

REVIEWS

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The Influence of Occlusal Loading on the Periodontal Tissue. A Literature Review. Part II: Occlusion and Recession, Occlusion and Healthy Periodontium

Ocena wpływu zaburzeń zwarcia na tkanki przyzębia
– przegląd piśmiennictwa.

Część II – okluzja a recesje dziąseł, okluzja a zdrowe przyzębie

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A – research concept and design; B – collection and/or assembly of data; C – data analysis and interpretation;
D – writing the article; E – critical revision of the article; F – final approval of article

Abstract

The stomatognathic system is a morphological and functional complex where any disturbance in one part of this system influences the functioning of the others. The possible relation between teeth, their supporting structures, the jaws, the masticatory muscles and the temporomandibular joints is a subject of many studies. The impact of occlusion on the response of periodontal tissues are still being discussed. The aim of this study was to review the literature concerning the association between the occlusal loading and the formation of gingival recession and changes in the healthy periodontal tissues. On the basis of clinical trials in human populations the following conclusions can be drawn: premature contacts in maximum intercuspation and balancing occlusal contacts during lateral movements are doubtful factors responsible for destructive changes in the healthy periodontium, but the absence of mutually protected occlusion may contribute to the development of gingival recession, so the examination of occlusion and correction of improper tooth contact are suggested in this clinical cases (**Dent. Med. Probl. 2016, 53, 4, 529–535**).

Key words: occlusion, periodontium, gingival recession.

Słowa kluczowe: okluzja, przyzębie, recesje dziąsłowe.

Gingival recession is characterized by apical displacement of the gingival margin to the cemento-enamel junction, which in consequence contributes to the dehiscence of the root surface [1]. Epidemiological studies confirm a frequent occurrence of gingival recession in the adult population, and its prevalence increases with age. They also reveal that gingival recessions are found more frequently on the buccal surfaces [2–7]. Clinical problems related to gingival recession are as follows: dentin hypersensitivity, higher risk of

non-carious cervical lesions, root caries and elongation of the tooth crown resulting in esthetic problems, especially when the anterior teeth are affected. Gingival recession uncomplicated by inflammation is termed ‘classic recession’. It is the most common form of gingival recession, with clinical attachment loss on the buccal surface, but without the presence of additional factors. Inadequate oral hygiene or recessions reaching the muco-gingival line can lead to secondary inflammation and the development of periodonti-

tis. Shrinking gums in the course of periodontitis is another type of recession, but no longer classified as a classical recession [8].

The etiology of gingival recession is multi-causal. Numerous population studies have been conducted to identify potential etiological factors of gingival recession [2–13]. The following morphological and anatomical factors (osseous, gingival and dental): thin alveolar bone on the buccal surface, bone dehiscences, thin gingival phenotype, high frenal attachments, shallow oral vestibule or incorrect position of teeth in the arch are the main causes of this pathology. In addition to these predispositions, there are triggers (precipitating factors) such as bacterial plaque and subgingival calculus, mechanical trauma (due to an improper technique of brushing teeth, its frequency or habits like chronic impaction of foreign bodies against the gingiva), iatrogenic factors – orthodontic (tooth displacement in the buccal direction), prosthetic (fixed prosthodontic restorations range exceeding biological width), periodontal (often carried out scaling) and surgical (resection methods in the treatment of periodontitis) treatments [6, 8–10]. Smoking (chemical trauma) and level of education are other risk indicators [4, 9–12]. The impact of primary occlusal trauma on the development of gingival recession is recognized as controversial [8]. However, some authors classified it as a predisposing factor [6, 13].

The analysis of epidemiological data employing linear and multivariable regression models was used to assess the relationship between potential factors and the occurrence of gingival recession [3, 4, 9–13]. The following variables showed statistically significant correlation with the presence of the recession: age [3, 4, 10, 11, 13], masculine gender [4, 10, 11, 13], smoking [4, 9–13], the extent of gingival inflammation (inverse correlation) [3, 9], and the presence of dental plaque [4, 11, 12]. The introduction of the coefficient of determination (R^2) in the multiple regression analysis helps identify what part of the dependent variable is explained by the model. In their studies of gingival recession Zawada et al. [9] stated that although the model was significant (independent variables: coefficient of nicotine addiction, bleeding on probing [BOP] and approximal attachment loss – a significant impact escalating and the malocclusion – reducing effect and male – escalating), its fit was poor ($R^2 = 0.0763$). In the studies conducted by Serino et al. [3] R^2 was 0.58. This means that 58% of buccal recession can be explained by the variables (e.g., loss of approximal attachment). At the tooth level analysis, the coefficient of determination was lower ($R^2 = 0.17$). The highest coefficient of determination ($R^2 = 0.72$) has been reported

by Dominiak [14]. In the multivariable regression model three factors were taken into account: age of the patients, the angle width of the labial bone in the anterior segment of the mandible and the vertical dimension of the bone dehiscence, which explained the 72% number of periodontal recession. In other studies using the multiple regression model, R^2 was not mentioned [4, 7, 10, 11]. The correct conclusion was drawn from these studies by Dominiak et al. [13]: modifiable risk factors do not determine the whole etiopathological conditions. Other factors, anatomical and genetic, play a very important role in gingival etiology [13, 14].

Stillman [15, 16] first discovered the relationship between occlusal trauma and gingival damage; however, there are authors who cast doubt on this relationship [17]. The clinical practice shows that Stillman's clefts, another form of recession, are induced by occlusal trauma [8]. The mechanism involved in the development of recession has been described by Consolaro [18, 19]. Occlusal overloads generate pressure and pull out forces. This leads to the compression of periodontal fibers accompanied by the vascular diameter narrowing and disrupting fibers and periodontal cells. This results in the local growth of mediators that determine the process of bone reconstruction; in an insignificant increase in the level of mediators the process of bone development is induced, while in the significant increase the process of resorption is observed. During the primary occlusal trauma periodontal tissues adapt themselves to the excessive occlusal forces through the condensation of alveolar cortical bone, irregular extension of periodontal space and increased bone density, which is visible on the X-ray image. However, too high and permanent overload leads to an excessive stretching and/or compression of periodontal ligament in the cervical region. This can cause a significantly increased level of mediators responsible for bone resorption, leading finally to bending and loss of lamina dura in the V shape. This observation is made in the interdental space and on the buccal surface. The alveolar ridge bone on the buccal surface is frequently very thin. Its loss generates the connection between the periosteum and periodontal ligament, producing an elongated connective tissue attachment and increasing the distance between connective epithelium and the bone level. The connective epithelium can maintain the gingival level at the physiological height only for a certain period of occlusal trauma, but the decreased volume of tissues, tooth root dehiscence and the development of V-shaped recessions could be observed over time. This process is associated with the gingival tissue adaptation to the absence of osseous support. The decrease in

the volume is mediated by a permanent physiological reconstruction of tissues, which is aimed at restoring right proportions between gingival sulcus epithelium, junctional epithelium, gingival connective tissue and alveolar bone. Consonaro reports that the V-shaped recessions are associated with occlusions contrary to the U-shaped recessions, which are concomitant with periodontitis or results from an improper tooth brushing [19]. The majority of primary concomitant symptoms of the V-shaped recession can be attenuated through the elimination of occlusal trauma. The author suggests that clinically primary occlusal trauma occurs as a triad of symptoms: wear facets, abfraction and V-shaped gingival recession. The fact that wear facets and abfraction are observed only during the patient's examination, when gingival recession is not yet visible, should incline dentists to a careful assessment of X-ray pictures, which should indicate primary occlusal trauma manifested by the thickness of the lamina dura, irregular widening of periodontal space, V-shaped cervical vertical bone loss, bone sclerosis in the periapical region and/or interdental bone crest and root resorption in a more advanced stage. Intraoral radiographs permit the identification of periodontal tissue (lamina dura, interdental septum) and an early diagnosis of pathological processes, but this does not provide an opportunity to detect the bone dehiscence, one of the main anatomical factors of the recession. These are pictures of summation in which the phenomenon of overlapping anatomical structures makes it impossible to assess vestibular and lingual alveolar bones. Cone-beam computed tomography (CBCT), especially computed transsectoral tomography (TSS), reveals very small bone dehiscences in the order of 0.2 mm, impossible to identify in clinical or intraoral X-ray examinations [20]. The effect of factors associated with functional overload is still discussed; therefore, as suggested by Wolf et al. [8], gingival recessions might not be classified into the category of periodontal diseases, although the authors end this statement with a question mark, which means that they leave this issue open. Gingival recession at some sites may be the result of a combination of various factors. It should be noted that gingival recession is not an unavoidable physiological process due to aging, but may be explained by the cumulative effects of trauma and/or inflammation of the periodontium [4, 21]. Clinicians must identify the causative factors and eliminate them. Therefore, the confirmation or exclusion of the impact of abnormal occlusal contacts on healthy periodontal tissues and on the development of gingival recession will help to provide the proper treatment.

Aim

The aim of the study was to review the literature concerning the association between occlusal loading and the presence and progression of periodontal diseases. The results of the review are discussed in two parts. The first part of the study presents the most recent research on the impact of occlusal disharmony on periodontal tissue changes during periodontitis (published in DMP, 2015, Vol. 52, No. 215–221). The purpose of this paper is to clarify the effect of occlusal loading on the development of gingival recession or changes in healthy periodontal tissues.

Literature Review

Selection Criteria

Selection criteria for considering the studies for this review were as follows: interventional studies (with or without randomization) and observational studies (cohort studies, case-control studies, cross-sectional studies) (in English). The evaluated measures within subjects were: the clinical periodontal parameters (such as probing depth- PD, clinical attachment loss- CAL, tooth mobility), gingival recession, occlusal contacts. Participants of the studies were adults with clinical diagnosis of periodontal tissue (healthy periodontal tissue or periodontitis). The exclusion criteria were: animal studies, reviews, and case reports. Since only classical recession was taken into account, in the second part of the study periodontitis was another exclusion criterion.

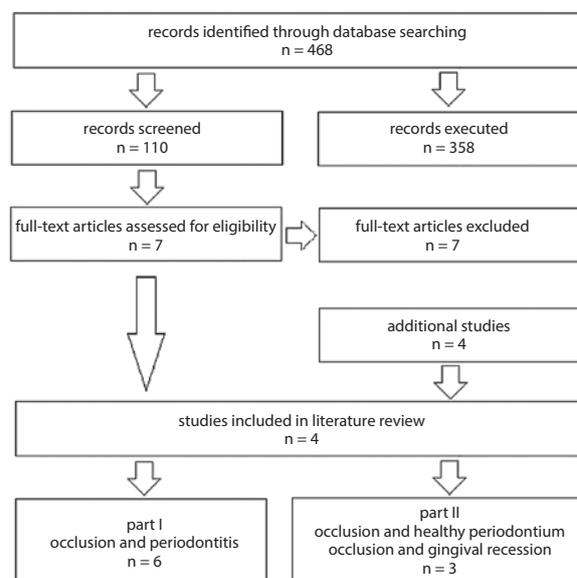


Fig. 1. Flow diagram of literature search

In this study, we performed a literature search using online medical database MEDLINE/PubMed and Scopus, covering the period from 1990 to 2015. The search criteria for both databases included: occlusal trauma AND periodontal tissue, occlusal trauma AND periodontal recession, dental occlusion, traumatic AND periodontal diseases/etiology, and for MEDLINE database the search included also dental occlusion, traumatic AND periodontitis. The method of selecting relevant literature is shown in Figure 1.

Results

During the search procedure 468 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 468 publications, 358 were excluded because their titles were not relevant to the subject of the review. Abstracts of the remaining 110 relevant papers were evaluated to see if they met the inclusion criteria. Of these, seven articles were selected and their full texts read [22–28]. Two articles did not meet the eligibility criteria [25, 28]. Bernhardt et al. [25] confirmed that the type of occlusal relationship affected periodontal tissue parameters, but did not indicate whether these changes concerned healthy or inflamed periodontium. Kundapur et al. [28] investigated the association between trauma from occlusion and gingival recession, but the authors assessed only signs of trauma from occlusion such as: fremitus test, presence of wear facets and tooth mobility, but not occlusal contacts.

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. Five articles were selected and their full texts read [29–33]. Harrel and Nunn [32] showed no relationship between the presence of gingival recession and occlusal disturbances, but the study group consisted of patients with moderate to severe periodontitis. Therefore, this paper was excluded. Four other additional publications were included in the study [29–31, 33]. Six articles [22–24, 29–31] concerning the influence of abnormal occlusal contacts and periodontitis were selected for the first part of the study (published in DMP, 2015, Vol. 52, No. 215–221). Three articles [26, 27, 33] were selected for the second part of the study.

Only one scientific paper on the correlation between abnormal occlusal contacts and the prevalence of gingival recession met the inclusion criteria described previously. The study was carried out by Prasad et al. in 2013 [27]. The authors focused on the effect of occlusal contacts in maximum intercuspation and during eccentric movements on the incidence of gingival damage in the form of recession and dehiscence. The study included 60 dental students, 50 of them having gingival recession, 10 showing gingival clefts. The subjects were free from possible etiological factors of gingival recession and gingival clefts other than occlusal forces. Tooth contacts were assessed using Arti-Fol, 8 µ thick (blue and red), and the Shimstock foil was used for checking anterior disclusion during maximum intercuspation. The study revealed the presence of gingival recessions on the teeth with group guidance (group function occlusion) more frequently than on those with canine guidance. In addition, gingival recession and dehiscences were present in almost all patients showing occlusal interferences during protrusive, lateroprotrusive and lateral excursive movements. Wear facets were also observed on numerous teeth with gingival recession and dehiscence. Therefore, the results suggest that the absence of mutually protected occlusion may contribute to the development of gingival recession.

The influence of occlusion on the healthy periodontium was investigated by Ishigaki et al. [33].

Table 1. List of Search Terms*

		Records		
Search	Query	MEDLINE/PubMed	Scopus	
#1	occlusal trauma AND periodontal tissue	93	56	
#2	occlusal trauma AND gingival recession	15	17	
#3	dental occlusion, traumatic AND periodontal diseases/etiology	181	21	
#4	dental occlusion, traumatic AND periodontitis	85	–	
Total		374	94	468

* Search of database MEDLINE/PubMed and Scopus covering the period from 1990 to 2015.

50 males and 50 females were selected from the students and staff at the Osaka University Faculty of Dentistry (the median age was 25.2 years). The researchers focused on the effect of balancing occlusal contacts on the clinical evaluation parameters of the periodontium status, such as teeth mobility, depth of gingival pockets and the level of connective tissue attachment, including the teeth with healthy periodontium. Non-working tooth contacts during lateral jaw movements were identified by using a 25 μ articulating paper. The studies did not show differences between the analyzed periodontium parameters of the first and second molars on the balancing side in both the absence or presence of concomitant occlusal contacts. So, it can be claimed that the balancing contacts were not traumatic for the periodontium. In the opinion of the authors, balancing contacts are a doubtful factor responsible for primary occlusal trauma, and the correction of those contacts is controversial.

The purpose of Reyes' et al. study [26] was to find the association between premature contacts in centric relation (PCCR), clinical attachment loss, and abfraction lesions. The study group comprised 46 subjects (the median age was 45 years), 44 subjects had teeth with and without PCCR. The study group included subjects with high level of oral hygiene awareness and 80% of them had < 2 mm attachment loss. PCCR was detected by using articulating double-sided paper Accufilm II (21 μ thickness) previously manipulated into centric relation by Dawson's method. Teeth with occlusal interferences were compared with contralateral teeth without PCCR. The results demonstrated that the presence of PCCR had no influence on the increased attachment loss. The study also suggested that premature contacts in centric relation are a doubtful factor responsible of inducing destructive changes in the healthy periodontium.

Discussion

The occlusal trauma can influence the progression of periodontitis affecting the increased depth of gingival pockets, loss of connective tissue attachment and tooth mobility [22, 23, 29–31] described in the first part of the study, published in DMP, 2015, Vol. 52, No. 215–221. However, it is not a primary factor responsible for the development of periodontal diseases. Premature contacts in the centric relation and balancing occlusal contacts during lateral movements are doubtful causes of destructive changes in the healthy periodontium [26, 33]. If abnormal occlusal contacts occur in the healthy periodontium, occlusal

adjustment is still disputable. The findings [26, 33] are comparable with the statement that periodontal pockets and apical migration of the junction epithelium are not a consequence of the excessive occlusal forces applied to the teeth with normal supporting structures established by Zander and Polson in 1977 [34]. The authors emphasized that tooth mobility and widened periodontal ligaments in the radiographs despite the absence of periodontal pocket could indicate primary occlusal trauma. It should be noted, however, that in the study carried out by Ishigaki et al. [33] the mean age of the study group was 25.2 years. In addition, these studies have not been repeated in specified time intervals. Perhaps another selection of the research and/or evaluation of the parameters of periodontal tissues in a period of time will allow the researchers to formulate a different conclusion.

After analyzing the effect of abnormal occlusal contacts on the formation of gingival recession, it is not possible to formulate clear-cut conclusions. The value of this study [27] is significant because it reveals that the absence of mutually protected occlusions may contribute to the development of gingival recession. Gingival recession was found in 85% of the subjects without anterior disclusion in maximum intercuspation. Nearly all the patients showed occlusal interferences in eccentric movements on the teeth showing gingival recession. The information that the study group comprised subjects who "were free from the influence of calculus and other etiological factors responsible for gingival recession and gingival clefts" [27], otherwise a purposeful and important point of the study, undermines its value due to the lack of precise information, what factors were considered as "excluded criteria" and how they were rated. Similar findings were shown by Dominiak et al. [13], who reported that the number of gingival recession increased by 1.34 while occlusal interferences during maximum intercuspation and by 0.82, while improper tooth contacts during protrusive movements were observed. In spite of controversial opinions on the impact of tooth contact interferences on the development of gingival recession, the authors are of the opinion that occlusal analysis should be carried out before surgical procedures covering the roots of teeth. The statement is in agreement with the result of the study carried out by Solnit and Stambaugh [35], who revealed in 1983 the gingival clefts repair after occlusal analysis and subsequent adjustment. However, this should be confirmed by other studies and the extent of the gingival recession in a period of time should be assessed.

It should be mentioned that the articulating papers and foils, varied in thickness, were used to

evaluate the primary occlusal trauma in the analyzed studies [26, 27, 33]. The thickness of articulating paper or foil has an impact on the accuracy of the tooth contacts, it is advisable to use thin films of less than 12.5 μ [36]; only Prasad [27] applied this recommendation. Other studies [26, 33] used thin articulating papers (21 and 25 μ), although the thickness can interfere with the perception of the masticatory system and thus can cause errors in the studies. Furthermore, this method of occlusal analysis is subjective and visual assessment of the acquired tooth contacts can cause many difficulties. In order to avoid imperfections of the method of instrumental occlusal analysis, the optimal solution would be to use a computerized occlusal analyzing system T-scan, which, in addition to the location of the tooth contacts, gives information about the size of the forces acting on points of contact and their changes over time. This method allows us to perform the occlusal analysis and record measurements in memory, which ensures repeatability [36, 37]. Moreover, the application of the T-scan would allow us to compare the results of studies carried out by different authors. In our opinion, it should be noted that only tooth contacts were examined but not the vector and value of the tooth loading. Occlusal analysis, the axial and oblique loadings, also with regard to the type

of occlusion, would perhaps confirm (or negate) the opinion that occlusal loading is a factor contributing to the destruction of periodontal tissue. Therefore, the further studies using T-scan system are advisable.

Conclusion

Premature contacts in maximum intercuspation and balancing occlusal contacts during lateral movements are doubtful factors responsible for the destructive changes in the healthy periodontium, so the validity of the correction (elimination) of those contacts is questionable.

Gingival recession is of multicausal etiology and it is the final result of the interactions of many factors. Their identification is not always entirely possible; however, the role of clinicians is to identify the causative factors and eliminate them. The studies in humans revealed the correlation between occlusal interferences and the formation of the gingival recession, so an examination of occlusion and correction of improper tooth contact are suggested. Further investigations about the importance of occlusion in the potential development of gingival recession are needed.

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