Secondary trauma from occlusion and periodontitis

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Objective: To assess the association between secondary trauma from occlusion and the severity of periodontitis. Method and Materials: A total of 288 subjects with chronic periodontitis of varying severity and 93 healthy subjects were included in the study. Premature and balance contacts were identified by manual palpation and visualization of occlusal contacts during clenching in habitual intercuspal and lateral or protrusive movements of the mandible. Statistical analysis was performed with Kruskal-Wallis, Mann-Whitney, and Spearman correlation tests. Results: Statistically significant differences (P < .001) were found for all variables tested (ie, the total amount of trauma per patient and the number of premature and balance contacts increased significantly with the level of clinical attachment loss). The Spearman test showed a statistically significant correlation between the total amount of trauma per patient and the severity of periodontitis (P < .001). Conclusion: The results of this study indicate that secondary trauma from occlusion (ie, premature and balance contacts) is frequently seen in periodontally compromised patients and is positively correlated with the severity of attachment loss. (Quintessence Int 2011;42:515–522)

Key words: occlusion, periodontitis, prevalence, trauma from occlusion

The influence of occlusal forces on periodontitis has been discussed controversially for nearly a century.¹ In the 1920s, several authors stated that excessive occlusal forces are a major causative factor for periodontal disease.²–⁴ Animal studies in the 1950s and 1960s showed that excessive occlusal forces could modify, but not initiate, periodontal destruction.⁵–⁹ Today, dysregulated inflammatory responses and intraoral colonization with specific pathogens have been widely accepted as the main causative agents of periodontal disease.¹⁰–¹⁵ This, however, does not mean that the role of occlusal forces as risk factors for the progression of periodontal diseases is fully understood. This is due to a lack of randomized controlled prospective trials evaluating the influence of occlusion in untreated patients. Those studies, however, are not ethically acceptable due to potential irreversible harm (attachment loss).¹⁶ In addition, animal study findings cannot be easily translated to human conditions because of species-specific differences within the stomatognathic systems.¹⁷ Therefore, data from retrospective studies have to be used to elucidate the role of occlusal forces on the progression of periodontal disease. In this regard, the detection rate of secondary trauma from occlusion in relation to the extent and severity of periodontal disease might be helpful in clarifying the role of occlusal forces in the progression of periodontal disease. The aim of the present study was to correlate the quality and quantity of secondary trauma from occlusion with the extent and severity of periodontal disease.
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METHODOLOGY AND MATERIALS

Patients and clinical examination
A total of 288 systemically healthy patients with generalized chronic periodontitis were enrolled in the study. The diagnosis of chronic periodontitis followed the criteria defined by the American Academy of Periodontology. Disease severity was based on the amount of clinical attachment loss (CAL) designated as slight (>30% of sites with 1 to 2 mm CAL), moderate (>30% of sites with 3 to 4 mm CAL), or severe (>30% of sites with >5 mm CAL). Patients were asked about any types of previous (surgical or nonsurgical) periodontal treatment. Exclusion criteria were defined as craniomandibular dysfunction or any treatment of the temporomandibular joints, fewer than 20 natural teeth, or less than 30% of periodontally affected tooth sites. The clinical examination included measurement of probing depth (six sites per tooth), tooth mobility, furcation involvement, gingival recessions, missing teeth, caries, restoration margins, tooth migration, pulp sensitivity, premature, and balance contacts. Pocket probing depths (PPD) and gingival recessions were measured with millimeter-calibrated periodontal probes (PCP-UNC 15, Hu-Friedy). The control group consisted of 93 systemically and periodontally healthy subjects. The exclusion criteria for the patients of the control group were the same as defined for the test group except for the periodontally affected sites. All clinical assessments were performed by two periodontists who were calibrated prior to the study by analyzing identical patients with different forms of trauma from occlusion.

Quality of trauma from occlusion
Premature contacts were categorized according to the affected teeth: anterior and posterior (premolars and molars) premature contacts (Figs 1 and 2). The prevalence of balance contacts on premolars and molars was also noted. Traumatic occlusion caused by premature and balance contacts was assumed when teeth showed mobility in function or fremitus, respectively. Fremitus was checked by manual palpation of the buccal aspect of the maxillary teeth.

Fig 1 (a) A 57-year-old man with generalized severe chronic periodontitis. (b) Maxillary right premolars with widening of the periodontal space and clinically observed premature contacts.

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during clenching in a habitual position. Occlusal contacts were visualized by the application of thin foil (Hanel Okklusions-Folie [12 μm], Coltene/Whaledent). The prevalence of balance contacts was evaluated using an ultra thin foil (Hanel Shimstock Folie (8 μm), Coltene/Whaledent) applied during lateral movements of the mandible out of a habitual position. Primary trauma from occlusion was defined as mobility or fremitus in teeth without CAL; secondary trauma from occlusion was defined as mobility or fremitus in teeth with CAL.

**Quantity of trauma from occlusion**

Patients were classified according to the relative quantity of the detected premature and balance contacts as patients without trauma from occlusion, with ≤ 3 sites with trauma from occlusion, and those with > 3 sites with trauma from occlusion. Trauma from occlusion per patient was the quotient of the quantity of trauma from occlusion and the number of patients was calculated for the test and control group, respectively. In addition, the total amount of trauma from occlusion for each patient was registered.

**Statistical analysis**

The Kruskal-Wallis test (statistical significance, $P < .05$) was used to assess the differences of the tested, noninterval-scaled variables (trauma from occlusion per patient, premature contacts anterior and posterior, balance contacts, total amount of trauma from occlusion per patient) between the different groups (control group; groups of slight, moderate, or severe periodontitis). Since the analysis was performed with the nonparametric Kruskal-Wallis test, the Mann-Whitney test was chosen as a post hoc test and for the evaluation of demographic and clinical baseline parameters (statistical significance, $P < .05$). Furthermore, the association of the severity of periodontitis on the variance of the total amount of trauma from occlusion per patient was analyzed using Spearman correlation (statistical significance, $P < .05$). The different types and quantities of trauma from occlusion were compared with the severity of periodontitis and per-patient values were calculated by averaging the acquired data.

**Fig 2**  
(a) A 48-year-old woman with generalized moderate periodontitis. Maxillary left lateral incisor with advanced bone loss and widening of the periodontal space. (b) Missing contact of maxillary and mandibular left canine in habitual intercuspation and premature contact on maxillary left lateral incisor and mandibular canine.
### RESULTS

**Demographics**

Data of 129 men and 159 women (mean age ± standard deviation [SD], 58.8 ± 10.4 years) were evaluated within the test group. The control group consisted of 35 men and 58 women (mean age, 48.1 ± 9.5 years). Statistically significant differences were detectable for all variables between the test and control group except sex ($P < .001$, Table 1). Compared to the control group, the test group exhibited more missing teeth (4.2 ± 2.1 vs 2.3 ± 2.0), higher PPDs (5.8 ± 1.2 vs 3.1 ± 0.8), gingival recessions (2.2 ± 1.6 vs 0.6 ± 0.8), and more teeth with mobility (4.7 ± 3.3 vs 1.7 ± 2.3) and furcation invasion (2.5 ± 1.4 vs 1.1 ± 1.3).

**Quality of trauma from occlusion**

Of all patients, 64.3% had trauma from occlusion. Table 2 shows that most patients suffering from slight periodontitis had no secondary trauma from occlusion ($n = 36$), whereas most patients with moderate periodontitis had ≤ 3 sites with trauma from occlusion ($n = 69$) and patients with severe periodontitis presented an increased number of > 3 sites with trauma from occlusion ($n = 42$) per patient.

Kruskal-Wallis tests revealed significant differences for the tested variable of quantity of trauma from occlusion per patient between the different severity grades of periodontitis (each $P < .001$, Table 2). Mann-Whitney tests showed that these significances were found for all possible comparisons between the groups of slight, moderate, and severe periodontitis. A statistically significant difference has been also found for the comparison of the control group and the group with slight periodontitis ($P = .013$).

**Quality of trauma from occlusion**

The prevalence of premature and balance contacts was dependent on the attachment level or the severity grade of periodontitis, respectively (Table 3). Kruskal-Wallis tests showed significant differences for all tested variables between the groups of slight, moderate, and severe periodontitis ($P < .001$, Table 3). Premature and balance contacts appeared more often when CAL was increased. Significant differences between the control group and the group of slight periodontitis were neither detectable for anterior ($P < .249$) or posterior ($P < .637$) premature contacts nor for balance contacts ($P < .697$). Spearman correlation describing the relationship between the total amount of trauma from occlusion per patient and the severity of periodontitis showed statistically significant results (correlation coefficient, $\rho = .51$, $P < .001$).
0.580; P < .001). Almost 33% of the variance of the value of total amount of secondary trauma from occlusion per patient is therefore to be explained statistically by the severity of periodontitis and vice versa.

**Per-patient analysis**

In the control group, 0.8 sites with trauma per patient were calculated. In the categories of slight, moderate, and severe periodontitis, values of 0.7, 2.2, and 4.6 sites with trauma per patient were determined, respectively. An extended analysis including the quality of the detected trauma from occlusion showed that patients with slight periodontitis had 0.1 premature contacts of maxillary anterior teeth per patient, whereas patients with moderate or severe periodontitis had 0.7 and 1.6 sites with trauma of that quality per patient, respectively. In contrast, patients in the control group showed 0.15 sites with trauma of that type. In cases of premature contacts of maxillary posterior teeth, those values reached 0.19 for the control group and 0.15 for slight, 0.45 for moderate, and 1.4 for severe periodontitis groups. With regard to balance contacts, the calculated values per patient were 0.48 for the control, 0.45 for slight, 1.0 for moderate, and 1.5 for severe periodontitis groups.

**DISCUSSION**

Trauma from occlusion is known to cause several changes in the periodontal tissues.\textsuperscript{17,22} Forces caused by occlusal trauma could decrease perfusion of the periodontal ligament (PDL), resulting in ischemia and necrosis of the PDL cells when the adaptive capacity of the PDL is exceeded.\textsuperscript{9,17,22,23} In this case, bacterial inflammation of the periodontium could progress faster because of the lower tissue resistance or tissue integrity. Hence, trauma from occlusion might be a catalyst for the destructive processes initiated by bacterial periodontal inflammation.\textsuperscript{21,24}

Trauma from occlusion can be classified as either primary or secondary.\textsuperscript{18,19,25} Primary trauma from occlusion is described as an abnormal occlusal force acting upon a healthy periodontium. Secondary trauma from occlusion is an occlusal force acting on a reduced or weakened periodontium; the force itself may not necessarily be abnormal but excessive for the weakened periodontium. Some authors prefer further distinction into acute and chronic trauma from occlusion to describe the temporal character of the force acting on the affected tissues.\textsuperscript{21} However, clinically, trauma from occlusion occurs as premature contacts with the suspected teeth showing fremitus and a radiographic widening of the periodontal space.\textsuperscript{17} On the other hand,

<table>
<thead>
<tr>
<th>Severity of periodontitis</th>
<th>Premature contacts (anterior)</th>
<th>Premature contacts (posterior)</th>
<th>Balance contacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control group</td>
<td>14</td>
<td>18</td>
<td>45</td>
</tr>
<tr>
<td>Slight periodontitis</td>
<td>6</td>
<td>8</td>
<td>25</td>
</tr>
<tr>
<td>Moderate periodontitis</td>
<td>120</td>
<td>76</td>
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<tr>
<td>Severe periodontitis</td>
<td>103</td>
<td>90</td>
<td>99</td>
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<tr>
<td>Trauma from occlusion</td>
<td>243</td>
<td>192</td>
<td>341</td>
</tr>
</tbody>
</table>

Statistical values:
- chi-square 175.92, df 3, P < .001*
- chi-square 138.23, df 3, P < .001*
- chi-square 75.49, df 3, P < .001*

*Statistically significant, P < .05 (Kruskal-Wallis).
hand, occlusal interferences are defined as occlusal contacts hindering harmonious jaw movements with the teeth maintaining contact.\textsuperscript{25} In contrast to the definition of trauma from occlusion, the definition of occlusal interferences does not include a description of the periodontal conditions of the examined teeth. Considering the test group in this study, only balance contacts were noted, which referred to teeth with reduced periodontium, analogous to the definition of secondary trauma from occlusion. Therefore, these contacts were considered to be a specific quality of secondary trauma from occlusion instead of occlusal interferences.

The results of this study show that 64.3% of the examined 381 patients suffered from trauma from occlusion and that the prevalence of trauma from occlusion is statistically associated with the severity of periodontitis. In the overall analysis, balance contacts (43.9%) were the most common trauma from occlusion followed by premature contacts of maxillary anterior (31.3%) and posterior (24.7%) teeth.

The Spearman test showed a strong significant correlation between the total amount of trauma from occlusion per patient and the severity of periodontitis, whereas these two variables determined reciprocally nearly 33% of their variance. As with any correlation test, it is not possible to extrapolate a causal relationship between the correlating variables and evaluate which one of the variables was cause or consequence. The statistical analysis of the control group revealed that the prevalence of balance contacts is increased even in patients without periodontal disease. Comparing the prevalences of the investigated trauma from occlusion, the data of this study show that patients with no or slight periodontal attachment loss presented most of the trauma on posterior teeth, caused by balance contacts or posterior premature contacts. As periodontal attachment loss increases in patients with moderate and severe periodontitis, anterior premature contacts become the leading type of trauma from occlusion (Fig 3). Different functional problems possibly caused by increasing attachment loss (posterior bite collapse, discrepancies between centric relation and centric occlusion, or an unstable occlusion) may be partially responsible for these results. Wang et al reported that severe periodontitis increases the probability of posterior bite collapse because treatment of molars suffering from advanced periodontal attachment loss and furcation involvement often has a worse long-term prognosis compared to anterior teeth.\textsuperscript{26} Additionally, anterior sliding of the mandible caused by discrepancies of centric relation and centric occlusion or a reduced vertical jaw relation resulting from posterior bite collapse can increase the functional load of the maxillary incisors.\textsuperscript{21,27–29} Therefore, severe periodontitis could lead to increased posterior tooth loss and an increased risk of developing anterior premature contacts following changes in the vertical jaw relation. Even when molars with severe periodontal attachment loss can be treated successfully, the teeth often suffer from increased mobility, which could result in an unstable centric occlusion and lead to increased functional load of the maxillary incisors.\textsuperscript{27–29}

Although a single statistically significant difference was detected between the control group and the group of slight periodontitis for the variable of trauma from occlusion per patient, this result is of less clinical importance. As the calculated value of trauma per patient was 0.8 for the control group, there is only little absolute difference compared with the lower value of 0.7 for slight periodontitis patients. One possible explanation for this significance might be the difference in the number of participants per group (55 vs 93). In contrast, all other comparisons between these two groups with the moderate and severe periodontitis groups showed statistically significant differences for all tested variables.

Different studies showed no or weak correlations between occlusal traumatization and the progression of periodontitis. Investigating premature and balance contacts in patients with moderate and severe periodontitis, Jin and Cao found no statistically relevant results that occlusal trauma could lead to an increased periodontal attachment loss.\textsuperscript{30} Pihlstrom et al reported similar results and concluded that there was no correlation between occlusal contacts in centric relation; working, nonworking, or protrusive positions; and the severity of periodontitis.\textsuperscript{31} However, although Jin and Cao\textsuperscript{30} and Pihlstrom et al\textsuperscript{31} reported that teeth showing fremitus had deeper PPD, more attachment loss, and lower
radiographic bone height than teeth without fremitus, they did not conclude that there is a relationship between trauma from occlusion and periodontitis.

Recent studies support the relationship between the severity of periodontitis and the amount of trauma from occlusion found in this study. Bernhardt et al. performed a cross-sectional study with 2,980 participants and reported that the occurrence of nonworking contacts was significantly associated with PPD and attachment loss. Nearly 39% of the patients were identified to suffer from balance contacts. Compared with the values of balance contacts in the slight periodontitis and control group in this study, results from Bernhardt et al. are in a similar range (39% vs 45% and 48%). Nunn and Harrel found that PPDs in patients with occlusal discrepancies were statistically significant higher than those in patients without interferences. Furthermore, in the cited study, occlusal discrepancies in patients with good oral hygiene were the only significant predictor of initial PPD. The results of Nunn and Harrel revealed that teeth with untreated occlusal discrepancies in periodontitis patients had a significantly increased likelihood of worsening in clinical conditions compared to teeth without these discrepancies. In 2009, Nunn and Harrel published further results showing that premature contacts in centric relation, posterior protrusive contacts, balancing contacts, combined working and balancing contacts, and the length of slide between centric relation and centric occlusion were significantly associated with PPD. These studies indicate that periodontitis patients with different types of trauma from occlusion have an increased risk of accelerated bone loss compared with periodontitis patients without trauma from occlusion. The influence of occlusion on the prognosis of the clinical periodontal conditions, especially shown by Nunn and Harrel, support the conclusion of the present study concerning the spatial distribution of trauma from occlusion in anterior and posterior teeth in relation to the severity of periodontitis.

**CONCLUSION**

Within the limits of this study, the results suggest that secondary trauma from occlusion is frequently found in patients suffering from periodontitis. The prevalence of trauma from occlusion was positively correlated with periodontal attachment loss or severity of periodontitis.
REFERENCES


