



# Dental Occlusion and Periodontal Disease: What Is the Real Relationship?

MONISH BHOLA, DDS, MSD; LEYVEE CABANILLA, DDS, MSD;  
AND SHILPA KOLHATKAR, DDS, MDS

**ABSTRACT** The role of occlusion in periodontal disease has always been a challenging topic. A good understanding of the current status of the relationship of occlusion and periodontitis is of paramount importance in order for dental clinicians to provide adequate and comprehensive periodontal treatment in patients presenting with traumatic occlusion. This article reviews the literature regarding the relationship between occlusion and periodontitis and presents recommendations for clinical practice based on available evidence. Clinical cases illustrating the complexity of this relationship and their management are presented.

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## AUTHORS

**Monish Bhola, DDS, MSD,** is an associate professor, Department of Periodontology and Dental Hygiene, University of Detroit Mercy School of Dentistry, in Detroit.

**Leyvee Cabanilla, DDS, MSD,** is an assistant professor, Department of Periodontology and Dental Hygiene, University of Detroit Mercy School of Dentistry, in Detroit.

**Shilpa Kolhatkar, DDS, MDS,** is a clinical assistant professor, Department of Periodontology and Dental Hygiene, University of Detroit Mercy School of Dentistry, in Detroit.

**T**he relationship between occlusal forces and periodontal disease has been studied extensively. Some of the research, conducted in 1930s implicated trauma from occlusion as the etiology of periodontitis.<sup>1,2</sup> Early experiments conducted on sheep and monkeys supported the role of trauma from occlusion as an etiologic factor in periodontal disease.<sup>2,3</sup> These earlier reports were primarily based on individual observations and opinions and their validity was questioned as they lacked proper controls. Furthermore, the design of the studies did not justify the conclusions drawn.

During the course of the next few decades, the role of microorganisms in

the development of periodontitis became clear, and emphasis switched to the role of trauma from occlusion as a possible cofactor in the development of periodontitis. This was primarily based on Glickman's work who proposed that a traumatogenic occlusion could alter and accelerate the progression of periodontitis, and direct the inflammatory process into the periodontal ligament and eventually bone.<sup>4,5</sup>

He proposed the pathway of gingival inflammation could be changed if forces of abnormal magnitude were acting on these teeth. As a result of further studies, he concluded that instead of an even destruction of the periodontium and alveolar bone, sites that are exposed to abnormal occlusal forces, develop angular bony defects and



**FIGURE 1.** Schematic diagram based on Glickman's theory of codestruction. The solid black arrow indicates the path taken by inflammation in the presence of occlusal trauma that would result in an angular pattern of bone loss. The gray arrow represents the path taken in the absence of occlusal trauma.

infrabony pockets.<sup>6,7</sup> This has been called the codestruction theory. **FIGURE 1** is a schematic diagram illustrating this concept.

As investigators studied the effects of subgingival plaque on attachment loss and bone loss, an important study by Waerhaug associated the location and the severity of attachment loss with the location of the "plaque front" on the tooth.<sup>8,9</sup> He examined autopsy specimens similar to Glickman's work, but in addition, measured the distance between the subgingival plaque and the inflammatory cell infiltrate in the gingiva and the surface of the alveolar bone. He concluded that angular bone defects and infrabony pockets occurred just as often on teeth that were not affected by trauma from occlusion, as compared to teeth with occlusal trauma. According to Waerhaug, loss of connective tissue attachment and resorption of bone around teeth was exclusively the result of inflammation associated with subgingival plaque. According to him, angular bone defects result due to a difference in the apical migration of subgingival plaque on adjacent teeth.

A majority of these early papers relied on autopsy material to develop the theories that linked traumatic occlusion to periodontitis. Although examination of autopsy material provides valuable information about the patterns of attachment loss and bone destruction, it has limited value in establishing a "cause-effect"

relationship between occlusal trauma and the progression of periodontitis. Thus, although Waerhaug's investigation did not support Glickman's findings, it paved the way for further research on this subject.

### Animal Studies

Some of the more prominent studies of the 1970s and 1980s were published by Lindhe, Ericsson, and Nyman, using the beagle dog animal model, and by Polson and Zander who used the squirrel monkey model for their studies.<sup>10-25</sup> Using these animal models, researchers could artificially induce experimental periodontitis by using silk ligatures or by letting the animals accumulate plaque and calculus over a variable period of time (usually six months). They could then superimpose traumatic occlusion by using cap splints, and evaluate its effect on bone loss and attachment loss.

Studies by Ericsson and Lindhe's group using beagles indicated that heavy occlusal forces, when combined with plaque-induced periodontitis led to accelerated attachment loss. Furthermore, in the absence of periodontitis, heavy occlusal forces led to increased tooth mobility and bone loss. Bone loss was primarily present in the form of widened periodontal ligament spaces, and, in a few cases, horizontal loss of crestal bone height.

Studies by Polson and Zander, using the squirrel monkey model, demonstrated that trauma from occlusion caused increased loss of alveolar bone, but failed to produce loss of connective tissue attachment. The authors also reported that elimination of traumatic forces in the presence of continuing periodontitis did not lead to bone regeneration or a reduction in mobility.

Based on animal studies, trauma from occlusion in the presence of inflammation may accelerate periodontal disease progression. Without plaque-induced inflammation, trauma from occlusion alone will not result in connective tissue loss but

can lead to widening of the periodontal ligament space, bone loss, and increased mobility. **FIGURES 2-4** are radiographic examples of some patterns of bone loss associated with trauma from occlusion.

### Human Studies

Pihlstrom et al. evaluated the association between occlusal trauma and periodontitis by examining a series of clinical and radiographic parameters of maxillary first molars.<sup>26</sup> They concluded that teeth with occlusal contacts in working, balancing, and nonworking positions had no greater severity of periodontitis than teeth without these contacts. Of the teeth examined, those that demonstrated signs of traumatic occlusion (mobility, widened periodontal ligament space), had greater probing depths, loss of attachment, less bone support, and higher gingival and calculus indices.

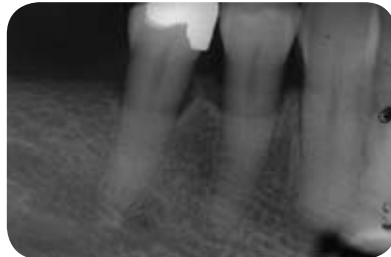
Groups of individuals interpret this data differently. Although teeth that demonstrated signs of traumatic occlusion had greater periodontal destruction, this could be related to the increased presence of local factors, such as plaque and calculus around these teeth. Thus, it is hard to establish whether the various signs of traumatic occlusion were the result of trauma from occlusion or developed secondary to loss of periodontal support due to plaque-related periodontal destruction when trying to establish a "cause and effect" relationship from this data.

Tooth No. 30 (**FIGURE 5**) presents a diagnostic challenge. It shows evidence of recent pulpectomy and vertical bone loss. The bone loss seen on the distal aspect may be associated with heavy occlusal forces or due to the presence of calculus and/or pulpal involvement.

Initial periodontal therapy consisted of scaling and root planning. Guided tissue regeneration using demineralized freeze-dried bone and a resorbable barrier was



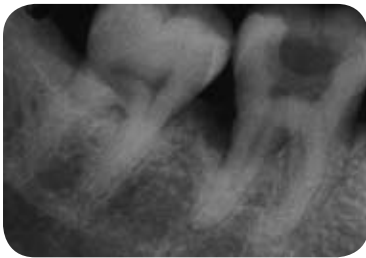
**FIGURE 2.** Vertical bone defect on the mesial and distal of No. 20, possibly associated with heavy occlusal load as a result of the absence of molar occlusion. (Radiograph courtesy of Dr. Shaziya Haque.)



**FIGURE 3.** Circumferential defect and widening of the periodontal ligament spaces on Nos. 28 and 29. (Radiograph courtesy of Dr. Donald Sherman.)



**FIGURE 4.** Large defect on the distal of No. 18, which tested vital. Open flap debridement ruled out the presence of root fracture. Heavy centric and eccentric contacts noted.



**FIGURE 5.** Tooth No. 30 presents a diagnostic challenge. It shows evidence of recent pulpectomy and vertical bone loss. The bone loss seen on the distal aspect may be associated with heavy occlusal forces or due to the presence of calculus and/or pulpal involvement.



**FIGURE 6.** Radiograph after 16 weeks.

performed. Endodontic treatment was completed and the tooth was provisionally restored with very “light” occlusion. Radiograph taken 16 weeks later (**FIGURE 6**) revealed resolution of vertical defect.

Burgett et al. conducted a randomized controlled trial where all patients received initial periodontal therapy and were divided into two groups: those who received occlusal adjustment, or those who received no occlusal adjustment prior to definitive periodontal therapy.<sup>27</sup>

Periodontal therapy consisted of both nonsurgical and surgical (modified Widman flap) treatment. After two years, patients who received occlusal adjustments had a statistically significant mean probing attachment gain when compared to the patients who did not receive occlusal adjustments. There was no significant effect of occlusal adjustment on the reduction in probing depths, and, surprisingly, they did not find any significant difference in reduction of tooth mobility

between the adjusted and the nonadjusted groups. A retrospective study by Jin and Cao concluded there were no significant differences in probing depth, clinical attachment levels, or the loss of alveolar bone height, when comparing teeth with and without abnormal occlusal contacts.<sup>28</sup>

Therefore, the study conducted by Jin and Cao supported some of the earlier observations of Burgett when teeth with and without abnormal occlusal contacts were evaluated using human subjects.<sup>27,28</sup>

Researchers have also examined the effect of trauma on the healing of periodontal tissues. Rosling et al. compared the healing of periodontal structures around mobile teeth associated with angular bone defects, and firm teeth, after periodontal surgery.<sup>29</sup> They concluded that infrabony pockets associated with hypermobile teeth exhibited the same degree of healing as those adjacent to firm teeth. Felszar et al. conducted another eight-year longitudinal study that examined the relationships between tooth mobility and periodontal therapy, and occlusal adjustment. They concluded that, although clinically mobile

teeth were successfully treated and maintained, they did not respond as well to treatment as firm teeth with comparable initial periodontal disease.<sup>30</sup> Their findings contradicted the results of Rosling’s study.

Findings have been published by numerous authors in the form of case reports or case series. Although these case reports provide important information and valuable insight, a certain course of treatment which is successful for a patient, may not transfer to a larger group of patients.<sup>31</sup>

It is quite promising that within the past 10 years, a number of human studies have been conducted in an attempt to gain more insight to the very challenging topic regarding the role of occlusion in periodontal disease initiation and progression. Recently, Bernhardt et al. investigated the potential associations between dynamic occlusal interferences and signs of periodontal disease in posterior teeth.<sup>32</sup> Their findings were based on a cross-sectional epidemiologic study titled “Study of Health in Pomerania.” The data in their study was derived from posterior teeth of 2,980 dentate subjects and was statistically analyzed using a mixed linear model that allowed them to get correlations between measurements on multiple teeth within each subject. They demonstrated a weak relationship between nonworking side contacts and increased probing depth and attachment loss.

Another recent study looked into the effect of occlusal contact during mastication on the status of the periodontal tissues.<sup>33</sup> This study was conducted under the assumption that forces generated during

mastication are potentially traumatic to the periodontium. It was demonstrated that chewing movements deviating from normal increased the mobility of specific types of teeth. The authors suggested that occlusal evaluation with border and tapping movements might be insufficient when trying to assess the effect of occlusal forces on the periodontium. They further stated that differences in the manner by which occlusal forces and discrepancies are evaluated may contribute to the conflicting findings seen in several human studies. This should be taken into consideration when interpreting results from various clinical studies.

A majority of previous investigations compared patients with occlusal discrepancies versus patients without occlusal discrepancies. Since changes in clinical parameters such as probing depths and attachment levels studied using this approach are generally reported as patient mean, it is very possible that progression in more active sites within a patient may be masked. Taking this into consideration, a group of investigators studied the effects of occlusal discrepancy using the individual tooth as the experimental unit.<sup>34-36</sup>

The progression or deterioration of the individual tooth instead of the patient mean was followed over time. The authors retrospectively analyzed records of patients from private practice, and reported that teeth with occlusal discrepancies presented with deeper pocket depths and worse prognosis than those who did not have occlusal discrepancies. In addition, when followed over time, there was a significant increase in probing depths in teeth with occlusal discrepancies, and when left untreated were associated with progression of periodontal disease. Furthermore, occlusal treatment seems to reduce the progression of periodontal disease over time. Thus, based on these recent human studies, occlusal discrepancies appear to be a risk factor in the

progression of periodontal disease.

To summarize results based on human studies, there is some evidence of association between trauma from occlusion and periodontal disease, but none proves a cause and effect relationship. Data is still inconclusive regarding the effect of trauma from occlusion on the response to periodontal therapy.

**PERI-IMPLANT BONE, has been shown to possess mechanoreceptors that allow sensory feedback from loaded implants.<sup>4</sup>**

### Impact of Occlusal Forces on the Peri-implant Structures

Implants have become an integral part of the field of dentistry, therefore it is worthwhile to briefly comment on the current evidence regarding the effect of occlusal forces on the peri-implant structures. Unlike natural teeth, which are suspended in the alveolus by the periodontal ligament (PDL), osseointegrated implants are more rigidly attached to bone. It has been demonstrated that implants can only be displaced 3-5  $\mu\text{m}$  vertically and 10-50  $\mu\text{m}$  laterally compared to 25-100  $\mu\text{m}$  vertically and 56-108  $\mu\text{m}$  buccolingually in natural teeth.<sup>39</sup> Thus, implants are unable to adapt like teeth.

When overloaded, teeth can respond by widening the PDL to accommodate excessive forces. This adaptive phenomenon is not seen in implants. Peri-implant bone, has been shown to possess mechanoreceptors that allow sensory feedback from loaded implants.<sup>40</sup> It is plausible that bone around the implant is able to respond to occlusal forces through these mechano-

receptors. When the load is excessive, peri-implant bone loss can occur.<sup>41</sup>

Readers are referred to recent articles for a more comprehensive review of available evidence regarding the relationship between occlusal forces and peri-implant structures.<sup>42,43</sup> The following statements represent current theories:

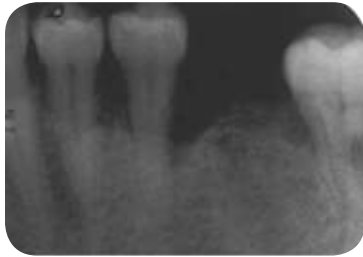
1. Mechanical stress below a certain threshold (6600 microstrain) may lead to bone apposition, but stresses above this threshold may lead to bone loss or complete loss of implant osseointegration.<sup>44</sup>
2. Occlusal overload can result in marginal bone loss around oral implants with no inflammation in the peri-implant tissues.<sup>45</sup>
3. Occlusal overload can result in complete loss of osseointegration.<sup>46</sup>
4. Occlusal overload in the presence of peri-implantitis could result in increased bone loss.<sup>45</sup>

Due to lack of randomized controlled or prospective cohort studies, a causative relationship between occlusal overload and bone loss or loss of osseointegration cannot be established at this time.

### Discussion

While some studies found a relationship between increased attachment loss and tooth mobility, others found no relationship between attachment loss and abnormal occlusal contacts. Tooth mobility can be a result of a variety of factors including loss of alveolar bone, attachment loss, and inflammation within the periodontal ligament or any other process, which may affect the supporting periodontal structures. Therefore, any relationship found between tooth mobility and progressing periodontitis does not necessarily implicate or defend occlusion as a cofactor in the progression of periodontal disease.<sup>37</sup>

Despite numerous studies that ad-



**FIGURE 7.** Vertical defect on distal of No. 20.



**FIGURE 8.** Three-month postocclusal adjustment.



**FIGURE 9.** Periapical radiograph taken of No. 29 in a 84-year-old African American female patient. The tooth had slight mobility with heavy centric and eccentric contacts. Splinting of the tooth was performed after occlusal adjustment. Surgical therapy consisted of guided tissue regeneration using demineralized freeze-dried bone and a resorbable barrier.

dress the theory of occlusion, there have been very few that can help answer the question “Does occlusal trauma modify the progression of attachment loss due to inflammatory periodontal disease?” In reviewing the literature, it is clear from the numerous experiments carried out both in animals and humans, that:<sup>38</sup>

1. Trauma from occlusion does not initiate gingivitis or periodontitis.
2. Occlusion may be a risk factor in the progression of periodontitis.
3. Healing following surgical treatment of periodontal disease may be more advantageous in non-mobile than in mobile teeth.

Based on the literature, it appears there is no clear answer to the role of occlusion in periodontal disease. Rather, this is a gray area and one has to examine each case on an individual basis, while keeping some evidence-based findings in mind. A clinician’s decision to use occlusal adjustment as part of periodontal therapy should be based on a number of factors, such as the type of periodontal therapy (surgical versus nonsurgical), goal of periodontal therapy, and establishing a dentition that the patient can maintain in health and function. A treatment directed toward removing occlusal trauma alone, such as occlusal adjustment or splinting, may reduce the mobility of the teeth, but will not prevent further progression of plaque-related periodontal disease or help regain the lost periodontium. Although longitudinal studies in humans are needed to provide a better understanding of this relationship, they are difficult to perform, given the nature of this subject and for ethical reasons.

### Conclusions

While occlusal forces do not initiate periodontitis, trauma from occlusion can result in resorption of alveolar crestal bone, leading to increased tooth mobility, which may be temporary or permanent. This bone resorption with increased tooth mobility should be regarded as a physiologic adaptation of the periodontium to the traumatic occlusal forces.

Periodontal health can be maintained without occlusal adjustment and although some studies showed a statistically significant gain in clinical attachment with occlusal adjustment, whether this is of any clinical significance and benefit to patients, is uncertain.<sup>27</sup> Once periodontal health is established, occlusal therapy can be performed if indicated, to help reduce mobility.

Occlusal adjustment is an effective therapy against increased tooth mobility when such mobility is associated with an increased width of the periodontal ligament. Increased tooth mobility as a result of reduced height of the alveolar bone can be accepted, provided the occlusion is stable (there is no further tooth migration or increasing mobility), and does not hinder the patient’s chewing ability or comfort. Tooth mobility is not synonymous with occlusal trauma, and may be related to a number of inflammatory conditions around the teeth.

### Recommendations for Clinical Practice

Any form of treatment should be geared at removing the inflammation in the periodontium first. This may include both nonsurgical and surgical periodontal therapy. Any potential occlusal factors

should be evaluated subsequent to this, and addressed if necessary. An exception to this course of treatment would be a situation where the occlusal factors interfere with the patient’s ability to masticate and function properly or for patient comfort. An example of such a situation would be a long-standing chronic periodontal condition, where the extent of bone loss results in excessive and/or progressive mobility of teeth.

In such cases it is advisable to address the occlusal component of the treatment plan, concurrently with periodontal therapy.

The following cases demonstrate the complexity of addressing trauma from occlusion in the presence of periodontal disease.

*Case 1.* Reduction of probing depth and mobility following occlusal adjustment and scaling and root planning.

**FIGURE 7** illustrates an angular bone defect on the distal aspect of tooth No. 20 with clinical probing depth of 8 mm. Buccolingual displacement of 2 mm was detected. Open contact between Nos. 20 and 21 was present. Heavy centric and eccentric occlusal contacts were noted on No. 20.

Occlusal adjustment on No. 20 and scaling and root planning were performed. At the three-month re-evaluation appointment, reduction in mobility and probing depth were seen. A radiograph taken at that appointment (**FIGURE 8**) revealed



**FIGURE 10.** The same area after 2½ years. Marked reduction in the mesial defect is noted along with complete resolution of the distal defect. The patient was functioning comfortably and reported no discomfort on chewing.

slight improvement in bone topography. Surgical periodontal therapy is required to address the residual vertical defect.

*Case 2.* Surgical therapy combined with splinting of teeth and occlusal adjustment to treat vertical defect on No. 29.

**FIGURE 9** shows periapical radiograph taken of No. 29 in a 84-year-old African American female patient. The tooth had slight mobility with heavy centric and eccentric contacts. Splinting of the tooth was performed after occlusal adjustment. Surgical therapy consisted of guided tissue regeneration using demineralized freeze-dried bone and a resorbable barrier.

**FIGURE 10** shows the same area after 2½ years. Marked reduction in the mesial defect is noted along with complete resolution of the distal defect. The patient was functioning comfortably and reported no discomfort on chewing. ■■■■

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**TO REQUEST A PRINTED COPY OF THIS ARTICLE, PLEASE CONTACT** Lylevee Cabanilla, DDS, MSD, Department of Periodontology and Dental Hygiene, University of Detroit Mercy School of Dentistry, 2700 Martin Luther King Jr. Blvd., Detroit, Mich., 48208.