



ORIGINAL ARTICLE

The effect of overbite and overjet on clinical parameters of periodontal disease: A case control study



Reham Nasser Al-Jasser

Department of Periodontics and Community Dentistry, College of Dentistry, King Saud University, PO Box 60169, Riyadh 11545, Saudi Arabia

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KEYWORDS

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Abstract *Aim:* To investigate the association of overjet and overbite with clinical parameters of periodontal disease.

Material and methods: The study was performed in Riyadh, Saudi Arabia, from March 2017 to March 2018. 600 Saudi males aged 20–30 years old were included. Participants were divided into three groups (n: 200) depending on the presence of overjet (OJ) or overbite (OB) and its relationship with periodontal disease. Periodontal parameters were assessed clinically and radiographically. One-way analysis of variance was used to test for any significant differences between groups. Tukey's post hoc comparison test was used to evaluate correlations among parameters.

Results: OJ exceeding 8 mm was correlated with debris, calculus, and periodontal scores on mandibular anterior teeth, especially on the lingual surfaces.

Both OJ and OB groups showed significantly increased PD, compared to that of the control group in measurement at the lingual ($P = 0.004, 0.003$) and proximal ($P = 0.002, 0.002$) surfaces of the lower anterior teeth. Finally, the CEJ-AB was statistically significantly higher in the OB group compared to the OJ and control groups ($P = 0.091, 0.008$).

Conclusion: The present study found a correlation between OJ and OB and periodontal disease, as measured using specific parameters. This indicates that periodontal treatment may be insufficient unless the overjet or overbite is corrected.

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1. Introduction

It has been postulated that certain morphological traits of malocclusion predispose to periodontal disease (Papapanou et al., 2018; Caton et al., 2018). Several studies have investigated the association between malocclusion and periodontal disease, but have yielded conflicting results (Gusmão et al.,

E-mail address: raljasser@ksu.edu.sa

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2011; Humagain and Kafle, 2015). Although it seems intuitively obvious that malocclusion should contribute to periodontal disease by making it more difficult to perform proper oral hygiene and to take care of teeth, recent studies have indicated that this has a minor effect (Humagain and Kafle, 2015; Salti et al., 2017; Bernhardt et al., 2019). An individual's wellness and motivation in fact has a greater effect on oral hygiene than how well the teeth are aligned. Several studies have revealed that there is only a tenuous link between the presence or absence of malocclusion and development of periodontal problems in later life (Bernhardt et al., 2019; Boas Nogueira et al., 2013). It was previously thought that trauma from occlusion played a significant role in the pathogenesis of periodontal problems (Ramjord and Ash, 1981; Geiger, 2001); however, further research has decreased the emphasis on occlusal trauma as a primary etiologic factor in periodontal disease (Drake et al., 2012). If plaque is controlled, the individual's occlusal status seems to make little, if any difference, on the development of periodontal problems, although it can exacerbate disease progression once it is established (Rossini et al., 2014).

Contradictory results have been reported regarding the effect of overbite (OB) and overjet (OJ) on periodontal status. Some reports have found associations between periodontal disease and increased maxillary OJ or OB (Barclay, 1996; Blair et al., 1997); while others have reported negative findings, concluding that OB is not a factor affecting periodontal status (Geiger, 1962; Alexander, 1970).

Therefore, the aim of the present study was to test the association of malocclusion (defined as an OJ > 8 mm or an OB > 6 mm) on periodontal health. Considering the aim, following hypothesis was tested.

- H¹ = Malocclusion is associated with periodontal health
 H² = Malocclusion is not associated with periodontal health

2. Material and methods

This study was conducted in March 2017 to March 2018 in accordance with the Helsinki Declaration of 1975, as revised in 2013. The protocol was approved by the Institutional Committee of Research Ethics at the King Saud University, Riyadh, Saudi Arabia (NF 4263). Research Project No. E-19-3638.

Each participating patient signed an informed consent form after the nature of the study had been explained to them. Each participating patient was informed that they could withdraw from the study at any time without jeopardizing their rights to proceed with dental care at the Dental College.

2.1. Population

The study was performed at the Dental College of King Saud University, Riyadh Saudi Arabia. Six hundred 20–30-year-old Saudi males participated in this study. All subjects were medically fit and had no history of orthodontic, periodontal, or prosthodontic treatment. Exclusion criteria were as follows: (1) uncontrolled systemic disease or condition that alters bone metabolism (i.e., diabetes, osteoporosis,

osteopenia, hyperparathyroidism, or Paget's disease); (2) history of oral cancer, sepsis, or adverse outcomes to oral procedures; (3) long-term use of antibiotics (> 2 weeks in the past two months); and (4) use of medications known to modify bone metabolism (i.e., bisphosphonates, corticosteroids).

Subjects were divided into three groups as follows:

- 1) Control group (n = 200): subjects with well-aligned teeth with an Angle Class I canine relationship (Angle, 1899), OJ and OB between 1 and 4 mm, which is considered to be normal orthodontically.
- 2) Overjet group (n = 200): subjects with an OJ of at least 8 mm and normal OB (1–4 mm).
- 3) Overbite group (n = 200): subjects with an OB > 6 mm and normal OJ (1–4 mm).

2.2. Orthodontic parameters

OJ was measured parallel to the occlusal plane from the labial surface of the lower central incisor to the labio-incisal edge of the upper central incisor. OB was measured with teeth in maximum intercuspation; the amount of overlap of the upper incisors with the lower incisors was marked horizontally on the lower incisors.

2.3. Periodontal parameters

2.3.1. Oral hygiene index

Oral hygiene was measured using the simplified oral hygiene index (OHIS) with its two components, the Debris Index (DI-S) and the Calculus Index (CI-S). Six surfaces on four posterior and two anterior teeth in each arch were examined from. In the posterior portion of the dentition, the first fully erupted tooth distal to the second bicuspid (the first premolar) was examined on each side of each arch. The buccal surfaces of the selected upper molars and the lingual surfaces of the selected lower molars were inspected. In the anterior portion of the mouth, labial surfaces of the upper right and lower left central incisor were scored. The index scoring system (debris and calculus) was as follows: Score 0 = no debris or calculus, Score 1 = one-third or less covered with debris/calculus, Score 2 = one-third to two-thirds covered with debris/calculus, Score 3 = more than two-thirds covered with debris/calculus, Score 9 = no information (missing tooth) (Greene and Vermillion, 1964).

2.3.2. Russel's periodontal index

Periodontal tissue condition was measured using Russel's periodontal index (RPI). The condition of the periodontal tissues was estimated individually for each of the six anterior teeth in both jaws, and was scored according to the following criteria: Score 0 = absence of overt inflammation in an area of free gingiva or loss of function due to destruction of supporting tissues; Score 1 = mild gingivitis, with only part of the gingiva affected; Score 2 = severe gingivitis, all around the tooth (>4 mm); Score 6 = pathological pocket formation; Score 8 = advanced destruction, with impaired masticatory function; Score 9 = missing tooth. The score for an individual patient was the arithmetic mean of the scores for all six anterior teeth in both arches (Russel, 1956).

2.4. Bleeding index

The dichotomous bleeding index (BI) scoring system was used on the same teeth as RPI to register bleeding after pocket depth measurement, as present (Score = 1) of absent (Score = 0) (Listgarten, 1980).

2.5. Periodontal probing depth

Six probing depth (PD) measurements were taken around each of the six anterior teeth of both arches, as follows: buccal, mesiobuccal, distobuccal, lingual, mesiolingual, and distolingual. A calibrated probe (Himring CGBI Stainless; Hu-Friedy Mfg. Co., LLC, Chicago, IL, USA) was used to take measurements of the pocket depth from the gingival margin, to the nearest mm. The probe was inserted gently into the gingival sulcus and stepped around the tooth at approximately 1-mm increments. The probe was kept as close as possible to the axial direction of the tooth while maintaining contact with the root surface (Lang et al., 1990).

2.6. Radiographic examination

For all subjects, six intra-oral bitewing standardized radiographs were taken for all subjects (Kodak DF-58 ultraspeed films) using Eggen's technique (Eggen, 1969). The distance between the crest of the interdental bone and the cemento-enamel junction (CEJ-AB) was measured using a magnifying glass, and two readings were taken to the nearest 0.1 mm; both were used in this study.

2.7. Data collection

All clinical and radiographic examinations were performed by one examiner (R.J.). The clinical examination was carried out under clinical conditions using the following instruments: plane mirror, periodontal probe (Himring CGBI, Stainless), metal ruler with an accuracy of 0.5 mm. All subjects were examined in a dental office, where dentist assisted in entering the data in a predesigned registration form.

2.8. Statistical analysis

Statistical analysis was performed using a commercially available software program (SPSS version 21.0, IBM Corp., Armonk, NY, USA). Reproducibility was tested on 31 individuals of the same age as the subjects in the study; all parameters were recorded twice with a 14-day interval (Table 1). The three groups were statistically described using mean values. One-way analysis of variance (ANOVA) was used to test for any signif-

icant differences between groups in terms of the following parameters: OHIS, RPI, periodontal pocket depth, and CEJ-AB for the upper and lower anterior teeth. Additionally, all parameters were compared between the upper and lower anterior teeth. Tukey's post hoc multiple comparison test was used to evaluate pairs of means and to compare the OJ and OB groups with the control group. The level of significance chosen for all statistical tests was $P < 0.05$.

3. Results

In terms of the OHIS, the mean DI-S values of the upper and lower anterior teeth were significantly higher in the OJ group than in the control group ($P = 0.03$). The mean CI-S values in the OJ group were also significantly higher score than in the control group ($P = 0.02$), while there was no significant difference between the OB group and the control group. No significant difference between the control group and either the OJ or OB group in terms of the BI. Furthermore, the lower anterior teeth had a significantly higher mean periodontal score based on RPI for both the OJ and OB groups than that of the control group ($P = 0.03, 0.04$); however, this was not significant for the upper anterior teeth (Table 2).

Regarding periodontal PD, the highest probing values in the buccal, lingual, and proximal surfaces were compared among all groups. The OJ and OB groups showed increased PD compared to the control group; however, the difference was only statistically significant for the OJ group compared to the control group for the lingual surface measurements of the upper anterior teeth ($P = 0.005$). In contrast, both OJ and OB groups showed significantly increased PD, compared to that of the control group in measurement at the lingual ($P = 0.04, 0.003$) and proximal ($P = 0.002, 0.002$) surfaces of the lower anterior teeth. Finally, the CEJ-AB was statistically significantly higher in the OB group compared to the OJ and control groups ($P = 0.09, 0.08$) (Tables 3 and 4).

4. Discussion

Depending upon its nature, malocclusion exerts various effects on the development of both gingivitis and periodontitis. In the present study, a positive relationship was found between the severity of OJ and the DI-S, CI-S, and RPI scores related to the anterior teeth, and PD at the lingual surfaces of the lower anterior teeth. In addition, statistically significantly more bone loss (CEJ-AB) was associated with the presence of OB. However, no significant correlation was found in terms of BI.

Previous investigations of the effect of OJ and OB on periodontal health found conflicting results. Many reports concluded that OJ is an important factor in the development of periodontal disease (Blair et al., 1997). However, other studies questioned the existence of this relationship (Goel et al., 2018).

Furthermore, several studies have described periodontal health as monitored by plaque accumulation and gingival bleeding in groups of individuals with anterior OJ. Many of those studies found a positive relationship between the degree of OJ and the amount of plaque and gingival inflammation present, which is consistent with our findings. PD has been used by various investigators to assess the effect of OJ on periodontal health. In some studies, no correlation was found (Nalcaci et al., 2012; Buckley, 1972), while others reported

Table 1 Reproducibility percentages for clinical parameters.

Parameter tested	Reproducibility percentage
Debris index	90.30%
Calculus index	83.90%
Periodontal index	90.30%
Bleeding index	93.50%
Probing pocket depth	93.50%

Table 2 Multiple comparisons of Debris and Calculus Index scores of the Simplified Oral Hygiene Index, Russel's Periodontal Index, and Bleeding Index for upper and lower anterior teeth among the study groups.

	Control	Overjet	p-value	Overbite	p-value
N	200	200		200	
DI-S [†]	1.27 (1.5)*	1.85 (1.4)	0.03	1.42 (1.2)	0.09
CI-S [‡]	0.19 (0.9)	0.48 (0.8)	0.02	0.27 (0.5)	0.8
RPI [§]	1.67 (0.5)	2.29 (0.6)	0.03	2.26 (0.8)	0.04
BI	0.13 (0.3)	0.23 (0.5)	0.08	0.25 (0.4)	0.06

* Scores are shown as mean (standard deviation).

[†] DI-S, Debris Index score of the Simplified Oral Hygiene Index.

[‡] CI-S, Calculus Index score of the Simplified Oral Hygiene Index.

[§] RPI, Russel's Periodontal Index.

^{||} BI, Bleeding Index.

Table 3 Multiple comparisons of probing depth for upper and lower anterior teeth among the study groups.

Upper anterior teeth (mm)	Control	Overjet	p-Value	Overbite	p-Value
Buccal PD [†]	1.74 (0.7)*	2.29 (0.5)	0.08	1.79 (1.0)	0.05
Lingual PD	1.90 (0.8)	2.97 (0.9)	0.005	2.32 (1.1)	0.07
Proximal PD	3.26 (0.6)	3.71 (0.5)	0.09	3.61 (0.7)	0.08
Lower anterior teeth (mm)					
Buccal PD	3.16 (0.5)	3.65 (0.2)	0.23	3.25 (0.8)	0.54
Lingual PD	2.74 (1.2)	3.55 (1.1)	0.04	3.39 (0.9)	0.003
Proximal PD	2.42 (0.6)	3.60 (0.5)	0.002	3.71 (0.4)	0.002

* Scores are shown as mean (standard deviation).

[†] PD, probing depth.

Table 4 Multiple comparison of the distance of cemento-enamel junction to alveolar bone crest for upper and lower anterior teeth among the study groups.

CEJ-AB [†] (mm)	Control	Overjet	p-value	Overbite	p-value
Upper anterior teeth	1.27 (1.1)*	1.47 (1.0)	0.09	1.43 (1.2)	0.08
Lower anterior teeth	1.66 (1.2)	1.67 (0.9)	0.1	2.12 (0.8)	0.04

* Scores are shown as mean (standard deviation).

[†] CEJ-AB, cemento-enamel junction to alveolar bone crest.

an association (Bjørnaas et al., 1994; Arora and Bhateja, 2015; Nasir et al., 2011). In the present study, the OJ group showed significantly deeper pockets at the lingual surface of the lower anterior teeth. The periodontal status was markedly poor in the mandible, indicating lower levels of oral hygiene on the lingual aspects of the lower teeth. This pattern of oral hygiene was consistent with that reported in previous studies (Angle, 1899).

The effect of OJ on alveolar bone support has also been investigated. Geiger (1962) and Bjørnaas et al. (1994). found that only certain traits of malocclusion negatively influence the level of bone support. In this study, no association was found between the level of alveolar bone support and the severity of OJ. The discrepancy between the present results and those of the above three previous studies may be explained by the different methodology used or may indicate that registration of small differences and weak associations require further improvement.

Regarding OB, the OB group showed a significant association with higher PI, PD, and distance to the CEJ in the lower anterior teeth only. Several studies have concluded that OB is

an important factor in the pathogenesis of periodontal disease (Barclay, 1996; Blair et al., 1997; Angle, 1899; Nalcaci et al., 2012) whereas others failed to show any significant effect (Lang et al., 1990; Nalcaci et al., 2012; Buckley, 1972). In the present study, PD as was also significantly increased in the lower segment. Additionally, the OB group showed significantly greater alveolar bone support reduction in the lower anterior segment. Generally, it has been observed that periodontal condition is markedly worse in the mandibular arch than the maxillary arch (Bjørnaas et al., 1994). Therefore, one could argue that the adverse effects of OB on periodontal health in the present study are related to the trend for worse periodontal conditions in the mandible.

In expressing a periodontist's view on occlusion, several authors have stated that excessive, average, or no overbite or overjet may be normal for certain individuals, while it may be abnormal for others (Arora and Bhateja, 2015; Nasir et al., 2011; Liu et al., 2011). Other authors have stated that excessive overbite and anterior open bite may impair periodontal health (Lang et al., 1990; Eggen, 1969). A study of 908 young Caucasian American adult males revealed a positive

correlation between OB and OJ and periodontal disease. In addition, a more recent observational study examined a group of 800 adult Indians and found a relationship of OJ and OB with periodontal disease, as assessed by the Occlusal Featured Index and RPI (Nalcaci et al., 2012).

In terms of periodontal parameters used in the present study, Buckley used the same parameters to register periodontal conditions in a group of 954 Irish adult workers and failed to find a positive correlation of OB, OJ, and intercuspation with periodontal disease in their sample (Goel et al., 2018). Bjørnaas et al. (1994) studied the association between OJ > 8 mm and the reduction of bone support as expressed by the CEJ-AB. Periodontal conditions in 21 military recruits with OJ > 8 mm were compared with those in 50 recruits with nearly ideal occlusion. The authors found a significant reduction of bone height of the four upper front teeth and of the four lower incisor teeth in the malocclusion group. Similarly, a group of 31 army recruits with OB > 6 mm revealed a significant reduction of bone height in the lower front teeth (Bjørnaas et al., 1994; Gkantidis et al., 2010; Paolo Pini-Prato et al., 2012).

The present study had some limitations, including that only one gender was studied, and that there was no long-term observation of this correlation after OJ and OB correction was reported. Therefore, well-designed, long-term, controlled studies are needed to carefully assess this relationship, which can aid in providing conclusive results. These will be beneficial for both periodontists and orthodontist in management of related clinical cases.

5. Conclusions

The study indicates that malocclusion creates a significant effect on periodontal health, and thus provides the validity and acceptance of H¹ of this study. In addition, periodontal health, particularly in the lower jaw, as assessed by DI-S, CI-S, BI, PD, and bone level were affected by the following malocclusion traits:

- 1) There was an association between horizontal OJ (> 8 mm) and DI-S, CI-S, and periodontal scores in the lower segment, and PD in the lingual surfaces of the lower anterior teeth.
- 2) There was an association between vertical OB (> 6 mm) and periodontal index, distance from the CEJ, and PD in the lower anterior teeth.
- 3) There was a direct association between OB and OJ; however, further long-term studies are needed to confirm the present findings.

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Declaration of Competing Interest

The author declares no competing interest.

Ethical approval

The research was approved by the Institutional Committee of Research Ethics at the King Saud University, Riyadh, Saudi Arabia (NF 4263).

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