Original Article

Relationship between Malocclusion and Periodontal Disease in Patients Seeking Orthodontic Treatment in Southwestern Saudi Arabia

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Abstract

Background: Malocclusion is known to cause plaque accumulation and periodontal breakdown. However, no previous study from Saudi Arabia has assessed this relationship in patients seeking orthodontic treatment for esthetics.

Objective: The objective of this study was to investigate the relationship between malocclusion and periodontal disease in terms of gingival inflammation, probing pocket depth (PPD) and recession in patients seeking orthodontic treatment for esthetic improvement.

Materials and Methods: This prospective cross-sectional study was conducted at the Outpatient Division of Periodontics, College of Dentistry, King Khalid University, Saudi Arabia, among consecutive new patients seeking orthodontic treatment for esthetic improvement between June and August 2018. Angle's class of malocclusion, various malalignments, plaque index (PI), gingival index (GI), adequacy of width of attached gingiva (WAG), response to fremitus test, PPD and gingival recession (GR) were recorded. $P < 0.05$ was considered statistically significant.

Results: A total of 410 consecutive patients were included. Of these, 314 patients had Class I, 57 had Class II (division I), 25 had Class II (division II) and 14 had Class III malocclusions. In patients with all types of malocclusion, the majority had a PI and GI of score 2 (74.1% and 83.7%, respectively). Most of the patients (85.9%) had adequate WAG; similarly, 94.9% had a negative fremitus test, which shows the absence of trauma from occlusion. Mean PPD and GR in the maxillary and mandibular arches showed varying results.

Conclusion: This study demonstrates a relationship between malocclusion and presence of periodontal disease in patients seeking orthodontic treatment for esthetic improvement in the southwestern region of Saudi Arabia. Therefore, in patients seeking orthodontic treatment, careful evaluation of gingival and oral hygiene along with adequacy of attached gingiva should be considered.

Keywords: Attached gingiva, crowding, gingival recession, malocclusion, orthodontic, periodontal status

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INTRODUCTION

Orthodontic treatment is sought by patients for various reasons, the most common being the correction of malaligned anterior teeth to enhance esthetics. Correcting malocclusions with orthodontic treatment is considered to be beneficial for periodontal health.[1] Although several studies have assessed the causative relationship between malocclusion and periodontal disease, the subject remains debatable.[2] However, early diagnosis of abnormal tooth position provides information to direct treatment and, in turn, prevents periodontal diseases' occurrence and progression. Therefore, orthodontic treatments have been recommended to be a part of periodontal management programs to have better access for plaque control, restoration of normal occlusion and esthetics.[3]

Normal occlusion is anatomically and functionally necessary for the development and maintenance of a healthy dentition.[4] Periodontitis is an inflammatory disease characterized by loss of connective tissue and alveolar bone, with bacterial plaque being the primary etiologic cause. However, factors that favor the retention of deposits, such as irregularity of tooth position and overhanging/ill-fitting dental restorations, could lead to periodontal compromise.[5] Studies have shown that irregularities in the position of teeth and crowding increase the rate and accumulation of bacterial plaque.[6] Clinical analysis has shown that crowding of teeth makes removal of plaque difficult, predisposing to gingival inflammation and periodontal destruction.[3,4] Malalignment of teeth frequently presents with gingival inflammation and may provide a case for orthodontic treatment.

In the recent past, the number of adult patients seeking orthodontic treatment has dramatically increased, and this necessitates more careful evaluation of the patients' periodontal status.[7,8] However, there is a lack of studies from Saudi Arabia assessing the relationship between malocclusion and periodontal disease. Therefore, the aim of this study was to investigate the relationship between malocclusion and periodontal disease in terms of gingival inflammation, probing pocket depth (PPD) and recession in patients seeking orthodontic treatment for esthetic improvement.

MATERIALS AND METHODS

This prospective, cross-sectional study was conducted between June 1, 2018, and August 31, 2018, at the Outpatient Division of Periodontics, College of Dentistry, King Khalid University, Saudi Arabia, among all consecutive new patients seeking orthodontic treatment for esthetic improvement after being referred from the intern clinic for oral prophylaxis or Phase 1 periodontal therapy. Since there were no previous studies from this region on the topic, all adult patients aged 18–75 years who attended the outpatient department during the study period were included. All patients provided consent for participation. Ethical approval was obtained from the Scientific Research Committee of King Khalid University, Abha, Asir Region, Kingdom of Saudi Arabia (SRC/ETH/2017-18/075), on May 30, 2018, and the study was carried out in accordance with the code of ethics in the Declaration of Helsinki, 2013.

Patients were excluded if they had orthodontic appliances; removable dental prosthesis or any systemic conditions; missing first molars; periodontal therapy in the past 6 months; regular use of antiseptic mouthwash; systemic antibiotics within past 3 months or if they were smokers, former smokers, mouth breathers, pregnant women and/or lactating mothers.

Categorization of study subjects

Characteristics of study participants were collected in the following age strata: 18–20 years (I), 21–40 years (II), 41–60 years (III) and >60 years (IV). Malocclusion was classified based on Angle's molar relation.[9] For overjet (OJ) and overbite (OB), 1–2 mm was categorized as normal and >2 mm was considered as increased. Similarly, a classification was also made based on the absence/presence of anterior crossbite (ACB), spacing and crowding.

A single experienced examiner conducted the orthodontic and periodontal examinations to avoid bias. Gingival recession (GR) (i.e., the distance between the free gingival margin and the cementoenamel junction) and PPD (distance from free gingival margin to the bottom of the sulcus or periodontal pocket) were measured for all anterior teeth (canine to canine). For these measurements, a periodontal probe (University of Michigan 'O' probe with William's marking[10]) was positioned parallel to the long axis of the tooth at each site, and each measurement was rounded off to the lower whole millimeter. Clinical attachment loss was the primary outcome variable calculated using PPD and GR. The severity of periodontitis in the anterior region was defined as severe pocket depth when probing depth was ≥7 mm, moderate when it was ≥5 to <7 mm and mild when it was >3 and <5 mm.[11] Adequacy of width of attached gingiva (WAG), fremitus test, gingival index (GI) and plaque index (PI) were also recorded in these patients. Adequacy of WAG was done by tension test. This was done by stretching the lip or cheek. If the free gingiva margin moves during stretching of lips,

then the attached gingiva was considered to be inadequate. PPD was performed on six sites per tooth and the mean value was used for analysis, and index teeth were used for recording GI and PI.

Examiner calibration was done before the study using re-examination of 20 volunteers by the same examiner after a period of 2–3 weeks. The intra-examiner correlation coefficient for repeated measurements was 0.85 ($P < 0.05$), indicating high reliability. Furthermore, clinical measurements were recorded using a double-pass method to minimize measurement errors.

Data analysis

Frequency and percentages were calculated as summary measures for condensing the raw data. Chi-square test for goodness-of-fit was used for finding significant differences in various types of malalignment. Kruskal–Wallis test was used to assess for significant differences on continuous dependent variable by categorical independent variable. $P < 0.05$ was considered statistically significant. Odds ratios (ORs) with 95% confidence interval (CI) were also evaluated. A subject- and tooth-level statistical analysis was performed for each of the parameters using SPSS for Windows, version 16.0 (SPSS Inc., Chicago, IL, USA).

RESULTS

A total of 410 consecutive new patients who consented to participate were included in the study. They were categorized into the following age groups: ≤20 years = 14, 21–40 years = 172, 41–60 years = 201 and >60 years = 23. Of these, 250 (61%) were male and 160 (39%) were female. There were a nonsignificantly higher number of patients with normal OJ than increased OJ (270 vs. 140, respectively; $P > 0.15$; OR: 1.109; 95% CI: 0.530–2.230). In terms of OB, 299 patients had a normal OB with 248 (82.9%) having adequate WAG, while 111 had increased OB with most (104; 93.7%) having adequate WAG; the difference between absence and presence of OB was statistically significant ($P < 0.001$; OR: 0.318; 95% CI: 0.122–0.826). A total of 58 patients had ACB, of which 47 (81.0%) had adequate WAG. There was a statistically significant difference in the number of patients without and with spacing (395 vs. 15, respectively; $P < 0.05$; OR: 2.267; 95% CI: 0.848–8.139). Among those with no spacing, 342 (86.6%) had adequate WAG, while among those with spacing, 10 (66.7%) had adequate WAG. In terms of crowding, 309 patients had no crowding, with 268 (86.7%) having adequate WAG. Of the 101 patients with crowding, 84 (83.2%) had adequate WAG [Table 1].

Tables 2 and 3 show that among patients with all types of malocclusion, the majority (74.1% and 83.7%) had a PI and GI of score 2, respectively. Most of the patients (85.9%) had adequate attached gingival, and similarly, 94.9% had a negative fremitus test, which shows the absence of trauma from occlusion. Frequency distribution and percentage of PI, GI and WAG according to malocclusion showed a statistically significant difference ($P < 0.05$).

Frequency distribution and percentage of periodontal status of maxillary and mandibular anterior teeth according to malocclusions also showed a statistically significant

Table 1: Frequency distribution and percentage of different malalignment types in terms of width of attached gingiva with logistic regression analysis

Type of malalignment	Width of attached gingiva				
	Adequate (%)	Inadequate (%)	Total (%)	*P*	OR (95% CI)
Overjet (mm)					
≤2	227 (84.1)	43 (15.9)	270 (100)	0.151	1.109 (0.530-2.230)
>2	125 (89.3)	15 (10.7)	140 (100)		
Total	352 (85.9)	58 (14.9)	410 (100)		
Overbite (mm)					
≤2	248 (82.9)	51 (17.1)	299 (100)	0.006*	0.318 (0.122-0.826)
>2	104 (93.7)	7 (6.3)	111 (100)		
Total	352 (85.9)	58 (14.9)	410 (100)		
Anterior crossbite					
Absent	305 (86.6)	47 (13.4)	352 (100)	0.256	1.241 (0.576-2.676)
Present	47 (81)	11 (19)	58 (100)		
Total	352 (85.9)	58 (14.9)	410 (100)		
Spacing					
0 (N)	342 (86.6)	53 (13.4)	395 (100)	0.030*	2.267 (0.848-8.139)
1 (Y)	10 (66.7)	5 (33.3)	15 (100)		
Total	352 (85.9)	58 (14.9)	410 (100)		
Crowding					
0 (N)	268 (86.7)	41 (13.3)	309 (100)	0.372	1.355 (0.707-2.597)
1 (Y)	84 (83.2)	17 (16.8)	101 (100)		
Total	352 (85.9)	58 (14.9)	410 (100)		

*$P<0.05$; Significant; OR – Odds ratio; CI – Confidence interval

Table 2: Frequency distribution and percentage of plaque index and gingival index according to malocclusion

Type of malocclusion	Plaque Index (%)					*P*
	Score 0	Score 1	Score 2	Score 3	Total	
Class I	1 (0.3)	65 (20.7)	227 (72.3)	21 (6.7)	314 (100)	0.046*
Class II division 1	0	8 (14)	47 (82.5)	29 (3.5)	57 (100)	
Class II division 2	0	5 (20.0)	19 (76)	1 (4.0)	25 (100)	
Class III	0	2 (14.3)	11 (78.6)	1 (7.1)	14 (100)	
Total	1 (0.3)	80 (19.5)	304 (74.1)	25 (6.1)	410 (100)	
Type of malocclusion	**Gingival Index (%)**					***P***
	Score 0	**Score 1**	**Score 2**	**Score 3**	**Total**	
Class I	2 (0.6)	40 (12.7)	259 (82.5)	13 (4.1)	314 (100)	0.046*
Class II division 1	1 (1.80)	3 (5.3)	49 (86.0)	4 (7.0)	57 (100)	
Class II division 2	0	2 (8.0)	23 (92.0)	0	25 (100)	
Class III	0	2 (14.3)	12 (85.70	0	14 (100)	
Total	3 (0.7)	47 (11.5)	343 (83.7)	17 (4.1)	410 (100)	

*$P<0.05$: Significant

Table 3: Frequency distribution and percentage of width of attached gingiva and fremitus test according to malocclusion

Type of malocclusion	Width of attached gingiva (%)			*P*
	Adequate	Inadequate	Total	
Class I	264 (84.1)	50 (15.9)	314 (100)	0.023*
Class II division 1	52 (91.2)	5 (8.8)	57 (100)	
Class II division 2	24 (96)	1 (4)	25 (100)	
Class III	12 (85.7)	2 (14.3)	14 (100)	
Total	352 (85.9)	58 (14.9)	410 (100)	
Type of malocclusion	**Fremitus test (%)**			***P***
	Negative	**Positive**	**Total**	
Class I	302 (96.2)	12 (93.8)	314 (100)	0.139
Class II division 1	52 (91.2)	5 (8.8)	57 (100)	(NS)
Class II division 2	23 (92.0)	2 (8.0)	25 (100)	
Class III	12 (85.7)	2 (14.3)	14 (100)	
Total	389 (94.9)	21 (5.1)	410 (100)	

*$P<0.05$: Significant; NS: $P>0.05$; Not significant

difference ($P < 0.05$). Mean PPD in the maxillary arch showed varying results. The highest percentage of normal PPD (≤3 mm) was seen among Class II (division 2) patients. In patients with Class I malocclusion, normal PPD was most common (47.1%), followed by >3 to <5 mm PPD (37.26%), while ≥7 mm PPD was least common (4.77%). Similar trends were seen in Class II and Class III malocclusions. Mean PPD in the mandibular arch also showed a pattern similar to that of the maxillary arch, that is, the highest percentage of normal PPD (≤3 mm) was among those with Class II (division 2) malocclusion. Grades of GR in the maxillary and mandibular arches also varied between various malocclusions [Tables 4 and 5].

Table 6 shows tooth-level analysis using Kruskal–Wallis test, where clinical attachment level on the lower left canine and lower right lateral incisor along with GR on the lower right lateral incisor showed significant results ($P < 0.05$).

DISCUSSION

Dental plaque has been found to cause periodontal disease, and it is more difficult to remove plaque from teeth that are malaligned.[3] To the best of the authors' knowledge, this is the first study from Saudi Arabia that has investigated the relationship between malocclusion and periodontal disease in terms of gingival inflammation, PPD and recession in patients seeking orthodontic treatment for esthetic improvement. As our hospital is the only tertiary care hospital for dental needs in the region, the authors believe that the samples obtained during the study period are representative of the general population in the southwestern region of Saudi Arabia.

The participants in this study were of a wide age range, but the vast majority were aged 21–60 years, indicating a preference trend in these age groups. In this study, the majority of the patients with all types of anterior teeth malalignments had a 2 mm or more of attached gingiva, which was considered adequate. These results are in coherence with those of a previous study.[12] However, Morris *et al*.[13] did not find any association between width of gingiva and gingival health. The study results point toward the fact that even with crowing and increased OB, majority of the patients had adequate WAG, and these factors did not impinge on WAG. Regardless of the type of malocclusion, some grade of plaque accumulation and gingival inflammation was noticed in most of the participants. Furthermore, malocclusion does not necessarily show clinical signs of trauma from occlusion, as in the present study, despite the varying degrees of malocclusion, most of the cases showed no clinical signs of trauma from occlusion. In general, only mild-to-moderate periodontal destruction (determined by shallow to moderate periodontal pockets) was more prevalent in both maxillary and mandibular anterior teeth.

This study found that in most types of malocclusions, varying grades of GR existed with mild-to-moderate periodontal pockets. These findings are in line with

Table 4: Frequency distribution and percentage of periodontal status of maxillary anterior teeth according to malocclusions

Type of malocclusion	Mean probing pocket depth in the maxillary arch (%)					*P*
	≤3 mm	>3-<5 mm	≥5-<7 mm	≥7 mm	Total	
Class I	148 (47.1)	117 (37.26)	34 (10.82)	15 (4.77)	314 (100)	0.046*
Class II division 1	25 (43.85)	21 (36.84)	7 (12.28)	4 (7.01)	57 (100)	
Class II division 2	17 (80.95)	6 (24.0)	1 (4.0)	1 (4.0)	25 (100)	
Class III	9 (64.28)	2 (14.28)	2 (14.28)	1 (7.14)	14 (100)	
Total	199 (48.53)	146 (35.60)	44 (10.73)	21 (5.12)	410 (100)	
Type of malocclusion	**Grades of gingival recession in the maxillary arch (%)**					***P***
	None or Class 1	**Class 2**	**Class 3**	**Class 4**	**Total**	
Class I	54 (17.2)	152 (48.4)	42 (13.4)	66 (21)	314 (100)	0.046*
Class II division 1	4 (7)	26 (45.6)	15 (26.3)	12 (21.1)	57 (100)	
Class II division 2	4 (16)	5 (20)	7 (28)	9 (36)	25 (100)	
Class III	2 (14.3)	6 (42.9)	3 (21.4)	3 (21.4)	14 (100)	
Total	64 (15.6)	189 (46.1)	67 (16.3)	90 (22)	410 (100)	

**$P<0.05$: Significant

Table 5: Frequency distribution and percentage of periodontal status of mandibular anterior teeth according to malocclusions

Type of malocclusion	Mean probing pocket depth in the mandibular arch (%)					*P*
	≤3 mm	>3-<5 mm	≥5-<7 mm	≥7 mm	Total	
Class I	61 (19.4)	126 (40.1)	98 (31.2)	29 (9.2)	314 (100)	0.011*
Class II division 1	7 (12.3)	22 (38.6)	23 (40.4)	5 (8.8)	57 (100)	
Class II division 2	7 (28)	3 (12)	7 (28)	8 (32)	25 (100)	
Class III	2 (14.3)	7 (50)	3 (21.4)	2 (14.3)	14 (100)	
Total	77 (18.8)	158 (38.5)	131 (32)	44 (10.7)	410 (100)	
Type of malocclusion	**Grades of gingival recession in the mandibular arch (%)**					***P***
	None or Class 1	**Class 2**	**Class 3**	**Class 4**	**Total**	
Class I	60 (19.10)	121 (38.53)	129 (41.08)	4 (1.27)	314 (100)	0.046*
Class II division 1	79 (12.28)	30 (52.63)	19 (33.33)	1 (1.75)	57 (100)	
Class II division 2	7 (28.0)	9 (36.0)	6 (24.0)	3 (12.0)	25 (100)	
Class III	2 (14.28)	5 (35.71)	6 (42.85)	1 (7.14)	14 (100)	
Total	76 (18.53)	165 (40.24)	160 (39.02)	9 (2.19)	410 (100)	

**$P<0.05$: Significant

Table 6: Tooth-level analysis using Kruskal-Wallis test showing significant results

Score	Occlusion type	*n*	Mean rank	Test statistics (chi-square, df, *P*)
Clinical attachment level tooth number 33	Class I	314	198.06	8.390, 3, 0.039*
	Class II division 1	57	242.93	
	Class II division 2	14	195.39	
	Class III	25	219.24	
	Total	410		
Gingival recession tooth number 42	Class I	298	188.62	8.602, 3, 0.035*
	Class II division 1	56	212.62	
	Class II division 2	14	213.36	
	Class III	24	246.88	
	Total	392		
Clinical attachment level tooth number 42	Class I	298	188.94	8.211, 3, 0.042*
	Class II division 1	56	209.68	
	Class II division 2	14	218.61	
	Class III	24	246.73	
	Total	392		

*$P<0.05$: Significant

the findings of a recent study where certain incisor malalignment traits were found to be associated with significant periodontal disease progression.[14] Similarly, in their systematic review, it was found that in more than half the included studies, there was an association between severity of malocclusion and presence of periodontal disease.[15] In contrast, some studies have found no correlation between malocclusion and presence of periodontal disease.[13] It should be noted that none of the studies included in the systematic review were adjusted for confounding variables. Nonetheless, the results of the current study and those in the literature indicate the need of additional studies to have a consolidated consensus regarding the association between malocclusion and periodontal diseases.

In the present study, most of the patients in all types of malocclusion classes had PI and GI of score 2. This finding is comparable with the results of studies on the interaction between malocclusion and gingivitis that have found greater levels of gingivitis in individuals with malocclusion compared with those without malocclusion, thereby suggesting a link between increased plaque accumulation in patients with malaligned dentition.[16-18]

Trauma from occlusion as a consequence of tooth malpositioning has been found to have deleterious effects on the supporting periodontium. The findings of the current study are in agreement with two recent studies

that found trauma from occlusion to alter the progression of periodontal disease.[19,20] The orthodontic treatment needs of the patients in this study ranged from minor tooth alignment to fixed orthodontic therapy, while the periodontal treatment needs varied from nonsurgical to surgical periodontal treatment; these results are similar to that known in the literature.[2] In the present study, it was found that the severity of malpositioning of teeth may influence the periodontal disease intensity, thereby reiterating the significance of a multidisciplinary approach. In addition, studies have shown that patients with severe malocclusion have lower oral health-related quality of life scores than patients with less critical treatment need.[21,22] Therefore, assessment of malocclusion and its periodontal implications are important, as it also impacts the quality of life.

Limitations

A limitation of this study is that it only included patients over a 3-month duration. Another limitation is that radiographic evaluation of bone destruction was not evaluated, as this was a preliminary study. Results of this study should be interpreted with caution, as various confounding factors for periodontal disease such as age, gender, socioeconomic factors, diet, oral hygiene tools used and its frequency, frequency of dental visits and family history of periodontitis have not been adjusted, and these could possibly influence the prevalence and severity of periodontal disease. However, the authors believe that by not adjusting for these factors the generalizability of the results is likely to have been increased. Another limitation of this study is that a more inclusive treatment need index such as dental esthetic index was not used along with Angle's classification in a complementary way. The authors recommend that longitudinal studies with a larger sample size should be carried out to understand the relationship between the development of malocclusion and periodontal disease.

CONCLUSION

Within its limitations, this study demonstrated a relationship between malocclusion and presence of periodontal disease in adult patients seeking orthodontic treatment for esthetic improvement. The majority of patients with varying malocclusion had moderately inflamed gingiva and poor oral hygiene. Therefore, in patients seeking orthodontic treatment, careful evaluation of the periodontal condition is likely to be essential for ensuring effective treatment.

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Ethical considerations

This study was approved by the Scientific Research Committee of King Khalid University, Abha, Asir Region, Kingdom of Saudi Arabia (SRC/ETH/2017-18/075) on May 30, 2018. In addition, the study was conducted in accordance with the ethical principles mentioned in the Declaration of Helsinki, 2013. Signed informed consent was obtained from all patients before inclusion in the study.

Peer review

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Conflicts of interest

There are no conflicts of interest.

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