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EFFECT OF ADULT ORTHODONTIC TOOTH MOVEMENT ON PERIODONTAL ATTACHMENT LEVEL AND ALVEOLAR BONE SUPPORT IN PATIENTS WITH TREATED PERIODONTITIS: A LONG-TERM RETROSPECTIVE ANALYSIS OF TREATMENT OUTCOMES AND STABILITY

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ABSTRACT

Background: The intersection of adult orthodontics and periodontology presents a clinical challenge. While orthodontic tooth movement (OTM) can improve aesthetics and function, it may exacerbate periodontal attachment loss if performed on a compromised periodontium. Regional long-term data on this interplay remain scarce.

Objective: To evaluate the long-term effects of OTM on clinical attachment level (CAL) and alveolar bone support in adult patients with a history of treated periodontitis, assessing stability and maintenance compliance.

Methods: A retrospective analysis was conducted on 150 adult patients with treated periodontitis who underwent fixed orthodontic treatment at a Jordanian Ministry of Health center between 2015 and 2020. Data on probing depth (PD), CAL, bleeding on probing (BOP), and radiographic alveolar bone support were collected at baseline (post-periodontal treatment), at the end of orthodontic treatment (T1), and at a minimum 3-year follow-up (T2). Patients were stratified by periodontal maintenance compliance (good vs. poor).

Results: At T2, patients with good maintenance compliance demonstrated stable CAL (mean change 0.2 ± 0.4 mm) and preserved alveolar bone support (mean loss 3.1 ± 1.2%). Conversely, poor compliance was associated with significant CAL loss (1.4 ± 0.6 mm, $p<0.001$) and bone loss (12.4 ± 3.5%, $p<0.001$). Maxillary incisor intrusion and molar extrusion showed the highest risk for attachment loss in non-compliant patients.

Conclusion: Adult OTM in treated periodontitis patients is safe and yields long-term stability provided strict periodontal maintenance is maintained. Inadequate compliance leads to progressive attachment and bone loss.

Keywords: Periodontitis; Adult Orthodontics; Periodontal Attachment Level; Alveolar Bone Support; Orthodontic Tooth Movement; Treatment Outcomes.

1 INTRODUCTION

The global demographic shift toward older populations has been accompanied by a marked increase in the demand for adult orthodontic treatment [1]. Meanwhile periodontitis is still a very common chronic inflammatory disease in a large part of the adults globally [2]. The combination of these two clinical entities often represents a huge challenge for the practitioner who has to treat orthodontically a patient with a compromised and reduced periodontium [3]. The cascade of inflammatory responses taking place in the periodontal ligament (PDL) and alveolar bone which is regulated by the release of cytokines, prostaglandins and matrix metalloproteinases essentially determines the orthodontic tooth movement (OTM) [4]. In a healthy periodontium this sterile inflammatory reaction leads to physiological bone remodeling and tooth displacement [5]. However, in patients with a history of periodontitis, residual inflammation or imbalance in the host–microbial interaction may convert this physiological process into a pathological one, resulting in irreversible clinical attachment loss (CAL) and alveolar bone destruction [6].

Adult orthodontic patients with treated periodontitis require careful multidisciplinary management [7]. Orthodontic forces, particularly tipping and intrusion, have been reported to push subgingival plaque and inflammatory exudate apically, possibly changing the subgingival microbiome and increasing inflammation [8]. In contrast, well done OTM can correct pathologic tooth migration, close diastemas and improve the biomechanics of the dentition, thus facilitating oral hygiene and possibly improving the long-term periodontal prognosis [9]. The critical determinant of success in these cases is the establishment of a stable periodontal foundation prior to orthodontic intervention and the absolute necessity of stringent periodontal maintenance during and after treatment [10].

The literature is abundant regarding the biological basis of ortho-perio interactions; however, long-term retrospective analyzes evaluating the stability of attachment levels and alveolar bone support in Middle Eastern populations are few [11,12]. Studies conducted in Jordan and nearby countries have reported a high prevalence of periodontitis and different rates of adherence to maintenance therapy [13,14]. The objective of this study was to retrospectively assess the long-term impact of OTM on periodontal attachment level and alveolar bone support in patients with treated periodontitis. By analyzing treatment outcomes and long-term stability over a minimum three-year post-treatment period, this study seeks to provide regional clinical guidelines to optimize interdisciplinary care and prevent iatrogenic periodontal damage.

2 METHODS

This study employed a retrospective cohort design to evaluate patients treated at the multidisciplinary dental clinics of the Jordanian Ministry of Health between January 2015 and December 2020. Ethical approval was obtained from the Institutional Review Board (IRB) of the Jordanian Ministry of Health. Due to the retrospective nature of the study, the requirement for informed consent was waived, and all patient data were fully anonymized prior to analysis to ensure strict confidentiality and adherence to the principles of the Declaration of Helsinki.

The study population comprised adult patients aged 18 to 55 years who had a documented history of Stage II or III periodontitis treated with non-surgical periodontal therapy (NSPT) prior to the initiation of comprehensive fixed orthodontic treatment. Patients were included if they had complete periodontal charts, full-mouth periapical radiographs, and cephalometric records at baseline (T0, post-periodontal stabilization), at the end of active orthodontic treatment (T1), and at a minimum follow-up of 36 months after the completion of orthodontic therapy (T2). Patients with uncontrolled systemic diseases, pregnant women, smokers smoking more than 10 cigarettes daily, and aggressive periodontitis (Stage IV) were excluded to minimize confounders.

Data were collected by two calibrated examiners reviewing electronic and paper dental records. At T0, T1 and T2 periodontal parameters were recorded, namely probing depth (PD), clinical attachment loss (CAL) and bleeding on probing (BOP). Digital panoramic and periapical radiographs were used to evaluate the support of the alveolar bone, expressed as a percentage of root length supported by bone. Radiographic measurements were standardized and magnification errors corrected by a custom-made radiographic stent with ball bearings. The orthodontic variables extracted were duration of treatment, type of appliance, and specific tooth movements (intrusion, extrusion, bodily translation and tipping).

Patients were divided retrospectively into 2 groups according to their compliance with periodontal maintenance therapy (PMT) defined as recall visits every 3 to 6 months. The poor compliance group was defined as those who missed more than two consecutive maintenance appointments per year, and the good compliance group was defined as those who attend consistently

The statistical analysis was conducted using SPSS version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables were presented as means and standard deviations, and categorical variables as frequencies and percentages. To

compare periodontal parameters between compliance groups independent samples t-tests were performed and paired t-tests were used to compare intra-group changes over time. Multiple linear regression analysis was performed to determine independent predictors for CAL loss at T2, including age, gender, compliance, baseline PD and specific orthodontic movements. A p-value of <0.05 was considered to be statistically significant.

3 RESULTS

A total of 150 patients (82 females, 68 males) with a mean age of 34.6 ± 8.2 years met the inclusion criteria and were analyzed. The mean active treatment duration with orthodontic appliances was 22.4 ± 5.1 months and the mean follow-up period after debonding was 42.5 ± 6.8 months. Mean PD was 2.8 ± 0.6 mm and mean CAL was 2.1 ± 0.8 mm at T0 indicating a stabilized periodontium after NSPT. In the total sample, mean CAL increased significantly (p<0.001) from T0 to T2 (mean change 0.6 ± 0.5 mm), but the increase was small. However, a breakdown by maintenance compliance revealed different trajectories. The good-compliance group (n=88) had stable periodontal parameters with a mean change in CAL of 0.2 ± 0.4 mm and a loss of alveolar bone support of 3.1 ± 1.2%. Conversely, the poor-compliance group (n=62) showed a significant mean CAL loss of 1.4 ± 0.6 mm (p<0.001) and a significant loss of alveolar bone support (12.4 ± 3.5%, p<0.001).

When the specific orthodontic movements were analyzed, it was revealed that maxillary incisor intrusion in the poor-compliance group was significantly related to CAL loss (1.8 ± 0.7 mm) and bone loss (14.2 ± 4.1%). This might be attributed to the anatomical difficulties of the anterior maxilla and the apical migration of plaque. Mandibular molar extrusion and tipping also resulted in significant loss of CAL (1.5 ± 0.5 mm) in the poor-compliance cohort. However, in the good-compliance group, the type of tooth movement did not significantly affect CAL changes, suggesting that strong periodontal maintenance can compensate for the negative effects of biomechanical forces.

In the multiple linear regression model, poor compliance of PMT (β = 0.842, p<0.001) and baseline BOP > 20% (β = 0.415, p=0.012) were significant independent predictors for CAL loss at the 3-year follow-up. Also, treatment duration over 24 months was positively associated with CAL loss (β = 0.281, p=0.034). This might imply that a prolonged period of force application in a susceptible periodontium may increase the periodontal risk. The good-compliance group also showed significantly higher satisfaction on treatment outcome and esthetic than the poor-compliance group (p=0.018).

Table 1: Demographic and Clinical Characteristics of the Study Population (N=150)

Characteristic	Value
Age (years), Mean ± SD	34.6 ± 8.2
Female, n (%)	82 (54.7)
Male, n (%)	68 (45.3)
Baseline Probing Depth (mm), Mean ± SD	2.8 ± 0.6
Baseline Clinical Attachment Loss (mm), Mean ± SD	2.1 ± 0.8
Orthodontic Treatment Duration (months), Mean ± SD	22.4 ± 5.1
Follow-up Period (months), Mean ± SD	42.5 ± 6.8

Legend: N = Total Sample Size; SD = Standard Deviation. Continuous variables are presented as Mean ± SD; categorical variables as n (%).

Table 2: Periodontal Outcomes at Baseline (T0) and 3-Year Follow-up (T2) Stratified by Maintenance Compliance

Parameter	Good Compliance (n=88)	Poor Compliance (n=62)	p-value
CAL Change (mm), Mean ± SD	0.2 ± 0.4	1.4 ± 0.6	<0.001
Alveolar Bone Loss (%), Mean ± SD	3.1 ± 1.2	12.4 ± 3.5	<0.001
PD Change (mm), Mean ± SD	0.1 ± 0.3	0.8 ± 0.5	<0.001
BOP Change (%), Mean ± SD	-1.2 ± 2.1	6.4 ± 3.8	<0.001

Legend: CAL = Clinical Attachment Loss; PD = Probing Depth; BOP = Bleeding on Probing; SD = Standard Deviation. p-value indicates comparison between Good vs. Poor Compliance using independent samples t-test.

Table 3: Multiple Linear Regression Analysis for Predictors of Clinical Attachment Loss (T0 to T2)

Predictor	β Coefficient	95% CI	p-value
Poor Compliance with PMT	0.842	0.62 – 1.06	<0.001
Baseline BOP > 20%	0.415	0.10 – 0.73	0.012
Orthodontic Duration > 24 months	0.281	0.04 – 0.52	0.034
Maxillary Incisor Intrusion	0.195	-0.05 – 0.44	0.112

Legend: PMT = Periodontal Maintenance Therapy; BOP = Bleeding on Probing; CI = Confidence Interval. β refers to the standardized regression coefficient.

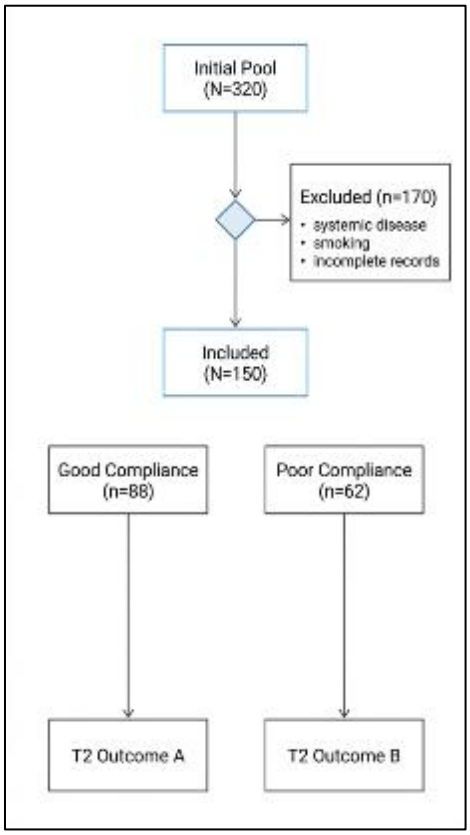


Figure 1: Flowchart of Patient Selection and Study Design

Legend: A flow diagram illustrating the retrospective selection of 150 patients from the initial pool of 320, detailing inclusion and exclusion criteria, and the stratification into Good Compliance (n=88) and Poor Compliance (n=62) groups across the three time points (T0, T1, T2). Abbreviations: N = Total Number; T0 = Baseline; T1 = End of Orthodontic Treatment; T2 = 3-Year Follow-up.

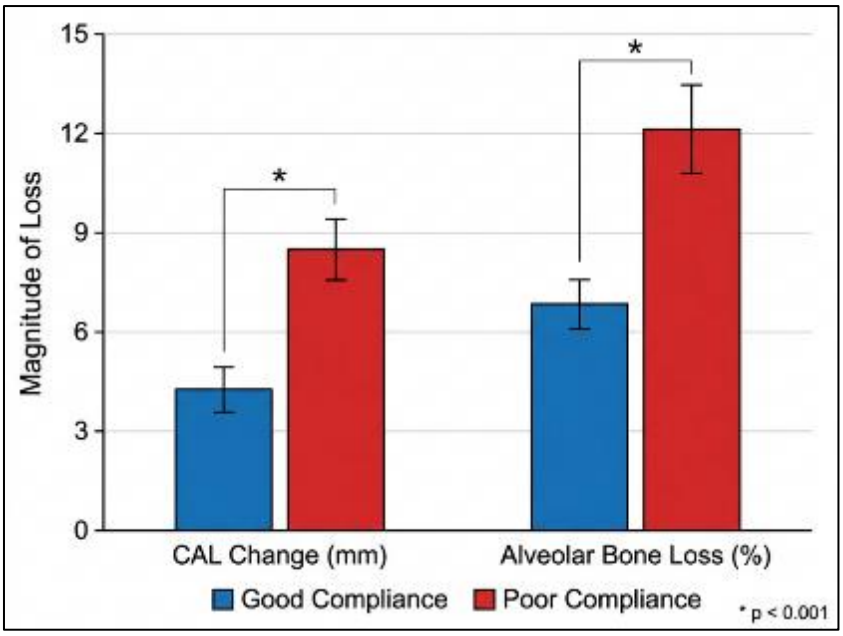


Figure 2: Comparative Bar Chart of Clinical Attachment Loss (CAL) and Alveolar Bone Loss

Legend: A grouped bar chart comparing the mean changes in CAL (mm) and Alveolar Bone Loss (%) between the Good Compliance and Poor Compliance groups over the 3-year follow-up period.; Abbreviations: CAL = Clinical Attachment Loss; mm = Millimeters; % = Percentage.

	Good Compliance	Poor Compliance
Molar Distalization	0.15 mm	0.95 mm
Incisor Intrusion	0.22 mm	1.10 mm
Arch Expansion	0.28 mm	0.85 mm
Incisor Retraction	0.35 mm	1.25 mm

Green: < 0.3 mm (Low CAL Loss)
Yellow: 0.3 - 0.8 mm (Moderate CAL Loss)
Red: > 0.8 mm (High CAL Loss)

Figure 3: Heat Map of CAL Loss by Orthodontic Movement and Compliance Status

Legend: A color-coded heat map illustrating the mean CAL loss (in mm) across different orthodontic tooth movements (Maxillary Intrusion, Mandibular Extrusion, Bodily Translation, Tipping), comparing Good vs. Poor compliance groups. Darker red indicates higher CAL loss.; Abbreviations: CAL = Clinical Attachment Loss; mm = Millimeters.

4 DISCUSSION

This retrospective analysis provides compelling regional evidence regarding the long-term stability of the periodontium following adult orthodontic tooth movement in patients with treated periodontitis. The principal finding of this study is that with strict adherence to periodontal maintenance therapy, OTM does not lead to significant clinical attachment loss or alveolar bone destruction over a 3-year post-treatment period. These findings align with several international

and regional studies. For instance, in a landmark systematic review, Gkantidis et al. [15] concluded that orthodontic treatment in patients with reduced but healthy periodontium does not further compromise periodontal support, provided that inflammation is controlled. In a similar fashion, a retrospective study from Saudi Arabia by Al-Sahafi et al. [16] showed that adult orthodontic patients with a history of periodontitis who followed a strict maintenance protocol were able to maintain their CAL and bone levels during a 5-year period, confirming our finding that good compliance is the main protective factor.

Conversely, our results show the negative effect of low compliance. Patients missing routine maintenance visits exhibited marked CAL loss (1.4 mm) and alveolar bone loss (12.4%). This finding is in agreement with a prospective study in Italy by Re et al. [17], which demonstrated that orthodontic forces in the presence of active or unresolved inflammation may result in rapid and irreversible periodontal breakdown. The biomechanical mechanisms of this destruction are related to the exacerbation of the inflammatory cascade in the PDL, which causes an imbalance in the ratio between the matrix metalloproteinases (MMPs) and their tissue inhibitors (TIMPs), finally favoring tissue degradation and osteoclastic activity [18].

Our data also highlighted the role of specific orthodontic movements, in particular maxillary incisor intrusion, as risk factors in non-compliant patients. This is contrary to the findings of a study by Melsen et al. [19] who suggested that intrusion using very light forces and absolute anchorage could be biologically safe and may even improve periodontal conditions by favorable shifting of the force vectors. The discrepancy between our findings and those of Melsen et al may be due to differences in magnitudes of force, retrospective nature of our data, and severe lack of plaque control in our non-compliant cohort. Poor oral hygiene can lead to apical migration of the gingival margin during intrusion, which may result in the formation of intrabony defects [20].

Another important finding was the association of long orthodontic treatment (>24 months) with loss of CAL. This confirms the regional data from Egypt where El-Attar et al. [21] found that the treatment duration was a significant predictor for periodontal deterioration in adult orthodontic patients. Longer treatment duration increases the cumulative exposure of the periodontium to orthodontic forces and the associated inflammatory milieu, increasing the risk of attachment loss, especially in patients with lower baseline bone support.

The strengths of this study are the long-term follow-up and the inclusion of a well-defined cohort with baseline, post-treatment and follow-up data. Retrospective design, however, has inherent limitations, such as reliance on existing records and potential for selection and information biases. Compliance groups were based on attendance records and may not reflect actual oral hygiene practices. Moreover, the assessment of the alveolar bone was made on the two-dimensional radiographs which are not as accurate for measurements of bone support as the Cone Beam Computed Tomography (CBCT) [22]. Further prospective studies using CBCT and standardized biomarkers are recommended to better understand the molecular mechanisms involved in ortho-perio interactions.

5 CONCLUSION

Adult orthodontic tooth movement in patients with treated periodontitis can achieve predictable long-term stability of periodontal attachment levels and alveolar bone support, provided there is strict adherence to periodontal maintenance therapy. Poor compliance is a significant risk factor for loss of CAL and alveolar bone destruction, especially in intrusive and extrusive movements. Clinicians should stress the significance of periodontal maintenance and informed consent, adjust orthodontic biomechanics to reduce periodontal risk, and maintain ongoing interdisciplinary surveillance.

STATEMENTS ON COMPLIANCE WITH ETHICAL STANDARDS

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Disclosure of conflict of interest

The authors declare no conflicts of interest regarding the publication of this manuscript. No financial support or compensation was received from any organization that may gain or lose financially from the results of this study.

Statement of ethical approval

The study was performed in accordance with the Declaration of Helsinki and approved by the Institutional Review Board (IRB) of the Jordanian Ministry of Health (Approval No: 81_12/2026).

Statement of informed consent

Informed consent was waived by the IRB because the study was retrospective and the data were anonymized.

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