilla. Shapiro (1985) described a procedure of periodic curettage to stimulate the regrowth of a destroyed papilla. Beagle (1992) reported the reconstruction of lost interdental soft tissues using a combination of roll technique and papilla preservation technique. Han & Takey (1996) proposed the use of a pedicle graft with a semilunar incision together with the coronal displacement of the gingival–papillary unit. Azzi et al. (1998) described a technique using buccal and palatal split-thickness flaps and connective tissue graft.

Often, periodontal disease can lead to the migration of involved teeth, with flaring and space opening in the frontal region so as to cause severe functional and esthetic problems. Today's patients increasingly demand esthetic results in combination with periodontal therapy,

Fig. 1. Patient with extrusion of the left central incisor and loss of the interdental papilla. Initial clinical situation (a); final clinical situation (b); 1-year follow-up control (c); radiographs at baseline and final examination (d).

and this creates the opportunity for orthodontic treatment of the pathologically migrated teeth, with the possibility to improve the long-term prognosis after teeth realignment (Re et al. 2000). Usually, in the frontal region, tooth migration following periodontal disease is a combination of extrusion and a certain grade of proinclination. This kind of migration is often associated with the presence of infrabony defects. Ideally, teeth can be moved into the defects until there is no further clinical evidence of the predisposing defects (Nevins & Wise 1990, Thilander 1996, Cardaropoli et al. 2001). Moreover, pathologic extrusion of periodontally involved teeth can be treated by orthodontic intrusion, in order to re-establish the physiologic clinical crown length and to shorten the distance between the cemento-enamel junction and the marginal bone level (Melsen et al. 1989).

Tarnow et al. (1992) have demonstrated that the most significant factor in determining the presence of the interdental papilla is the distance from the contact point to the crest of the bone. When the distance is 5 mm or less, the papilla is almost always present and when the distance is 7 mm or more, the papilla is usually missing. Certainly, intrusive movement together with space closure is able to give a new contact point or to move apically the contact point between two elongated and spaced teeth, reducing the distance with the crest of the bone and enhancing the papilla possibilities to refill the interproximal embrasure.

Olsson & Lindhe (1991) suggested that subjects with a long-narrow form of the upper central incisors have a thin periodontal biotype and may experience more soft-tissue recession than subjects with a short-wide tooth form and thick periodontal biotype.

The aim of this work was to evaluate the predictability of a combined orthodontic–periodontic treatment in determining the reconstruction of the interdental papilla between the upper central incisors of 28 adult periodontal patients. Moreover, the response to such therapy by patients belonging to a narrow or a wide periodontal biotype has been evaluated.

Material and Methods

In the present study, 28 patients, 22 female and six male, aged 29–60 years (mean 44.79 years, standard deviation 7.76 years) were treated on the basis of the following inclusion criteria: (1) the absence of any systemic disease and no drugs assumption for general health problems; (2) adult periodontitis previously treated by scaling and root planing; (3) good oral hygiene at home with Full Mouth Plaque Score $\leqslant 15\%$ (O'Leary et al. 1972); (4) migration and extrusion of a maxillary central incisor; (5) diastema opening between the two central incisors and loss of the interdental papilla; (6) radiological evidence of infraosseous defect on the mesial aspect of the extruded incisor; (7) probing pocket depth $\geqslant 6$ mm at the osseous defect.

Of the treated teeth, 15 were right central incisors and 13 were left central incisors. All patients had periodontal treatment by means of open-flap surgery, with complete debridement of the root surface and elimination of the granulation tissue from the defect.

Fig. 2. Patient with extrusion of the left central incisor and loss of the interdental papilla. Initial clinical situation (a); final clinical situation (b); 1-year follow-up control (c); radiographs at baseline and final examination (d).

The flap design was a full-thickness intrasulcular incision, from the distal aspect of the left lateral incisor to the distal aspect of the right lateral incisor, with vertical release incisions if needed but no papilla preservation technique (Cortellini et al. 1995). No augmentation material or barrier membrane was utilized. At sutures removal, about 7–10 days after surgery, fixed appliances were placed and orthodontic treatment started following the Segmented Arch technique (Burstone 1977, Braun & Marcotte 1995). Active orthodontic appliances consisted of cantilevers or base arches made of TMA $0.017'' \times 0.025''$. The anchorage system was made by palatal arches and $0.036''$ stainless-steel segments connecting posterior teeth.

Teeth were intruded, realigned and diastemas were closed by means of continuous and light forces, about 10–15 g/tooth. No alternative procedures, i.e. stripping or bonding, were used to close spaces and create contact points.

During the treatment period, patients were included in an oral hygiene maintenance program with a recall appointment at 3–4 months intervals (Boyd 1978, Axelsson & Lindhe 1981).

Orthodontic therapy lasted 6–18 months, with a mean time of 11.71 months (standard deviation 2.98 months).

All patients received post-therapeutic fixed retainers by means of Maryland splint (Corrente et al. 2000) bonded from the left to the right upper cuspid, including six elements. This long-term retention was utilized in order to avoid orthodontic relapse and to decrease tooth mobility, improving chewing comfort.

For each patient, the probing pocket depth (PPD) and the clinical attachment level (CAL) at the interproximal bony defect sites, the index for papilla presence (PI), the distance from the contact point to the crest of bone (BC–CP) and the periodontal biotype (PB) were assessed on the treated central incisors.

The parameters PPD, CAL and PI were measured before surgical treatment, at the end of orthodontic therapy and at the 1-year follow-up recall. The distance BC–CP was measured at the end of orthodontic therapy.

Clinical measurements were taken using a calibrated periodontal probe (PC-15; Hu-Friedy, USA). BC–CP was assessed, under local anesthesia, inserting the probe vertically into the buccal aspect of the contact point until the crest of the bone was sounded. All measurements were rounded off to the nearest millimeter.

To evaluate the presence of the interdental papilla, the classification system proposed by Nordland & Tarnow (1998) has been used. They used identifiable anatomical landmarks for reference, and sorted the degree of loss into four classes. The three landmarks were the interdental contact point (CP), the facial apical extent (bCEJ) and the interproximal coronal extent (iCEJ) of the cemento-enamel junction. Class 0 (normal) was defined when papilla completely fills the interproximal embrasure, Class I when papilla lies between CP and iCEJ, Class II when papilla lies between iCEJ and bCEJ and

Class III when papilla lies apical to bCEJ. On the basis of this classification system, the index for evaluating the degree of papilla's presence was defined, giving four values (0, 1, 2, 3) corresponding to the classes by Nordland & Tarnow.

To determine the periodontal biotype of the treated teeth, the system proposed by Olsson & Lindhe (1991) has been used. They stated that variation in the morphology of the periodontium was related to the shape and form of the teeth.

On the basis of the ratio between the width (CW) and the length (CL) of the crowns (CW/CL ratio), central incisors were divided as having a long-narrow form, corresponding to a narrow-thin periodontal biotype (NPB), or a short-wide form, corresponding to a wide-thick periodontal biotype (WBP).

Initial, final and follow-up data of PPD and CAL were analyzed by means of *t*-test for paired data. Values with $p < 0.001$ were considered as statistically significant.

To test changes in the PI scores at baseline, end of treatment and follow-up, the Wilcoxon's test for paired comparisons was used. Values with $p < 0.001$ were considered as statistically significant.

Variations of PI values in the two groups with different periodontal architecture (NPB and WPB) were also evaluated with *t*-test for non-paired data. *p*-Values < 0.001 were considered as statistically significant.

On initial and final study casts, using a calibrated caliper (P1560-15; Leone, Italy), the amount of intrusion of the treated incisor with respect to the incisal edge of the controlateral tooth was also measured.

Results

The average intrusion was 1.95 mm (SD = 0.48 mm), range 1–3.5 mm. One patient experienced 1 mm of intrusion; in seven cases the amount of intrusion was 1.5 mm and in 17 cases it was 2 mm; three patients had, respectively, 2.5, 3 and 3.5 mm of intrusion for each.

The final mean distance from the contact point of the two central incisors to the crest of bone (BC–CP) was 6.46 mm (SD = 0.91 mm), range 5–9 mm. Three patients reported a final BC–CP of 5 mm, 13 patients of 6 mm; in nine cases the distance was 7 mm, in two cases it was 8 mm and only one patient had a final BC-CP of 9 mm.

Table 1. Mean initial, final and follow-up values (plus standard deviation), with differences, of probing pocket depth (PPD) and clinical attachment level (CAL) (*t*-test for coupled data)

	Initial	Final	Difference	Follow-up	Difference
PPD (mm)	6.79 ± 1.13	2.50 ± 0.51	4.29 ± 1.12 $p = 0.000$	2.64 ± 0.49	0.14 ± 0.36 $p = 0.043$
CAL (mm)	9.21 ± 1.57	3.29 ± 1.21	5.93 ± 1.41 $p = 0.000$	3.54 ± 1.10	0.25 ± 0.44 $p = 0.006$

Table 2. Mean initial, final and follow-up values (plus standard deviation) of papilla presence index (PI) (Wilcoxon's test for paired comparisons)

	Initial	Final	Follow-up
PI	1.57 ± 0.68	0.61 ± 0.57 $p = 0.000$	0.68 ± 0.55 $p = 0.000$

The initial mean PPD was 6.79 mm, while the final mean PPD was 2.50 mm, with an average decrease of 4.29 mm. The difference was statistically significant. The significant decrease of PPD was stable at the follow-up measurement (2.64 mm).

The baseline mean CAL was 9.21 mm and the final mean CAL was 3.29 mm, with an average gain of 5.93 mm. The difference was statistically significant and remained stable at the follow-up moment (3.54 mm).

The mean values and statistical analysis of PPD and CAL are reported in Table 1. The initial, final and follow-up mean PI values were 1.57, 0.61 and 0.68, respectively. The difference between the initial and final and between the initial and follow-up individual PI scores was statistically significant. The mean values and statistical analysis of PI are reported in Table 2.

At the end of treatment, 12 patients were classified as belonging to Class 0 (43% of the total patients), 15 patients to Class 1 (54%) and only one patient to Class 2 according to the papilla presence index (PI). At the follow-up time, only two patients changed their classification, passing from Class 0 to Class 1. Frequencies of PI various score units are reported in Table 3. Patients with final PI Class 0 had a mean BC–CP distance of 6.09 mm (SD = 0.70 mm, range 5–7 mm), while patients of final PI Class 1 had a mean BC–CP distance of 6.63 mm (SD = 0.94 mm, range 5–9 mm). The patient of PI Class 2 had a BC–CP distance of 8 mm.

On the basis of the CW/CL Ratio, 10 patients were classified as having an NBP and 18 patients were classified as having a WPB. The evaluation of PI mean modifications, from baseline to post-treatment, between the two groups

Table 3. Frequency of various Papilla Index score units

	Papilla Index Score			
	0	1	2	3
baseline		15	10	3
final	12	15	1	
follow-up	10	17	1	

NPB and WPB showed no statistical difference. Of the 10 patients of group NPB, two were classified as PI Class 0, seven as PI Class 1 and one as PI Class 2. Of the 18 patients of group WPB, 10 were classified as PI Class 0 and eight as PI Class 1. Statistical analysis of PI modifications in groups NPB and WPB is reported in Table 4.

Discussion

A number of works have demonstrated that orthodontic treatment is no more a contraindication in the therapy of adult patients affected by severe periodontal disease (Melsen & Agerbaek 1994, Ong et al. 1998, Re et al. 2000). Moreover, orthodontics gives the possibility to finalize the treatment of such periodontal patients with pathologic migration, giving good function and satisfactory esthetic after realignment is completed.

Several authors orthodontically moved teeth into infrabony defects, showing the possibility to modify the defects' morphology, obtaining probing depth reduction and radiological bone defect resolution (Nevins & Wise 1990, Cardaropoli et al. 2001, Re et al. 2002a, b).

Intrusion can be a reliable therapeutic treatment in patients with a healthy periodontal status because it does not result in a decrease of marginal bone level, provided gingival inflammation is controlled (Melsen et al. 1989). Best

Table 4. Mean initial and final values (plus standard deviation) of index for papilla presence (PI) and its modification (ΔPI) in groups with narrow periodontal biotype (NPB) and wide periodontal biotype (WPB) (*t*-test for noncoupled data)

	NPB	WPB	Difference
initial PI	1.80 ± 0.79	1.44 ± 0.62	0.36 $p = 0.197$
final PI	0.90 ± 0.57	0.50 ± 0.51	0.40 $p = 0.068$
ΔPI	0.90 ± 0.74	0.94 ± 0.54	0.04 $p = 0.856$

results are obtained when intrusion is performed with light forces (5–15 g/tooth) and the line of action of the force passing close the center of resistance.

In recent years, esthetic demand in dentistry has increased greatly, because of the enhanced awareness of beauty. The management and reconstruction of ''pink esthetics'', the hard and soft tissues surrounding teeth, becomes more of an issue for today's clinicians. The absence of interproximal papilla may cause devastating problems for the patients. Clinicians from various disciplines have described several techniques to rebuild the missing papilla (Shapiro 1985, Beagle 1992, Han & Takey 1996, Azzi et al. 1998), but none of them seems to be able to ensure predictable results. Anatomic characteristics of the interproximal tissues have been described in the literature (Kohl & Zander 1961), and from a morphologic point of view we know that the presence of papilla strictly depends on the distance between the contact point and the crest of bone (Tarnow et al. 1992). When the distance is 5 mm or less, the papilla is usually present, but when the distance is longer the papilla is often missing.

In the present clinical work, the predictability of a combined orthodontic–periodontic treatment was evaluated, in order to recreate lost interdental papilla following periodontal disease in the upper central incisors. Esthetically, the patients in this study benefited from treatment. The periodontal status was maintained by a regular recall program and by the high standard of domiciliary oral hygiene of such patients, usually highly motivated in the maintenance of their dentition after realignment.

The intrusion of the extruded teeth and their movement into the infrabony defects resulted in the formation of a new contact area between the two incisors and in a normalized distance between the contact point and the crest of bone (BC–CP). These factors had a favorable impact on the guided reconstruction of the papilla.

The described protocol determined a reduction of the mean PPD, with a residual average value of 2.5 mm, compatible with healthy periodontal tissues at the end of treatment. PPD reduction also remained stable at the 1-year follow-up measurement.

The mean CAL gain at the end of therapy was 5.93 mm, and the result was maintained after 1 year.

The mean PI value improved almost one point in its range at the end of treatment (i.e. 0.61 from 1.57) and remained stable at the follow-up time.

From initial to final examination, 82% of the patients improved their PI value: 21 patients improved one unit in the range, one patient passed from PI Class 2 to PI Class 0, one patient passed from PI Class 3 to PI Class 1, while five patients did not improve their classification.

At the follow-up examination, only two patients registered an increase of the interdental soft-tissues recession, while 26 patients remained stable. These data clearly indicate a certain extent of papilla reconstruction.

In order to obtain such reliable results, a role of the orthodontic movement can be supposed, started 7–10 days after surgery, able to guide the periodontal tissues during the early phases of the post-surgical healing. In this way, soft tissues had the possibility to adapt on the new emergency profiles, changing day after day due to intrusion. Moreover, moved teeth were capable of filling the interproximal embrasures with their coronal portion that has a wide diameter. Together with the closure of the diastema, the decrease of the distance BC–CP created the presupposing conditions for the reconstruction of the papilla.

The parameter PI has been evaluated independently in the two groups of patients with different periodontal biotypes.

This evaluation was made because it has been suggested that the severity of different symptoms associated with periodontal disease may vary between different periodontal and gingival biotypes. Several authors (Weisgold 1977, Olsson & Lindhe 1991, Seibert & Lindhe 1997) reported that patients with thin periodontal biotype usually respond to plaque-induced inflammation with more recession of the gingival margin than patients with a thick periodontal biotype. So, it can be supposed that managing and reconstruction of the damaged soft tissues is more difficult in cases of thin periodontal biotype.

No significant difference was found in PI values between patients with narrow-thin (NPB) or wide-thick (WPB) periodontal tissues. We can assume that the presented combined treatment was able to determine a reconstruction of the interproximal papilla, with esthetic enhancing, also in patients with a thin gingival biotype, which is supposed to be more susceptible to soft-tissue recession.

The results presented in this clinical work were obtained in a population of 28 adult periodontal patients, in a study extremely standardized due to the restricted inclusion criteria. The results showed a positive outcome of all parameters examined. As the study has no controls, it is difficult to make inferences on the efficacy of this procedure, but due to the morphologic characteristics of the treated patients it is difficult to design a proper test-control study to assess the real efficacy of the presented combined approach.

From a clinical point of view, the final mean PI value suggests that after treatment, on average, papilla lies coronal to the interproximal level of the cemento-enamel junction (iCEJ). From the data analysis, the final mean PPD and CAL values indicate the position of the soft tissues margin apical to the iCEJ. The lack of correspondence between these data should not confuse the reader, because the difference is due to the speculation made on the mean values and to the lack of clinical correspondence between PI scores and CAL–PPD values, as different CAL–PPD values may be compatible with the same PI scores.

Midline interdental papilla reconstruction, independent of the dental and periodontal biotype, confirms the possibilities of such a combined orthodontic–periodontic protocol in the treatment of periodontal patients with esthetic problems following migration of the frontal teeth.

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