

Original Article

Periodontal parameters following orthodontic treatment in patients with aggressive periodontitis: A before-after clinical study

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ABSTRACT

Background: The success of combined periodontal and orthodontic approach in the treatment of aggressive periodontitis patients with the pathologic extruded anterior teeth is a main concern and stability of the treatment results is an important factor to evaluate the treatment. The present study investigated the periodontal parameters at the end of the orthodontic treatment in patients with the aggressive periodontitis.

Materials and Methods: Eight patients with an aggressive periodontal disease, extruded maxillary incisors, infrabony defects and probing depth of ≥ 5 mm were enrolled in this clinical trial (before, after). After periodontal therapy, orthodontic treatment was carried out for intrusion and alignment of teeth. Plaque index (PI), probing pocket depth (PPD), distance between incisal edge and interdental papilla, root length (RL), and defect dimensions (depth and width) were examined at the end of treatment and three as well as 6 months afterward. The data were subjected to repeated measure ANOVA test. $P < 0.05$ was considered as significant.

Results: There was statistically significant decrease in PPD, PI, and depth of the defects during T0, T3 and T6 ($P < 0.05$). No significant differences were observed in the RL and distance between incisal edge and interdental papilla ($P = 0.95$). Furthermore, width of the defects demonstrated significant decrease up to T3 ($P = 0.042$) while no significant changes from 3 months to 6 months were noted ($P = 0.59$).

Conclusion: The results showed that combined periodontal and orthodontic approach would be a successful treatment with acceptable stability in the case of regular follow-up visits and controlled oral hygiene habits.

Key Words: Aggressive periodontitis, orthodontic treatment, periodontal defect

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INTRODUCTION

Today, more demands have been observed to receive orthodontic treatments among different age groups in all societies.^[1] The efficiency and success of orthodontic treatment depends upon the response

of the host periodontal tissues. Orthodontic tooth movement involves reconstruction of the alveolar bone while the movement is associated with the physiological processes of cell activity in the periodontal connective tissue and osteoclast-osteoblast activity in the alveolar bone. Due to the complexity of esthetic and functional rehabilitations, the adjunction of periodontal and orthodontic treatments is necessitated to achieve the treatment goals.^[2]

Orthodontic therapy using fixed or removable appliances can result in the different side effects such as plaque formation or caries incidence.^[3,4] Furthermore, the bacterial population increases in the

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plaque-retentive sites impairing the mechanical plaque removal. These changes can cause a qualitative bacterial shift, with a higher incidence of periodontal pathogens such as *Actinobacillus actinomycetemcomitans* and *Porphyromonas gingivalis*.^[5] Orthodontic treatment affects the periodontium by facilitating plaque-associated gingivitis, contributing to gingival enlargement, an increase in the pocket probing depth (PPD), and bleeding on probing.^[6] All the aforementioned ideas call for a strict oral hygiene during the orthodontic treatments as well as in the years following the treatment.

Due to the risk of permanent tissue injuries and decreased periodontal support, orthodontic tooth movement in patients with untreated periodontal disease is contraindicated. Periodontal treatments such as scaling, root planing, and the removal of deep pockets must be performed before starting orthodontic treatment, as deep pockets can transmit microbial plaque from supragingival to the subgingival locations as well as attachment loss and angular bone defect developments.^[7,8]

Localized aggressive periodontitis, a form of severe periodontal disease, is associated with the connective tissue attachment loss as well as infrabony pockets and vertical bone defects in some specific areas of the dental arch, e.g., first molars and incisors, in the earlier ages.^[9,10]

In 30-50% of the patients infected with the moderate-severe forms of the disease, pathologic migration occurs with the attachment loss and severe bone resorptions, clinically apparent as the elongation, diastema, rotation and labial inclination of the central teeth.^[11,12]

Regenerative treatments are successfully used to manage the vertical bone defects; however, in the case of tooth migration from its original location, ideal esthetics along with the interdental papillae (IPD) reconstructions doesn't achieve even with the successful regenerative approaches requiring adjunctive orthodontic treatments.^[13]

The combined periodontal treatments and intrusion of the anterior elongated and translated teeth together with the controlled oral hygiene is the best treatment plan for the correction of the teeth relationships in the aggressive periodontitis.^[14]

Furthermore, tooth orthodontic vertical movement can resolve some bony defects in the periodontal patients

while this movement eliminates the need to bone respective surgeries.^[2]

Because of the importance of the stability of periodontal therapies, predetermined maintenance follow-up visits are required in patients.^[15] Oral hygiene instructions and 3-6 month visits as well as assessment of the sulcus depth, tooth mobility, gingival recession, bone surface examinations and root planning by the dental hygienist are recommended for these purposes.

The present study investigated the periodontal parameters at the end of orthodontic treatment in patients with aggressive periodontitis.

MATERIALS AND METHODS

This non control before-after clinical trial was approved by the Ethics Committee of Tehran University of Medical Sciences, Dental School. The examinations were performed with the understanding and written consent of each patient. The subjects consisted of eight patients (seven female and one male with the mean age of 30 years old) who had been referred for the treatment of the aggressive periodontitis with the history of teeth extrusion and orthodontic treatment. All patients presented the probing depth of ≥ 5 mm, infrabony defects, 1 mm or more extrusion compared to the similar tooth in the dental arch, while they were all cooperative with the follow-up examinations (Plaque index [PI] of less than 15%). In the case of the systemic disease involvement, drug consumption in the past 3 months, smoking habits, inability to afford orthodontic treatment expense, or not participating in the follow-up examinations, the patients were excluded from the study.

All patients showed clinical and radiographic manifestations of the aggressive periodontitis. They were all received scaling and root planning in regular timings as well as open full-thickness flap was made by a sulcular incision to remove the inner pocket walls and inflammation in consequent. The patients received oral hygiene instructions before orthodontic treatments beginning while they were asked to brush their teeth twice a day.

After stability of the periodontal status and reduction of the PI to 15% or less, when the patients were all satisfied to cooperate with the follow-up examinations, the fixed orthodontic treatment was started using

full arch approach, intrusion step up wire technique and realignment of the central teeth. The loads were applied equally to 10-15 g in each tooth (checked up with Correx™ measuring device, HAAG-STREIT Holding AG) regarding their specific periodontal situations. For preventing the anchorage loss we extend the posterior anchorage to full arch approach, serving from transpalatal arch and the appliances were adjusted once in each 4 weeks. The surface root planning and repeated oral hygiene instructions were done once in each 3 months. The complete orthodontic treatment lasted from 10 months to 2 years specific to each patient [Figure 1]. Afterward, the patients entered retention phase of the treatment. At the treatment end, the fixed appliances were removed and the fixed retainers (Braided stainless steel, 0/38 mm, Dentaflex®, Germany) were used in the maxillae and mandibles. The patients received oral hygiene instructions again.

The O'Leary PI was calculated using the disclosing tablets on the mesial, distal, buccal and lingual surfaces.

PPD was also determined on the six points of Distolingual (DL), Lingual (L), Mesio Lingual (ML), Distobuccal (DB), Buccal (B) and MesioBuccal (MB) by the William's probe in mm. Furthermore, the distance between the papillary

tips to the incisal edge of the teeth was measured to indicate the papillary height compared to the adjacent teeth using a graduated probe in mm. Then, periapical radiographies were obtained by a long cone parallel approach. In order to achieve a correct film position, adequate reliability and prevention of the higher exposures, a film holder of the putty silicone index was fabricated for each patient from his/her own occlusal position. The film was located parallel to the teeth long axis and perpendicular to the beam with the dose of 40 Kvp. On the radiographic image, a line was drawn perpendicular to the root (Tooth Crest point;TC) from the most upper area of the Bone Crest (BC) using a pencil and Negatoscope. The distance between TC and BC suggested the Defect Width (DW). Again, a line was drawn from BC to the most extreme area of the bone defect. The distance between TC and Bone Defect (BD) showed the Defect Depth (DD). For the measurement of the Root Length (RL), a line was traced from the lowest regions of the root to the lowest regions of Cementoenamel Junction (CEJ) [Figure 2].

The measurements were repeated on the three and 6 months after the end of the orthodontic treatments while the data were statistically analyzed using the repeated measure ANOVA and Bonferroni *post hoc* tests on 0, 3 and 6 months following orthodontic treatments. $P < 0.05$ was considered as significant.



Figure 1: (a, b) Frontal and lateral view of extruded right maxillary central related to bone loss in a patient affected by localized aggressive periodontitis (pathologic movement) after periodontal treatment and just before starting of orthodontic force, (c, d) 6 month after fixed orthodontic treatment utilizing full arch technique and step up wire intended for intrusion of anterior extruded tooth, (e) end of the orthodontic force treatment

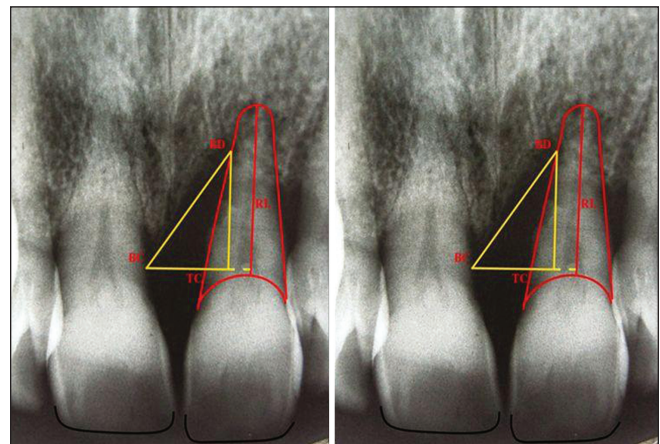


Figure 2: The most upper area of the Bone Crest determined as BC) point. The point that created from a line that was drawn perpendicular to the root from BC point determined as Tooth Crest or (TC) point. The point that created from a line that was drawn from the BC point to the most extreme area of the Bone Defect determined as BD point. The measurement from the lowest regions of the root to the lowest regions of cemento enamel junction CEJ of tooth determined as root length

RESULTS

The mean and standard deviation of PI scores was $27.39 \pm 8.75\%$ at the end of the orthodontic treatment (T0) decreasing to $17.63 \pm 4.57\%$ at the 3rd month (T3) and $11.88 \pm 2.59\%$ at the 6th month following the treatment (T6). The changes of plaque scores were statistically significant during the studied time. Furthermore, the PI changes found between the end of the treatment (T0) compared to the 3rd ($P = 0.032$) and 6th month after the treatment, was also significant ($P = 0.022$). The differences found between the 3rd month and 6th month were also statistically significant ($P = 0.022$) [Table 1].

The mean and standard deviation of PPD were also 1.93 ± 0.9 mm, 1.79 ± 0.87 mm and 1.7 ± 0.85 mm at T0, T3, and T6 respectively with overall significant changes. Statistically, significant differences were also found between PPD measured at T0 and T3 ($P = 0.042$), T0 and T6 ($P = 0.039$), and T3 and T6 ($P = 0.047$) [Table 2].

The mean distance of the incisal edge to the IPD was 5.97 ± 0.44 mm at T0, 5.99 ± 0.42 mm at T3 and 5.97 ± 0.33 mm at T6 with no statistically significant differences ($P = 0.932$) [Table 3].

Furthermore, the mean DD in the patients was 2.5 ± 0.46 mm at T0, 2.34 ± 0.54 mm at T3 and 2.09 ± 0.7 mm at T6. The decrease measured in the DD was statistically

Table 1: Mean and standard deviation of plaque index

Plaque index	N	Minimum	Maximum	Mean	Standard deviation
PI 0	8	20.00	41.60	27.3875*	8.75221
PI 3	8	15.00	25.00	17.6250*	4.56501
PI 6	8	10.00	15.00	11.8750*	2.58775
Valid N (listwise)	8				

PI 0: Plaque index at the baseline; PI 3: Plaque index 3 month after finishing of treatment; PI 6: Plaque index 6 month after finishing of the treatment. *Statistically significant ($P < 0.05$)

Table 2: Mean and standard deviation of probing depth (in mm)

Probing pocket depth	Mean	Standard deviation	N
PPD 0	1.9300*	0.90550	8
PPD 3	1.7853*	0.87021	8
PPD 6	1.7017*	0.84956	8

PPD 0: Probing Pocket depth at baseline; PPD 3: Probing Pocket depth 3 month after finishing of the treatment; PPD 6: Probing Pocket depth 6 month after finishing of the treatment. *Statistically significant differences were found between PPD measured at T0 and T3, T0 and T6, and T3 and T6 ($P < 0.05$)

significant between T0 and T3 ($P = 0.0432$), T0 and T6 ($P = 0.039$), and T3 and T6 ($P = 0.035$) [Table 4].

There was also significant differences between T0 and T3 ($P = 0.042$), and T0 and T6 ($P = 0.039$) regarding the infrabony DW (2.15 ± 1.11 mm, 1.9 ± 1.11 mm and 1.9 ± 1.11 mm respectively) while no significant changes were observed between T3 and T6 ($P = 0.59$) [Table 5].

The RL was remained constant during the 6 months and no statistically significant differences were found between the times patients examined in this regard ($P = 0.95$).

Table 3: Mean and standard deviation of the distance between top of the papilla and incisal edge (in mm)

Papilla incisal distance	N	Minimum	Maximum	Mean	Standard deviation
PID 0	8	5.50	6.62	5.9720*	0.44421
PID 3	8	5.50	6.50	5.9980*	0.42464
PID 6	8	5.62	6.50	5.9740*	0.33672
Valid N (listwise)	8	—	—	—	—

PID 0: Papilla-incisal distance at baseline; PID 3: Papilla-incisal distance 3 month after finishing of the treatment; PID 6: Papilla-incisal distance 6 month after finishing of the treatment. *No statistically significant differences ($P > 0.05$)

Table 4: Mean and standard deviation of the defect depth (in mm)

Defect depth	N	Minimum	Maximum	Mean	Standard deviation
DD 0	8	2.00	3.00	2.500*	0.4629
DD 3	8	1.75	3.00	2.3438*	0.54996
DD 6	8	1.00	3.00	2.0938*	0.70632
Valid N (listwise)	8	—	—	—	—

DD 0: Defect depth at the baseline; DD 3: Defect depth 3 month after finishing of the treatment; DD 6: Defect depth 6 month after finishing of the treatment. *Statistically significant between T0 and T3, T0 and T6, and T3 and T6 (all: $P < 0.05$)

Table 5: Mean and standard deviation of the defect width (in mm)

Defect width	N	Minimum	Maximum	Mean	Standard deviation
DW 0	8	1.0	4.5	2.150*	1.1123
DW 3	8	0.50	4.00	1.9063*	1.11753
DW 6	8	0.50	4.00	1.9063*	1.11753
Valid N (listwise)	8	—	—	—	—

DW 0: Width of the defect at the baseline; DW 3: Width of the defect 3 month after finishing of the treatment; DW 6: Width of the defect 6 month after finishing of the treatment. Significant differences between T0 and T3 ($P < 0.05$), and T0 and T6 ($P < 0.05$). *No significant changes between T3 and T6 ($P > 0.05$)

DISCUSSION

Regenerative treatments have been used in the aggressive periodontitis patients involved with infrabony defects experiencing tooth pathologic migrations. As mere periodontal therapy is unable to improve destructions occurred because of the pathologic occlusion, especially those resulted for the interdental papillary elimination, and orthodontic therapies are recommended for the intrusion and alignment of the involved teeth.^[2,11,13] The stability of the treatment results are also important due to the severe bone destructions in these patient while most studies did not consider the issue in their short or long term assessments.^[16,17,22] Furthermore, patients may consider the appliance removal as the treatment final step without any attempt to cooperate with the maintenance phase. In the present study, periodontal parameters were examined at the maintenance phase of the treatment and reorganization of periodontal ligaments after the removal of orthodontic appliances.

Some studies reported adverse consequences for the orthodontic treatment of aggressive periodontitis patients with the history of anterior teeth extrusion such as inability to adequate mechanical plaque control after the treatment,^[18] the possible conversion of supra-gingival plaque to sub-gingival plaque (8), destruction of the periodontal tissues following orthodontic treatment,^[16,19] and increased tissue destructions in the orthodontic patients.^[20] Hence, excellent plaque control with the regular follow-up visits of 3-6 months and use of simply applied light and continuous orthodontic forces are suggested for the successful treatment of the patients with the vertical periodontal defects.

In the present study, fixed orthodontic retainers were used for the patients, which have been previously shown to result in the controlled movements in three plans enabling light and continuous loads application, necessary to achieve bone regenerations.^[20] These retainers make physiologic tooth movements possible and lead to the improved periodontal health and bone remodeling by controlling the unnecessary movements.^[21] Furthermore, the device does not require patient's cooperation being ideal for their easiness and esthetic demands.^[20,22,23] Some case, reports showed the decreased probing depth, improved defect dimensions, bone gain, acceptable C/R ratio, good periodontal health, good esthetics, and function following combination therapies for aggressive

periodontitis patients.^[24] As the treatment comprises both orthodontic and periodontal approaches, the maintenance and stability of both treatments must be taken into consideration. Although, some investigations stressed the importance of the treatment stability and maintenance phase, no study examined the treatment success in the long term as far as the authors know.

PI of the patients decreased constantly during the 6 month period, which may be due to the simplified oral hygiene habits after appliance removal and teeth realignment. These findings are similarly reported by Re, *et al.*,^[25] Prior to the appliance removal, the efficacy of oral hygiene habits is limited,^[16,20] which justify the great differences of PI between T0 and T3 and T6. Furthermore, the decreased plaque accumulation between T3 and T6 can be related to the use of modified bass technique in tooth brushing, which is the most effective mechanical method in the plaque removal.^[5,26] It is obvious that patients will be motivated observing the orthodontic treatment results with a great effort to maintain these results.

The significantly decreased probing depth during T0, T3, and T4 was also associated with the appliance removal or the use of new modified brushing method; both leading to the simplified oral hygiene habits, effective plaque removal, decreased pathogen population or gingival inflammation improvements.^[26] Direct relationships between PI and probing depth coincides with the studies reporting decreased probing depth and attachment gain after the reduced PI and inflammation.^[27]

Significant reductions in the probing depth were also reported when routine treatment modalities of the surgery or antibiotic therapies have been used for aggressive periodontitis patients.^[28] These studies showed reductions of the inflammation or pathogen populations as a prerequisite for the decreased probing depth as observed in the present study. Zhu, *et al.*, showed all under-40-aged aggressive periodontitis patients experienced probing depth reductions after receiving intrusion treatment,^[29] although, pocket depth remained stable between treatment end time and 1 year afterwards as shown by Re, *et al.*,^[25] According to Melsen, *et al.*, the decreased probing depth is a result of new connective tissue formation after increased periodontal ligament cellular activity and closure of the formative cells to the tooth surface.^[30] Passanzaei interpreted the increased new

connective tissue formation after successful root planning in the orthodontic/periodontic combination therapy of aggressive periodontitis as a result of the roots' tendency to the mesenchymal cells compared to the epithelium cells.^[31] However, some reports denied the role of new connective tissue after orthodontic treatments stating long junction epithelium as a reason for the decreased probing depth.^[32]

Although, showing the probing depth to be reduced, our results failed to discriminate between new connective tissue and long junctional epithelium as histopathological specimens were required for this purpose, which was not possible in the studied subjects (However, considering the results reported by Passanzaei and decreased radiographic dimensions of the bone defects; new connective tissue possibly had been formed.^[31]

No significant differences were observed regarding the distance between tooth incisal edge to the interdental gingival margins during T0, T3, and T6 time intervals. The tooth stable relationships with the adjacent teeth, the stable orthodontic treatment results and no recessions in the interdental gingival tissue may be responsible in this regards. As IPD adheres to the underlying bone surface, the stable periodontal tissue and underlying bone prognosis is made as there is no recession in the interdental gingival tissues.^[33] Orthodontic treatments were effective to reconstruct IPD calling for a way to preserve the results in the long term period.^[20] Similar to our findings, Re, *et al.*, concluded no gingival recession, no appearance change as well as periodontal improvements after 1-years follow-up in aggressive periodontitis patients underwent intrusion therapy and bonded retainers.^[25] However, Levin, *et al.*, regarded fixed retainers as a cause for gingival recessions due to the limited oral hygiene control and 50% failures were reported for the fixed retainers during 4-40 month post-treatment observations.^[34]

The RLs were remained stable at T0, T3, and T6 as determined by the radiographic images suggesting lack of any root recession and availability of the standardized radiographic images. It has declared no root recession when intruding the tooth toward the infrabony defects being correlated with the applying light and continuous loads similarly to our results.^[20] Intrusion apparently focuses loads in the apex, PDL region and surrounding bone, although, with the lower values applying toward a bony defect;

ischemic necrosis risk would be reduced, PDL cells be affected and their turn over would be increased.^[20] On the contrary, some investigations reported signs of root recessions during the orthodontic active phase as a natural mechanism of intrusive forces which are related to the conical characteristic of the anterior teeth and force concentration in the apex. Ischemic necrosis of PDL and miner eliminations in the precementum, cementoblasts, and dentinoclasts' colonization are the consequences of the mentioned mechanism.^[35]

In the present study, significant reductions were found between the paired follow-up times after the treatment concerning DD and width; although, the width differences were insignificant between T3 and T6. The increased bone formation following orthodontic tooth movements toward infrabony defects are justified by different mechanisms such as PDL tissue tension and its role as a natural barrier against epithelial cells penetration into the defect (Guided Bone Regeneration (GBR) imitation),^[20] the increased bone formations by the periodontal ligament cells,^[22,36,37] the effect of orthodontic mechanical forces as the first messenger as well as its effect on the bone coupling^[37] jiggling,^[38] reactivation of the bone formation and osteogenic properties of the remaining soft tissue in the primary defect location.^[30] The defect dimensions was examined when the orthodontic treatment had been finished in which bone complete mineralization did not occur yet, in turn, the reduced defect dimensions may be related to the gradual mineralization of the bone during orthodontic treatment phase as shown by the radiographic imagine.^[20] Furthermore, prevention of the jiggling phenomenon,^[38] followed by the tooth splint with the fixed retainer could reduce inflammation and pathogen agents that is important in the formation and remineralization of the new bone. In addition, orthodontic forces may result in the increased width of periodontal ligament space with the reduced bone remodeling. After the orthodontic treatment and force elimination, PDL returns to its normal values gradually. Therefore, the decreased radiographic dimensions of the defects are influenced by the changes occurred in periodontal ligament spaces.^[39,40]

The stable radiographic width of the defects at T3 and T6 time intervals can be interpreted in terms of completed bone mineralization at T3, so that, as shown by radiographic images, PDL would have returned to its normal values at T3.

However, the authors believe; further studies are necessary to measure clinical parameters with a constant reference point in a larger sample size to facilitate a more accurate long-term evaluation of gingival changes.

CONCLUSION

With the limitations of this study, the stable treatment results can be obtained with the regular follow-up visits and controlled oral hygiene habits in patient with aggressive periodontitis that are treated with a combination of periodontal and orthodontic treatment option.

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