The Effect of Occlusal Loading on the Periodontal Tissues. A Literature Review.
Part I – Occlusion and Periodontitis

Ocena wpływu zaburzeń zwarcia na tkanki przyzębia – przegląd piśmiennictwa. Część I – okluzja a periodontitis

Abstract
The aim of this study was to review the literature concerning the association between occlusal loading and the presence and progression of periodontal diseases. The results of the work will be discussed in two parts. The first part of the study presents the latest research on the impact of occlusal disharmony on periodontal tissue changes during periodontitis. The second section reviews the literature on the relationship between the occlusal trauma and changes in the healthy periodontal tissues and formation of gingival recession. The results of some studies allow to conclude that occlusal interferences may correlate with periodontal tissue destruction during periodontitis and the presence of gingival recession, although some studies deny this findings. However, despite these various reports assessing occlusion and the response of periodontal tissues it is noted that untreated abnormal occlusal contacts exacerbate periodontal diseases. Confirmed in research impact of occlusal adjustment on an improvement in periodontal parameters suggests the desirability of occlusive therapy in patients with periodontal diseases and the need a multidisciplinary approach to patients and their treatment team. The studies suggest occlusal therapy as an effective management of these pathologies. Therefore, a thorough diagnosis and comprehensive treatment, properly scheduled and carried out in cooperation with periodontists and prosthodontists, play an important role to achieve the intended therapeutic success (Dent. Med. Probl. 2015, 52, 2, 215–221).

Key words: periodontitis, occlusion, periodontium.

Słowa kluczowe: zapalenie przyzębia, okluzja, przyzębie.
ysis of occlusal contacts, both with malocclusion and without, is essential in assessing the loading of teeth and surrounding tissues and also in assessing the mandibular position determined by these contacts in relation to the masticatory muscles and TMJ function.

The optimal model of occlusion suggested by Okeson [3] serves as a good tool to analyse the occlusion. At the combined dental arches the mandibular condyles are in the most upper-anterior position resting on the posterior slopes of arthral cusps. In the maximum intercuspal position (maximal intercuspation) all posterior teeth are in simultaneous and even contact. There are contacts between functional cusps and sulci of opposing teeth. The contact areas of anterior teeth are much smaller than those of posterior teeth. Between teeth of both dental arches the so-called triads are preserved, which means the contact of one tooth with two teeth of the opposite arch, except for the lower medial incisors. Contacts between antagonists enable distribution of occlusal forces over a larger number of teeth and axial loading to assure the most favourable distribution of forces in dental alveoli. During protrusive excursions the guidance on anterior teeth causes an immediate disclusion of teeth in the lateral segments. During lateral excursions only canine teeth are in working contact, whereas the remaining teeth undergo immediate disclusion. Deviations from the optimal occlusion model are regarded as occlusal disharmony or occlusal interferences.

Occlusal disharmony may be associated only with dental abnormalities manifested by the absence of normal contact points between functional cusps and sulci of opposing teeth, by the absence of optimal guidance, and/or with premature occlusal contacts, which may lead to an abnormal intermaxillary relationship. Abnormal occlusal contacts may be caused by dislocated teeth, malocclusions, dental mistreatment, traumas (e.g., fracture of the mandible and/or maxilla) and tooth wear. This may in turn lead to increased stress of masticatory muscles due to parafunctions or different habits (e.g. the habit of unilateral mastication) [4–6]. The consequences of abnormal occlusal contacts on any element of SS are the subject of many studies. Thus, the impact of occlusal disharmony on the oral tissues has been considered, including effects on aspects like abrasion, abfraction, fractured teeth/roots, increased mobility of teeth, dislocation, rotation, tooth inclination, partial luxation of the tooth, McCalls festoons, root dehiscence, gingival recession), masticatory muscles and TMJ (myo- and athropaties) [4–8].

Numerous researchers have made an attempt to clarify the role of occlusal overloading on periodontal tissues. In the second decade of the 20th century it was thought that excessive occlusal forces were the major causative factor of periodontal pathology [9]. As a result of animal studies carried out in the 1960s and 1970s it was postulated that occlusal forces do not initiate the destruction of periodontal tissues, but they modify the progression of periodontal disease [10–13]. In 1999, the American Academy of Periodontology evaluated the role of occlusion on periodontal tissues. The report of the International Workshop group adopted the following definition of occlusal trauma: “injury resulting in tissue changes within the attachment apparatus as a result of occlusal forces” [14]. The concepts primary and secondary occlusal trauma were used. Primary occlusal trauma was defined as “injury resulting in tissue changes from excessive occlusal forces applied to a tooth or teeth with normal supporting structures”. Secondary occlusal trauma was defined as “injury resulting in tissue changes from excessive or normal occlusal forces applied to a tooth or teeth with reduced supporting structures”. Occlusal trauma may occur in conjunction with inflammatory periodontal diseases or may be independent of it and occur in an intact periodontium [14–16]. Although the role of occlusal forces, their vectors and value, in relation to the development or progression of periodontitis is still the subject of dispute, it has not as yet been fully understood, mostly because of the lack of randomised, prospective studies carried out in humans.

The purpose of this review was to clarify whether there is an effect of occlusal loading on the development and/or progression of periodontal disease.

**Literature Review**

**Selection Criteria**

Selection criteria for considering studies for this review was as follows: interventional studies (with or without randomisation) and observational studies (cohort studies, case-control studies, cross-sectional studies) (in English). Participants of the studies were adults with clinical diagnosis of periodontal tissue (healthy periodontal tissue or periodontitis). The intervention in experimental studies was an occlusal adjustment, the evaluated measures were clinical parameters (such as probing depth – PD, clinical attachment loss – CAL, tooth mobility) and gingival recession. The exclusion criteria were: animal studies, reviews, and case reports.

In the study, we performed a literature search using online medical database MEDLINE/ PubMed, covering the period from 1990 to 2014.
The search criteria included: occlusal trauma and periodontal tissue, occlusal trauma and periodontal recession, dental occlusion, traumatic and periodontal diseases/aetiology, dental occlusion, traumatic and periodontitis. The method of selecting relevant literature is shown in Fig. 1.

**Results**

During the search procedure 357 references were identified (Table 1). The publications for review included all studies pertaining to the impact of abnormal occlusal contacts on periodontal tissues, healthy or inflamed, on human subjects, published in English. The review did not include the effect of traumatic occlusion on peri-implant tissue, dental prostheses/appliances, periapical diseases and periodontal tissue during orthodontic treatment. Of the 357 publications, 269 were excluded because their titles were unrelated to the subject of the review. Abstracts of the remaining 88 relevant papers were evaluated to see if they met the inclusion criteria. Of these, seven articles were selected and their full texts read [20–23, 25, 27, 28]. Two articles did not meet the eligibility criteria [23, 28]. The search was enhanced by screening the references list of papers related to the subject of the review for additional articles that might have been missed. Thus five additional publications were included in the study [17–19, 24, 26]. Six articles [17–22] concerning the influence of abnormal occlusal contacts and periodontitis were selected for the first part of the study (Fig 1).

**Discussion**

This review includes experimental (clinical trials) and observational studies on human subjects in the period 1990–2014. Through clinical trials it is possible to analyse data parameters over time, and thus assess the impact on the development and progression of periodontal disease. Experimental studies were conducted by Burgett et al. [17], and Harrel et al. [18]. The researchers analysed the impact of occlusal adjustment on the parameters of periodontal tissues in patients diagnosed with periodontitis.

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**Table 1. List of search terms**

<table>
<thead>
<tr>
<th>Search Query</th>
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<tr>
<td>#1 occlusal trauma AND periodontal tissue</td>
<td>85</td>
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<tr>
<td>#2 occlusal trauma AND gingival recession</td>
<td>15</td>
</tr>
<tr>
<td>#3 dental occlusion, traumatic AND periodontal diseases/aetiology</td>
<td>175</td>
</tr>
<tr>
<td>#4 dental occlusion, traumatic AND periodontitis</td>
<td>82</td>
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</tbody>
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* Search of database MEDLINE/PubMed covering the period from 1990 to 2014.
The only randomised study of this subject has thus far been performed by Burgett et al. [17]. The study focused on the effect of occlusal adjustment combined with periodontal treatment on the level of connective tissue attachment, the depth of gingival pockets and tooth mobility. The patient sample included subjects diagnosed with moderate to severe periodontitis (n = 50). The mean age was 44 years. The subjects underwent initial hygienic-phase treatment. In this study there was a randomised selection of patients receiving vs not receiving occlusal adjustments. All patients had periodontal surgery on one side of the mouth and non-surgical treatment on the other side. After a two-year observation period a reduced loss of connective tissue attachment level after occlusal correction was revealed. The latter was regarded as an adjunctive therapy in the treatment of periodontal diseases. Response to occlusal adjustment was similar for the surgical and non-surgical treatment. The initial tooth mobility had no effect on the connective tissue attachment level (AL). Similarly, occlusal correction had no effect on the depth of gingival pockets (PD). The results of this study thus indicate a greater loss of attachment level when occlusal adjustments have not been performed in the treatment of periodontitis.

In the study by Burgett et al. [17] there was no information about blinding the trial for the researchers. The article does not specify if the seeming occlusal adjustment was performed in the control group. Occlusal correction was carried out according to generally accepted accounting principles (obtaining even and stable tooth contact in centric relation, freedom in centric, smooth gliding contacts in centric and eccentric mandibular motion, and elimination of balancing side interferences). However, the type of occlusion found in the patients under treatment was not described. Therefore, it is not possible to assess what type of abnormal occlusal contacts had an impact on periodontal tissues.

More recently, a large-scale study has been carried out by Harrel and Nunn [18]. The aim of their study was to evaluate the effect of treatment of occlusal discrepancies on the progression of periodontal diseases. The study group comprised of 89 patients with the diagnosed moderate to severe periodontitis. A complete periodontal examination including an analysis of the occlusion was repeated at least one year after the first examination. The patients were divided into one of three groups: untreated patients, those who had completed non-surgical treatment, but had undergone no occlusal treatment (partially treated patients) and control group that had completed all recommended treatment (completely treated patients). Occlusal discrepancies were observed in 56 patients, 26 of these received some form of occlusal correction. Statistical analyses were carried out at the tooth level. Initial PD was significantly lower for teeth without occlusal discrepancies compared with the teeth treated for occlusal discrepancies or had untreated occlusal discrepancies. The teeth of patients without occlusal correction showed a significantly increased gingival pocket depth compared to those whose teeth had been corrected and teeth free from occlusal disturbances. In addition, in patients who had undergone the comprehensive periodontal treatment, including occlusal correction, the teeth diagnosed with occlusal disturbances, as well as those not affected by occlusal trauma, responded to the treatment. In patients for whom the recommended comprehensive periodontal treatment was not applied, a PD around the teeth in occlusal trauma was greater than in teeth in non-traumatic occlusion. No significant differences in the initial tooth mobility was found between the three groups, while the annual recording of tooth mobility was lower in the group without occlusal discrepancies compared with those with or without treated occlusal discrepancies.

These studies suggest the possibility of improving clinical periodontal parameters if a periodontal treatment is correlated with occlusal adjustment. However, in both studies, there are variations regarding PDs. Burgett et al. [17] showed no relationship between the occlusal adjustment and PDs, while Harrel and Nunn [18] demonstrated such a relationship. Comparing the results of the two studies may not be suitable due to their different methodology. The Burgett et al.’s study [17] was a prospective research, while Harrel and Nunn’s study [18] was a retrospective one. Statistical analyses were carried out at the patient level in the first study [17], but at tooth level in the second one [18]. It means, in the Burgett et al.’s study [17] mean clinical parameters were evaluated for both groups of patients, while in the second one [18] the outcome measures were evaluated for each tooth. Despite these differences, an occlusal adjustment in any of the studies did not have any adverse effects. In contrast, if no occlusal adjustment was performed despite the presence of occlusal discrepancies, the various periodontal clinical parameters during treatment of periodontitis may deteriorate, suggesting its use as an additional therapy.

These interventional studies allow an assessment of the role of occlusal discrepancies to periodontal parameters. However, it would be unethical to conduct a randomised prospective study on the role of occlusal discrepancies on patients with untreated periodontitis. Observational studies are
an important source of knowledge of this question. It should be considered that the major limitation of an observational study is that it involves the analysis of data collected at a single point in time. Every observational study is limited because it doesn’t allow an assessment of disease activity. Moreover, any correlation test does not allow assessment of which of the variables is the cause and which is the consequence, but only possible relationships.

Harrel and Nunn [19] in their subsequent studies have analysed the relationship between initial occlusal discrepancies and initial clinical periodontal parameters and the effect of different occlusal contacts on PDs in the groups of patients diagnosed with moderate to advanced periodontitis [20]. The studies revealed that teeth with initial occlusal discrepancies had significantly deeper initial PDs, worse initial prognoses and greater mobility than teeth without occlusal discrepancies. The multiple GEE regression model showed that smoking, gender and oral hygiene were significant confounders for initial PDs. The separate GEE regression models for patient with good oral hygiene have indicated that the initial occlusal discrepancy is the only significant predictor of PDs and may contribute to periodontal disease. The studies also revealed increased depth of PDs around teeth in premature contact in centric occlusion. In eccentric occlusion, increased PD was found around teeth in contact within the area of lateral teeth in the prosusive movement and balancing contacts with or without working contacts during lateral movements. In addition, the longer the slide in centric, the higher the risk of increased PDs. Moreover, the lateral discrepancy between centric relation and centric occlusion leads to deeper PD than horizontal or vertical slides from centric. The study suggests that the incisal guidance on the anterior teeth correlates with the decreased gingival pocket depth. Interestingly, the conclusion has also been drawn that the correlation between the increased pocket depth and abnormal occlusal discrepancies is stronger than that between pocket depth and tobacco smoking.

Branschofsky et al. [21] found a positive relationship between occlusal trauma and the severity of periodontitis. The study was conducted among 288 patients diagnosed with periodontitis. The control group consisted of 93 patients that were generally and periodontally healthy. Their study revealed that the number of premature contacts and balancing contacts correlates with increased clinical attachment loss. Patients with a more severe form of periodontitis had an increased number of abnormal occlusal contacts. The most frequent form of occlusal discrepancy was balancing contacts, also in the control group without periodontitis. If the loss of connective tissue attachment does not occur or is insignificant, premature or balancing contacts are mainly observed in the posterior teeth. Significant loss of connective tissue attachment is found if the balancing contacts are located in the anterior teeth. As the authors themselves point out, a significant correlation does not reveal which of the variables is the cause and which is the consequence. On the basis of the results of this study the conclusion cannot be drawn that traumatic occlusion aggravates the course of periodontal disease; only that the prevalence of trauma from occlusion has a positive correlation with clinical attachment loss or severity of periodontitis.

Jin and Cao [22], on the other hand, could not confirm the relationship between several selected symptoms of occlusal trauma and severity of periodontitis. The 32 patients selected for this study had untreated moderate to advanced periodontitis. The researchers, analysing the influence of abnormal occlusal contacts (premature contacts in centric relation occlusion, non-working eccentric contacts, premature contacts of anterior teeth or posterior balancing contacts), found no significant effects on periodontal parameters like PD, AL, percentage of alveolar bone height (BH). However, the authors constructed a “trauma from occlusion index” (TOI) (combining recordings of functional tooth mobility and radiographically widened periodontal ligament space), and an “adaptability index” (AI) (combining pronounced tooth wear and radiographically thickened lamina dura). An analysis of the relationship between these two indices showed that teeth with pronounced tooth mobility and wide periodontal ligaments (TOI-positive) exhibited deeper PD, more AL and less osseous support than TOI-negative ones.

In a cross-sectional study Bernhardt et al. [23] confirmed that the type of occlusal relationship affected periodontal tissue parameters. The study group consisted of a representative population sample of 2980 patients. The mean age was 44 years. A tooth-based multivariable analysis, containing characteristics of the teeth within subjects was conducted. The advantage of this analysis was to assess the direct relationship between tooth-specific occlusal factors and AL and PD on the same tooth and the ability to detect potential confounders. This result indicated that the occurrence of non-working balancing contacts was significantly related to increased PD and clinical AL. The presence of non-working balancing contacts and working side contacts on the same tooth was significantly associated with increased PD only. Working side contacts were not significantly related to PD.
Bernhardt et al. [23], found many of the same confounders for PD as Harrel and Nunn [19]: male gender, smoking, poor plaque index (PLI), low education level and tooth type (molars). Risk indicators for greater AL were recorded by Bernhardt et al. [23]. Their study included only eccentric occlusal interferences. Tooth mobility was not recorded. Therefore, it is not possible to compare these results with those presented by Harrel and Nunn in 2009 [20]. Nevertheless, both studies confirm the relationship between occlusal disturbances and periodontal parameters: the latter study [20] confirm the relationship between centric and eccentric occlusal interferences and PD, the former one [23], only between eccentric occlusal interferences and PD and AL. Interpreting the results of Bernhardt et al.’s study [23], it should be considered that the periodontal status of the patients was not diagnosed. Their findings indicate that 10% of the periodontal sites had PD ≥ 4 mm and 39% had AL ≥ 3 mm. However, these results do not indicate whether these changes concern healthy or inflamed periodontium.

Conclusion

Numerous studies concern the effect of occlusion on the periodontal parameters and progression of periodontal diseases. Nowadays; in the opinion of many researches, occlusal trauma increases periodontal tissue destruction during periodontitis affecting increased PD, AL or tooth mobility [17–21]. However, others could not find any such effect [22]. Periodontitis can be treated without occlusal adjustment, but some experimental studies found an association between occlusal adjustment and an improvement in periodontal parameters [17, 18]. Based on these studies the conclusion is that untreated occlusal discrepancies exacerbate the periodontal disease, and that occlusal therapy should be an integral part of the periodontal treatment. If that is accepted, a thorough diagnosis and comprehensive treatment is needed, respecting patient’s masticatory function and comfort, properly scheduled and carried out in cooperation between periodontists and prosthodontists.

References

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