UNIVERSITY OF MEDICINE AND PHARMACY
„CAROL DAVILA", BUCHAREST
DOCTORAL SCHOOL
DOCTORAL FIELD DENTISTRY

ASSOCIATIONS BETWEEN OCCLUSAL TRAUMA AND PERIODONTAL DISEASE

SUMMARY OF THE DOCTORAL THESIS

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Introduction

In the current context, interest in oral health among the general population has steadily increased, as reflected by the rapid development of new diagnostic and therapeutic techniques, as well as by the expansion of research and scientific knowledge in the field of dento-periodontal pathology. Periodontal disease represents a major public health concern and ranks among the most prevalent conditions worldwide [1,2]. In 2010, the reported prevalence of periodontal disease ranged between 20% and 50% globally [1].

Early experimental studies demonstrated that excessive occlusal forces, in the absence of bacterially induced inflammation, do not result in irreversible loss of periodontal attachment but primarily induce adaptive changes within the alveolar bone [3,4]. In contrast, contemporary clinical research has shown that, in the presence of gingival inflammation, occlusal trauma may accelerate bone resorption and attachment loss, suggesting a synergistic interaction between bacterial biofilm and biomechanical factors [5–7].

The aim of the present research is to highlight the importance of occlusal diagnosis and to analyze the therapeutic implications of managing occlusal trauma in patients with periodontal disease. In this context, the study evaluates the role of occlusal parameters in the progression of periodontal disease and determines the impact of correcting occlusal imbalances on the clinical stability of the marginal periodontium. By integrating modern digital occlusal analysis technologies, such as the OccluSense system, with clinical and paraclinical periodontal assessments, this research seeks to obtain an objective evaluation of the interaction between occlusal biomechanical factors and periodontal inflammation within the framework of periodontal disease.

The topic of this scientific investigation aligns with one of the priority research areas identified by the American Academy of Periodontology for 2025–2026, namely the diagnosis of occlusal trauma as a strategy for preventing the progression of alveolar bone loss.

Exploring the relationship between occlusal trauma and periodontal disease is essential for several reasons:

1. **Clinical relevance** – In daily clinical practice, tooth mobility, pathologic tooth migration, and masticatory discomfort are frequently observed in patients with marginal periodontal disease.

2. **Optimization of periodontal treatment in the presence of occlusal trauma** – Effective therapeutic management requires not only control of the infectious component but also elimination of harmful biomechanical factors generated by occlusal relationships.

3. **Interdisciplinary integration** – This topic has implications across multiple dental specialties, including periodontology, prosthodontics, restorative dentistry, orthodontics, and implantology, where long-term oral stability depends on achieving occlusal balance in relation to dento-alveolar pathology and specific therapeutic interventions.

4. **Existing gaps in the literature** – Uncertainties persist regarding the precise role of occlusal trauma in the progression of periodontal disease, thereby justifying further clinical and imaging-based investigations.

I. The General Part comprises three chapters and outlines the theoretical framework regarding occlusal trauma associated with periodontal disease in the current scientific context.

Chapter 1 presents general aspects concerning the association between occlusal trauma and periodontal disease, as well as methods of evaluation and diagnosis, ranging from traditional techniques to modern digital tools. **Chapter 2** addresses the anatomy and physiology of the marginal periodontium, the etiopathogenesis of periodontal disease, the role of chlorhexidine in bacterial biofilm control, as well as the new classification of periodontal diseases. **Chapter 3** provides comprehensive information on occlusal trauma, including its biological mechanisms, clinical signs, and diagnostic criteria.

Occlusal trauma is described as the result of an imbalance between the magnitude of applied forces and the structural resistance of the periodontium. Under physiological conditions, functional forces are distributed and absorbed through adaptive mechanisms of the periodontal ligament and alveolar bone, thereby contributing to the maintenance of periodontal homeostasis (Thesis, Chapter 3.1.1).

When occlusal forces exceed functional limits — whether in terms of intensity, direction, frequency, or duration—biomechanical overload occurs. In a healthy periodontium, the response may include widening of the periodontal ligament space and compensatory bone remodeling. In a compromised periodontium, however, even physiological forces may become traumatic, leading to increased tooth mobility, pathologic tooth migration, and vertical bone defects (Thesis, Chapter 3.1.1; Chapter 3.3).

In the etiopathogenesis of periodontal disease, subgingival bacterial biofilm is identified as the primary etiologic factor, while periodontitis is described within the modern paradigm as a dysbiotic inflammatory disease: not a single bacterial species is responsible, but rather a dysbiotic microbial community interacting with the host immune response [8–12] (Thesis, Chapter 2.2.1). Systemic factors (such as smoking, uncontrolled diabetes, and chronic stress) are incorporated as modifiers of immune response and tissue healing, whereas local factors (dental calculus, defective restorations, plaque-retentive factors, positional anomalies, and non-functional occlusal contacts) are regarded as contributors to the persistence of dysbiosis and progression of periodontal lesions (Thesis, Chapter 2.2.2).

The diagnosis of occlusal trauma is complex, as no single pathognomonic sign exists. Assessment relies on the association of multiple clinical and radiographic findings, including pathologic tooth mobility, occlusal fremitus, percussion sensitivity, recent tooth migration, widening of the periodontal ligament space, and the presence of non-functional occlusal contacts [13].

Traditional diagnostic methods, such as articulating paper or occlusal wax, are limited because they cannot quantify the intensity and temporal sequence of occlusal forces. Therefore, digital systems such as T-Scan and OccluSense allow identification of non-functional contacts and precise quantification of occlusal forces, thereby reducing subjectivity in occlusal analysis [14]. The integration of these technologies represents a significant advancement in contemporary research investigating the relationship between occlusal trauma and periodontal disease.

Chlorhexidine (CHX) is presented in this scientific research as one of the most widely used adjunctive antiseptic agents in periodontal therapy, due to its broad antimicrobial spectrum and substantivity (the ability to bind to oral surfaces and be released gradually over time) [15].

During the initial phase of treatment, CHX may reduce bacterial load and gingival inflammation (Thesis, Chapter 2.2.1).

The present research emphasizes that the efficacy of CHX is limited in the case of mature, polymicrobial biofilms characteristic of advanced periodontitis. The three-dimensional organization of the biofilm and the synergistic interactions among pathogenic species reduce the accessibility and effectiveness of antiseptic agents. Moreover, prolonged use may be associated with local adverse effects, including tooth staining, taste alterations, and mucosal desquamation. For these reasons, current recommendations support short-term administration, in conjunction with mechanical periodontal therapy [16] (Thesis, Chapter 2.2.1).

These considerations are particularly relevant to the prospective study included in the present thesis, which investigates the evolution of the CPITN index in the context of CHX use among patients presenting with non-functional occlusal contacts, in the absence of occlusal adjustment (Thesis, Chapter 6).

II. Personal Contributions comprises four chapters, presenting the general research methodology, including the working hypotheses, research objectives, methods, and anticipated outcomes (**Chapter 4**), the actual research conducted—the studies performed (**Chapters 5** and **6**), as well as the general conclusions and personal contributions (**Chapter 7**).

Chapter 4 outlines the scientific research methodology, which aims to investigate the role of non-functional occlusal contacts and occlusal overload in the dynamics of periodontal inflammation associated with periodontal disease. The study employs modern digital diagnostic methods and complementary therapeutic protocols to evaluate this interaction.

The main hypothesis of the present research is that occlusal trauma—manifested through non-functional contacts, premature contacts, and interferences during mandibular movements—may act as an aggravating factor in the progression of periodontal disease, accelerating alveolar bone loss and negatively influencing the prognosis of affected teeth.

Furthermore, it is proposed that the use of modern digital occlusal analysis systems (such as OccluSense) enables a more precise and reproducible assessment of occlusal force distribution compared to traditional occlusal evaluation methods using articulating paper or occlusal wax.

The overall objective of the scientific research conducted within this doctoral thesis is to evaluate the impact of non-functional occlusal contacts on periodontal status and to emphasize the importance of biomechanical diagnosis in the management of patients with periodontal disease.

In this context, the research pursues the following specific objectives:

1. To analyze the relationship between occlusal trauma and the presence of periodontal inflammation.

2. To identify premature contacts and occlusal interferences in the enrolled patients using digital diagnostic methods.

3. To perform comprehensive clinical and paraclinical examination of the marginal periodontium in patients in whom non-functional occlusal contacts were identified in static occlusion or during mandibular dynamics.

4. To monitor the clinical periodontal evolution following the implementation of a periodontal therapeutic protocol, including inflammation control through antiseptic measures (use of chlorhexidine-based mouthwashes), in the absence of occlusal adjustments.

5. To formulate evidence-based clinical recommendations regarding the integration of occlusal analysis into contemporary periodontal treatment.

The proposed research has both observational and interventional clinical components and is oriented toward an interdisciplinary evaluation of the patient, centered on occlusal and periodontal analysis. The study is based on the examination of patients diagnosed with non-functional occlusal contacts.

The general methodology includes:

- digital occlusal analysis;
- comprehensive clinical and paraclinical periodontal evaluation;
- correlation of the collected data;
- implementation of a non-surgical periodontal therapeutic protocol without modification of occlusion;
- monitoring of clinical outcomes over time.

The research comprises two clinical studies, in accordance with the thesis topic: a cross-sectional study aimed at correlating non-functional occlusal contacts with periodontal status, and a prospective study designed to evaluate periodontal evolution in relation to the use of

chlorhexidine mouthwashes, in the absence of occlusal adjustments (Thesis, Chapter 4.2.1; Chapter 4.2.2).

The main methodological stages included the preparation of the ethics submission file and obtaining approval from the Ethics Committee of "Carol Davila" University of Medicine and Pharmacy (approval code PO-35-F-03; Thesis, Appendix 7), the selection of patients aged at least 18 years presenting clinical signs suggestive of occlusal trauma, the exclusion of patients with uncontrolled systemic conditions or recent treatments that could influence the periodontal response, as well as the acquisition of informed consent (Thesis, Chapter 4.2.2).

Occlusal analysis was performed using digital assessment with the OccluSense system for the identification of premature contacts and occlusal interferences in intercuspal position (IM) / centric relation (RC), as well as during mandibular dynamics. The recorded findings were documented in the occlusal analysis form (Thesis, Appendix 8).

Clinical examination included a standardized periodontal chart in which the following parameters were recorded (Thesis, Appendix 9):

- Plaque index
- Bleeding on probing (BOP)
- Probing depth (PD)
- Clinical attachment level (CAL)
- Degree of tooth mobility
- Furcation involvement

In addition, CPITN index values were determined and recorded in the periodontal chart.

Paraclinical assessment consisted of the evaluation of an existing panoramic radiograph not older than six months. The radiographic analysis focused on widening of the periodontal ligament space and the presence and morphology of alveolar bone defects.

Based on the identified findings and CPITN index values, patients were informed about the indicated non-surgical therapeutic approach aimed at controlling periodontal inflammation. The treatment protocol included:

- biofilm control and supra- and subgingival scaling, as well as subgingival instrumentation;
- the use of chlorhexidine-based mouthwashes as an adjunctive antiseptic measure;
- post-therapeutic monitoring of periodontal status.

Patients were re-evaluated at predefined intervals, at 3 and 6 months, in order to assess the presence or absence of improvement in periodontal parameters.

In **Chapter 5**, the study entitled *"Cross-Sectional Study of Occlusal Loading and Periodontal Status of Teeth with Deflective Occlusal Contacts"* investigates the relationship between non-functional occlusal contacts and alterations of the marginal periodontium [17], **the primary hypothesis** of the study is that teeth presenting abnormal non-functional occlusal contacts are subjected to higher occlusal loads compared to teeth without occlusal trauma, and that this occlusal overload is associated with a greater severity of marginal periodontal damage.

Secondary hypotheses:

- The type of non-functional occlusal contact influences the severity of periodontal involvement;

- Teeth presenting premature contacts between maximum intercuspation and centric relation exhibit more pronounced periodontal alterations compared to teeth with occlusal interferences occurring during eccentric movements (lateral excursions and protrusion);

- Occlusal biomechanical parameters can be correlated with the clinical and radiographic parameters of teeth affected by periodontal disease.

This chapter presents a cross-sectional observational clinical study. The study sample consisted of 52 adult patients; the gender distribution included 32 females (61.5%) and 20 males (38.5%), with ages ranging from 23 to 72 years and a mean age of approximately 41 years (Thesis, Chapter 5.4.1; Table 5.1).

The OccluSense system (Dr. Jean Bausch GmbH & Co. KG, Germany), used in the present study, is a modern device designed to record the distribution of occlusal forces and to identify non-functional occlusal contacts (Thesis, Chapter 5.3; Figure 5.2).

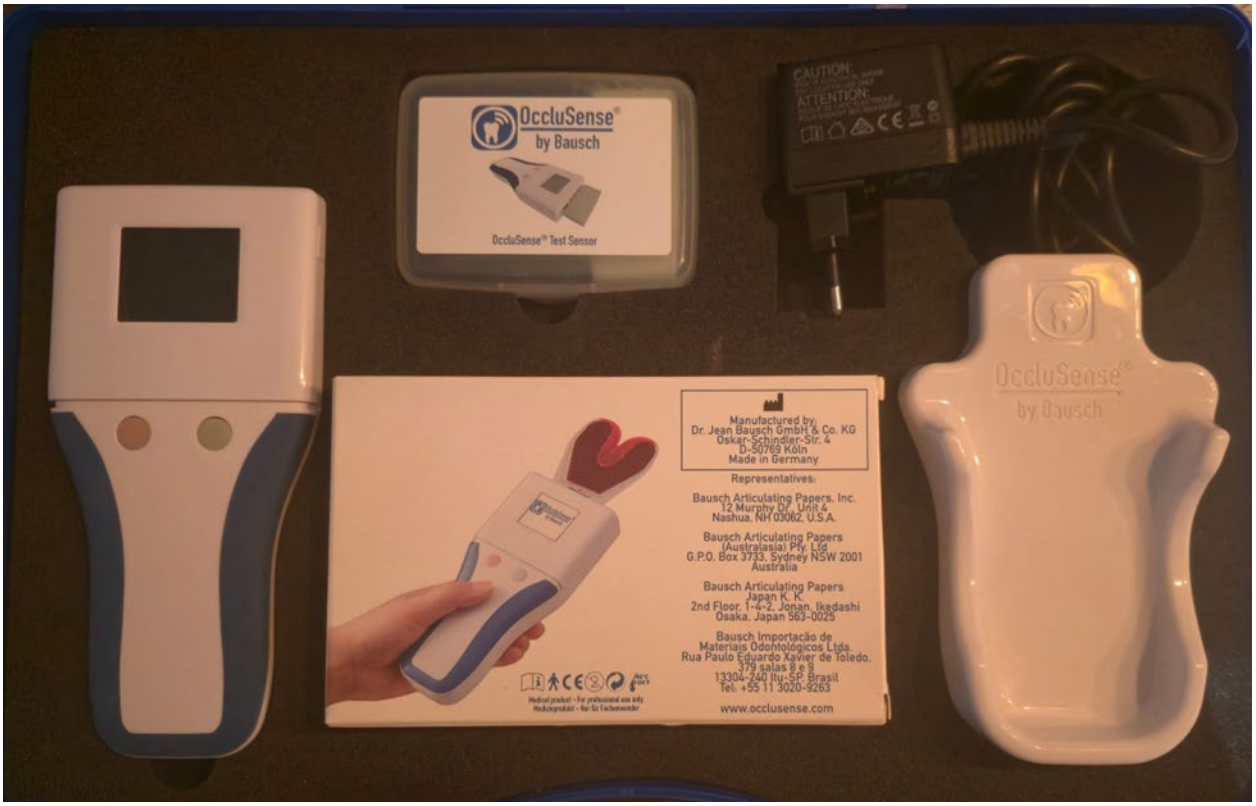

Figure 5.2. Occlusense device - components

At the beginning of each day, the device was calibrated using the test sensor provided by the manufacturer. Recordings were initiated daily only after validation of the calibration test.

The OccluSense system consists of a handheld device with an integrated display and a single-use sensor approximately 60 µm thick, coated on both sides with articulating paper, which facilitates the marking of occlusal contacts on the dental surfaces during recording. The sensor is mounted in an ergonomic holder and connected wirelessly to a dedicated application installed on an iPad tablet (Apple Inc., Cupertino, CA, USA).

The sensor contains 256 pressure-sensitive points capable of detecting fine variations in occlusal force intensity. The device operates by recording changes in electrical resistance within the sensor, generated by pressure applied during dental contact. The acquired data are transmitted in real time to the software application, where they are processed and graphically displayed in both two-dimensional and three-dimensional formats.

Recordings were performed over a standardized duration of 10 seconds at a frequency of 100 Hz. The single-use sensor allowed identification of occlusal contacts and quantification of their intensity.

The identified contacts were classified as follows:

- premature contacts occurring between centric relation (RC) and maximum intercuspation (IM);
- interferences during protrusive movements;
- interferences during lateral excursions.

An important methodological feature of the study was the intra-individual comparison design. For each tooth presenting non-functional contact, control teeth (adjacent and contralateral homologous teeth) within the same arch were selected to control for individual variables such as age, general health status, gingival phenotype, and oral hygiene, thereby allowing a more accurate assessment of the local impact of occlusal overload (Thesis, Chapter 5.4.8).

At the level of each tooth, the following parameters were evaluated:

- maximum differences in occlusal pressure, expressed in µm and as a percentage;
- maximum periodontal probing depth, expressed in mm;
- maximum gingival recession, expressed in mm;
- degree of tooth mobility;
- presence of pathologic tooth migration;
- degree of tooth wear;
- alveolar bone loss, assessed radiographically;
- widening of the periodontal ligament space.

Clinical assessment of the marginal periodontium was performed using standardized periodontal probing with a UNC-15 periodontal probe (Hu-Friedy, Chicago, IL, USA), at six sites per tooth—mesiobuccal, mid-buccal, distobuccal, mesiolingual, mid-lingual, and distolingual—to obtain a comprehensive and reproducible evaluation of periodontal status.

All included patients presented non-functional occlusal contacts identified through digital occlusal analysis. The analysis demonstrated that teeth with non-functional contacts exhibited significantly higher maximum occlusal load values compared to control teeth (Thesis, Chapter 5.4.2).

During occlusal recordings, both premature contacts in centric relation (RC) / maximum intercuspation (IM) and interferences during mandibular dynamics were identified. The scientific analysis demonstrated that maximum occlusal pressures were more pronounced in the case of premature contacts occurring in centric relation, although the most non-functional occlusal contacts were found in the protrusive movement (Thesis, Chapter 5.4.2; Figure 5.13, Figure 5.12).

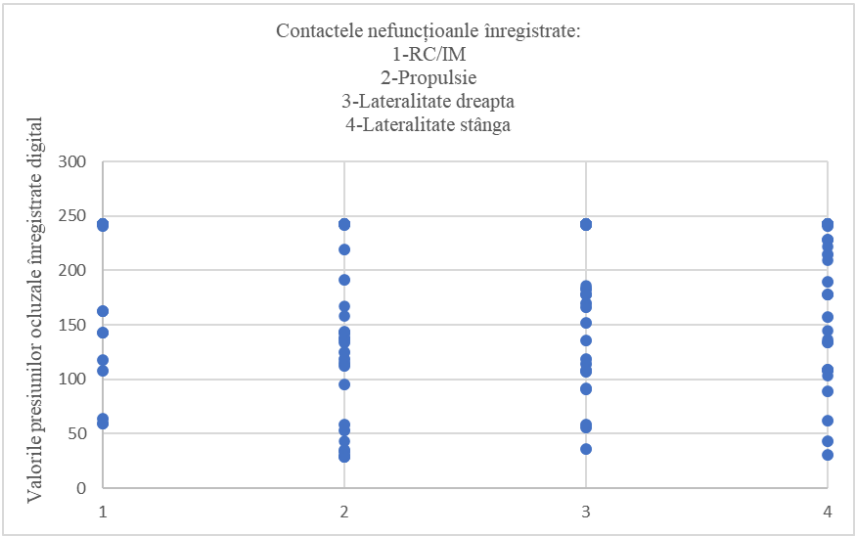

Figure 5.13 Distribution of pressure contacts values during the occlusal analysis

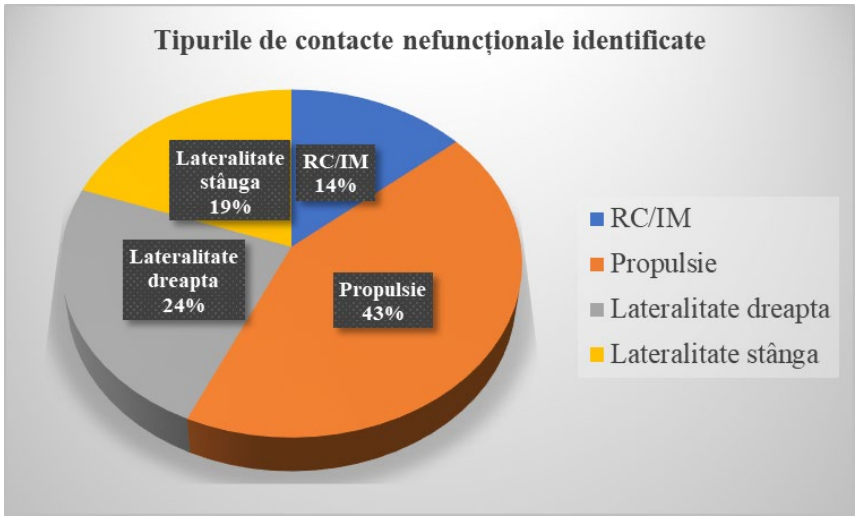

Figure 5.12. Distribution of different deflective occlusal contacts during the evaluation

This finding may be explained by the biomechanical characteristics of premature contacts, which are applied repetitively, axially, and in a stable mandibular position. In centric relation, the point of force application generated by the masticatory muscles is located closer to the temporomandibular joint (TMJ), which serves as the mandibular fulcrum, and is associated with maximal muscular contraction. This results in constant loading of the periodontal supporting structures [7,18]. The mandible reaches centric relation during swallowing, a function that occurs on average 500–700 times per day (during sleep, wakefulness, and mastication) [19,20]. In contrast, eccentric interferences occur transiently during functional mandibular movements and therefore exert a lower biomechanical impact [21]. Their frequency increases during uncontrolled movements and parafunctional activities, such as bruxism [22] (Thesis, Chapter 3.1.1; Chapter 5.5).

Out of a total of 493 non-functional contacts recorded at the dental level, the thesis reports the following distribution (Thesis, Chapter 5; Table 5.4):

Table 5.4. Distribution of deflective occlusal contacts [17]

Type of deflective occlusal contact	Number (n)	Percentage (%)
Premature contacts	68	13,8
Protrusive interferences	212	43,0
Right lateral interferences	117	23,7
Left lateral interferences	96	19,5
Total	493	100

The study reports that occlusal interferences were identified with a higher frequency than premature contacts, with protrusive interferences being the most prevalent. Right lateral interferences occurred more often than left lateral interferences, as shown in the thesis (Thesis, Chapter 5, Table 5.4.).

From a biomechanical perspective, protrusive and lateral interferences may generate lateral force components, which are less well tolerated by the dento-periodontal supporting apparatus compared to axial forces, particularly in the presence of reduced alveolar bone support [23]. This lateral component is relevant to the development of vertical bone defects and pathologic tooth migration (Thesis, Chapter 3.1.4; Chapter 5.5).

The periodontal parameters assessed included probing depth (PD), gingival recession, bleeding on probing (BOP), tooth mobility, furcation involvement, pathologic tooth migration, and tooth wear. Radiographic parameters included alveolar bone loss and widening of the periodontal ligament space (Thesis, Chapter 4.2.2; Chapter 5.4.3–5.4.6).

Within Study I, tooth wear was evaluated and correlated with occlusal overload, being considered an additional clinical indicator of occlusal trauma. Marked tooth wear was frequently associated with increased maximum occlusal load values (Thesis, Chapter 5.4.7).

The results summarized in the thesis indicate that, compared to control teeth, teeth presenting non-functional occlusal contacts exhibited significantly higher maximum occlusal pressure values and were associated with more severe clinical and radiographic parameters. These included greater periodontal probing depths, increased gingival recession, more frequent pathologic tooth migration, more pronounced tooth wear, greater alveolar bone loss, and more frequent widening of the periodontal ligament space (Thesis, Chapter 5.4.8; Table 5.2).

Table 5.2 of the scientific research provides a quantitative comparison (N = 493 teeth with non-functional contacts vs. N = 473 adjacent control teeth vs. N = 457 contralateral homologous teeth). Examples of values (adapted from Thesis, Chapter 5, Table 5.3) are presented below:

Table 5.3. adapted – Comparison of occlusal pressure differences and periodontal status in teeth with and without non-functional occlusal contacts, $p<0.05$ [24]

Variable (mean / %)	Tooth with non-functional occlusal contact	Adjacent tooth	Homologous tooth
Maximum occlusal pressure	208	72	97
PD (mm)	4,15	3,61	3,70

Gingival recession(mm)	0,83	0,69	0,65
Tooth migration (%)	27%	18%	21%
Dental wear (mean value)	0,45	0,38	0,36
Bone loss Rx (mm)	1,59	1,15	1,25
Widening of periodontal ligament (%)	11%	7%	7%

According to Study I, statistically significant differences were identified for the majority of the evaluated variables ($p < 0.05$), and pairwise comparisons were adjusted using the Bonferroni correction method (Thesis, Chapter 5; Table 5.2).

From a clinical perspective, the mean difference of approximately 0.5 mm in probing depth (PD) between teeth with non-functional contacts and control teeth may be relevant within the framework of the staging classification of periodontitis (Thesis, Chapter 2.3). Furthermore, the higher frequency of pathologic tooth migration and widening of the periodontal ligament space supports the role of occlusal overload as an aggravating factor (Thesis, Chapter 3.3; Chapter 5.4.8).

In the analysis according to contact type, the thesis demonstrates that teeth presenting premature contacts were associated with more severe periodontal findings compared to those with occlusal interferences, particularly with respect to probing depth, gingival recession, tooth mobility, and alveolar bone loss (Thesis, Chapter 5; Table 5.5). This observation supports the hypothesis that the timing and mode of force application (abrupt contact during closure in RC/IM) may be critical determinants of tissue impact, beyond the average magnitude of occlusal forces alone.

The scientific research discusses the results in light of the biological and histopathological mechanisms underlying occlusal trauma. In the presence of inflammation, occlusal overload may amplify bone resorption through increased osteoclastic activity and impairment of periodontal ligament microcirculation, thereby favoring widening of the periodontal ligament

space, increased tooth mobility, and pathologic tooth migration (Thesis, Chapter 3.1.4; Chapter 3.3).

From a clinical perspective, the thesis argues for the integration of occlusal diagnosis into the periodontal treatment plan, particularly in cases presenting with tooth mobility, pathologic tooth migration, pronounced tooth wear, non-carious cervical lesions (wedge-shaped lesions), and radiographic findings suggesting occlusal overload (Thesis, Chapter 5.6).

In the field of regenerative therapy, the thesis emphasizes the importance of local biomechanical stability. Occlusal overload increases tooth mobility and reduces the predictability of regenerative outcomes. Therefore, correction of occlusal interferences, control of parafunctional habits, and, in selected cases, temporary splinting may create a favorable biomechanical environment for periodontal tissue regeneration [17].

The overall interpretation proposed is that occlusal trauma acts predominantly as a modifying factor influencing disease severity rather than as a primary etiologic factor. However, in the presence of inflammation, it may accelerate clinical and radiographic manifestations, thereby justifying an interdisciplinary occlusion–periodontium assessment [7] (Thesis, Chapter. 3.3; Chapter. 5.6).

The study limitations are inherent to observational clinical research and include: (1) the cross-sectional design, which allows identification of associations but does not establish causality; (2) potential residual confounding variables (such as baseline severity of inflammation, unreported parafunctional habits, or anatomical particularities), even though the intra-individual comparison design mitigates part of these effects; (3) the use of panoramic radiography for the assessment of bone resorption, which presents limitations in the three-dimensional quantification of periodontal defects; and (4) the impossibility of histological confirmation of occlusal trauma (Thesis, Chapter 5.7; Chapter 3.3).

These limitations do not diminish the clinical relevance of the findings; however, they support the need for longitudinal studies and the integration of three-dimensional imaging methods, as well as systematic monitoring of parafunctional habits, in order to refine the proposed explanatory model.

In Chapter 6, entitled *"Evolution of Periodontal Status (CPITN) in Relation to Chlorhexidine Use in Patients with Non-Functional Occlusal Contacts,"* the analysis shifts toward the prospective evaluation of periodontal changes under antiseptic therapy in the absence

of occlusal adjustment[24], **the primary hypothesis** of the study was that the use of chlorhexidine results in a significant short-term improvement of inflammatory periodontal parameters, even in the presence of occlusal trauma (Thesis, Chapter 4.2.1; Chapter 6.4).

The objectives of the study were:

- to monitor the evolution of CPITN scores at baseline, at 3 months, and at 6 months;
- to compare patients who used chlorhexidine (CHX) with those who did not use the antiseptic agent;
- to evaluate the influence of CHX concentration on periodontal response;
- to assess the limitations of antiseptic therapy in the absence of biomechanical occlusal correction.

The study was designed as a prospective observational study and included the same cohort of 52 patients enrolled in the clinical study presented in Chapter 5 (Thesis, Chapter 6.4). The study received approval from the Ethics Committee of "Carol Davila" University of Medicine and Pharmacy, Bucharest (protocol PO-35-F-03), as mentioned both in the methodology chapter and in the description of the prospective study (Thesis, Chapter 4.2.2; Chapter 6.4).

This study presents the CPITN index recorded by sextants, a tool useful for screening and monitoring purposes. Registration is performed using the WHO periodontal probe (Hu-Friedy, Chicago, IL, USA), which features a 0.5 mm ball tip and standardized markings at 3.5, 5.5, 8.5, and 11.5 mm, facilitating rapid assessment of probing depth as well as the presence of bleeding on probing, dental calculus, or periodontal pockets (Thesis, Chapter 6.4).

The CPITN scores are summarized in the thesis as follows: 0– healthy periodontium; 1– bleeding on probing; 2– calculus; 3– shallow pockets (PD ≤ 5.5 mm); 4– deep pockets (PD > 5.5 mm), each category being associated with progressively more complex therapeutic recommendations (oral hygiene instruction, scaling, subgingival instrumentation, and comprehensive periodontal treatment) (Thesis, Chapter 6.4).

In the prospective study, CPITN was recorded at baseline, at 3 months, and at 6 months by the same calibrated examiner, to reduce inter-examiner variability (Thesis, Chapter 6.4).

Patients were divided into two groups: those who used chlorhexidine (CHX) mouthwash and those who did not use CHX. All patients received a non-surgical therapeutic protocol aimed at controlling periodontal inflammation. Intentionally, occlusion was not modified during the

follow-up period to observe periodontal evolution in the presence of non-functional contacts. As part of the therapeutic protocol, adjunctive use of chlorhexidine mouthwash was recommended at a dose of 10 mL twice daily for 14 days. The concentration of CHX in the mouthwashes used was left to the participants' choice or depended on pharmacy availability (Thesis, Chapter 4.2.1; Chapter 6.4).

Patients were divided into two groups:

- **CHX group** – patients who used chlorhexidine-based mouthwash according to the prescribed instructions;
- **Non-CHX group** – patients who did not use chlorhexidine.

The recorded data included:

- **General data:** age and gender;
- **Data regarding occlusal contact type:** non-functional contact, premature contact, protrusive interference, right or left lateral interference;
- **Data regarding periodontal status:** presence of bleeding on probing, supra- and/or subgingival calculus, and periodontal probing depth.

According to the study findings, a reduction in CPITN scores was observed at 3 months in the CHX group, suggesting a decrease in inflammation and therapeutic needs during the initial phase (Thesis, Chapter 6.5.1). In the non-CHX group, improvements were less pronounced or occurred more gradually, supporting the adjunctive effect of the antiseptic agent in the control of supragingival biofilm and inflammation (Thesis, Chapter 6.5.2).

At 6 months, the research highlighted a reduction in the antiseptic effect compared to the 3-month evaluation. This finding was interpreted as a limitation of the long-term effectiveness of CHX in the absence of comprehensive etiologic control and an interdisciplinary approach to predisposing factors, including biomechanical factors (Thesis, Chapter 6.6.2–6.6.3).

These results were statistically significant for all sextants except sextant 5 (Thesis, Chapter 6.5; Figure 6.4 and Table 6.1).

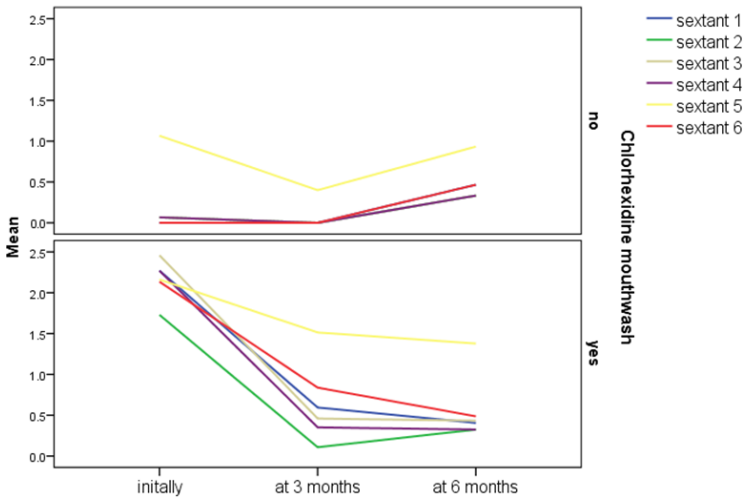

Figure 6.4. Evolution of CPITN Scores Throughout the Study in Participants Who Used and Did Not Use Chlorhexidine Mouthwash [24]

Table 6.1. p-value for CPITN index scores during the follow-up period in participants who used, respectively did not use, chlorhexidine mouthwash [24]

p-Value for CPITN scores during the study	With CHX (n = 37)	Without CHX (n = 15)
Sextant 1	<0.001	0.135
Sextant 2	<0.001	0.607
Sextant 3	<0.001	0.368
Sextant 4	<0.001	0.368
Sextant 5	0.007	0.206
Sextant 6	<0.001	0.135
Total score	<0.001	0.135
Friedman Test		

In the analysis of CHX concentration, the study did not identify major clinical differences between the investigated concentrations (Thesis, Chapter 6.5.3; Figure 6.6), suggesting that, under a standardized therapeutic protocol, the determinants of periodontal response are more likely related to oral hygiene compliance and mechanical plaque control rather than to minor variations in chlorhexidine concentration (Thesis, Chapter 6.5.3).

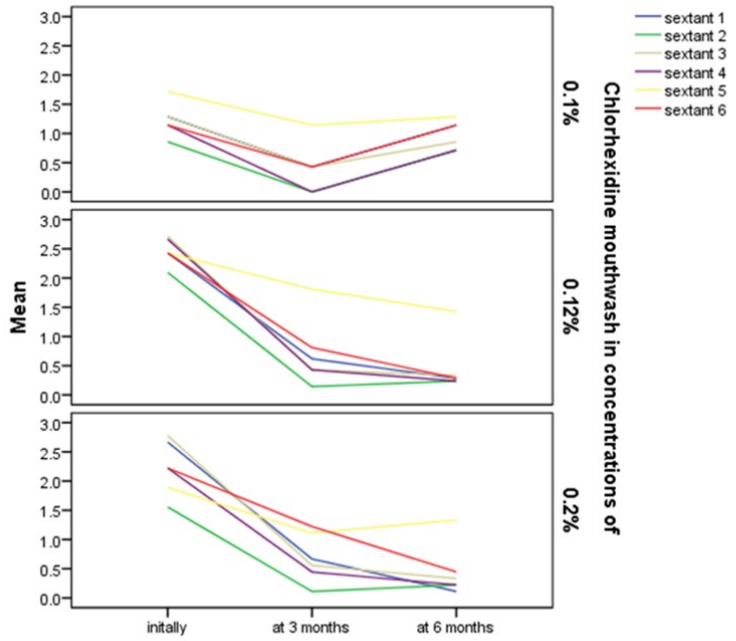

Figure 6.6. Evolution of CPITN Scores Throughout the Study in Participants Using Chlorhexidine Mouthwash at Different Concentrations [24]

Patients who did not use chlorhexidine mouthwash exhibited a different pattern in the evolution of periodontal status. In this group, CPITN scores remained relatively stable or showed a slight tendency toward worsening over the 6-month follow-up period (Table 6.2).

Table 6.2. Comparison of Chlorhexidine Efficacy for Each Sextant Over the Follow-Up Period, Adjusted for Baseline CPITN Values (T0) [24]

	CPITN						
		T1			**T2**		
		CHX n (%)	**Without CHX n (%)**	***p***	**CHX n (%)**	**Without CHX n (%)**	***p***
Sextant 1	Improved	30 (81.1)	0 (0)	<0.001	8 (21.6)	0 (0)	0.089
	Unchanged	7 (18.9)	15 (100)		27 (73)	13 (86.7)	
	Worsened	0 (0)	0 (0)		2 (5.4)	2 (13.3)	
Sextant 2	Improved	30 (81.1)	1 (6.7)	<0.001	2 (5.4)	0 (0)	>0.999

	Unchanged	7 (18.9)	14 (93.3)		32 (86.5)	14 (93.3)	
	Worsened	0 (0)	0 (0)		3 (8.1)	1 (6.7)	
Sextant 3	Improved	31 (83.8)	1 (6.7)	<0.001	6 (16.2)	0 (0)	0.207
	Unchanged	6 (16.2)	14 (93.3)		29 (78.4)	14 (93.3)	
	Worsened	0 (0)	0 (0)		2 (5.4)	1 (6.7)	
Sextant 4	Improved	31 (83.8)	1 (6.7)	<0.001	5 (13.5)	0 (0)	0.441
	Unchanged	6 (16.2)	14 (93.3)		30 (81.1)	14 (93.3)	
	Worsened	0 (0)	0 (0)		2 (5.4)	1 (6.7)	
Sextant 5	Improved	16 (42.2)	6 (40)	0.758	9 (24.3)	2 (13.3)	0.336
	Unchanged	16 (42.2)	8 (53.3)		24 (64.9)	9 (60)	
	Worsened	5 (13.5)	1 (6.7)		4 (10.8)	4 (26.7)	
Sextant 6	Improved	27 (73.0)	0 (0)	<0.001	10 (27)	0 (0)	0.029
	Unchanged	10 (27.0)	15 (100)		25 (67.6)	13 (86.7)	
	Worsened	0 (0)	0 (0)		2 (5.4)	2 (13.3)	
Total	Improved	32 (86.5)	7 (46.7)	0.004	22 (59.5)	2 (13.3)	0.007
	Unchanged	3 (8.1)	7 (46.7)		10 (27)	9 (60)	
	Worsened	2 (5.4)	1 (6.7)		5 (13.5)	4 (26.7)	
Fisher‘s exact test							

The scientific research discusses the possibility that patients with occlusal trauma may exhibit additional biomechanical vulnerability. Even if inflammation temporarily decreases under the influence of chlorhexidine (CHX), the persistence of non-functional contacts may maintain local occlusal overload. Consequently, long-term stability may require biomechanical interventions—such as occlusal adjustments, control of parafunctional habits, and selective splinting—following initial control of inflammation (Thesis, Chapter 6.6.3; Chapter 5.6).

Furthermore, the study reiterates the limitations associated with prolonged CHX use and recommends short-term administration in conjunction with mechanical periodontal therapy and clinical monitoring, in accordance with the cited literature (Thesis, Chapter 2.2.1; Chapter 6.6.2).

Study limitations include the relatively short follow-up duration (6 months) for a chronic disease, the use of CPITN as a screening tool (which does not fully capture the detailed variations in CAL and PD at the individual tooth level), and the intentional absence of occlusal

modification during follow-up. This design does not allow direct conclusions regarding the benefits of occlusal adjustment but rather provides insight into periodontal evolution under antiseptic control in the presence of non-functional contacts (Thesis, Chapter 6.8).

The study proposes, as a future research direction, comparative investigations in which inflammation control is combined with occlusal correction, in order to evaluate the combined effect on periodontal stability.

In Chapter 7, entitled *"General Conclusions and Personal Contributions,"* the following general conclusions are presented based on the scientific research conducted (Thesis, Chapter 7.1):

1. **Periodontal disease** is a multifactorial inflammatory condition in which bacterial biofilm initiates and sustains inflammation, while local and systemic factors modulate disease severity and response to treatment.

2. **Occlusal trauma** represents a relevant biomechanical cofactor with aggravating potential in the presence of inflammation and/or reduced periodontal support. It acts by amplifying local mechanical stress and influencing bone remodeling processes.

3. Teeth presenting **non-functional occlusal contacts** exhibit higher maximum occlusal loads and are associated with more severe clinical and radiographic periodontal parameters (probing depth, gingival recession, pathologic tooth migration, alveolar bone loss, and widening of the periodontal ligament space), suggesting a localized impact of occlusal overload.

4. Regarding the association between non-functional traumatic occlusal contacts and the severity of periodontal inflammation, the findings suggest a synergistic interaction. Microbial plaque sustains periodontal inflammation, and within this inflammatory environment, non-functional occlusal contacts and occlusal overload accelerate the destruction of supporting structures, leading to unfavorable progression and increased disease severity. Under these conditions, non-functional occlusal contacts may acquire a destructive role.

5. Premature contacts occurring between centric relation (RC) and maximum intercuspation (IM) tend to be associated with more severe periodontal manifestations compared to eccentric interferences, highlighting the relevance of contact type and force application conditions. The negative impact of premature contacts on the marginal periodontium may be explained by their functional characteristics: they occur more frequently during mandibular

dynamics; in centric relation, the mandible is stabilized at the level of the temporomandibular joint (TMJ), while in maximum intercuspation muscular contraction reaches its peak. Under these conditions, these dento-dental contacts occur first and bear the entire occlusal load.

6. The performed digital occlusal analysis demonstrated that it represents a valuable tool in the diagnosis and management of patients with periodontal disease, allowing a more objective and precise identification of traumatic occlusal contacts and quantification of occlusal force distribution compared to conventional occlusal recording methods.

7. The adjunctive use of chlorhexidine in non-surgical periodontal therapy for patients with periodontal disease associated with occlusal dysfunction may improve periodontal status in the short term; however, its effect may diminish over time if biomechanical factors persist. Effective management therefore requires an integrated therapeutic approach.

8. The presence of non-functional dento-dental contacts may negatively influence periodontal healing following the use of chlorhexidine mouthwashes. Consequently, after initial control of periodontal inflammation, occlusal correction through occlusal equilibration should be considered.

9. The CPITN index proved, in the context of this research as well, to be a rapid and useful screening tool for assessing treatment needs in periodontal disease associated with occlusal trauma.

10. The results of the present scientific research support the inclusion of digital occlusal evaluation in modern diagnostic and therapeutic protocols for periodontal disease, particularly when common clinical manifestations are present (tooth mobility, pathologic tooth migration, alveolar bone resorption).

11. The data obtained may contribute to the refinement of therapeutic strategies and to the development of evidence-based clinical guidelines adapted to emerging digital technologies available in contemporary dental practice.

Regarding **Personal Contributions**, these consist in the integration of digital occlusal evaluation (OccluSense) into the clinical assessment of patients with periodontal disease and in the demonstration, within a clinical cohort, of the association between local occlusal overload and the severity of periodontal manifestations (Thesis, Chapter 7.2; Chapter 5.4.8).

An element of originality lies in the differentiated analysis of types of non-functional occlusal contacts and their impact on the marginal periodontium. Study I demonstrated that teeth

presenting premature contacts between centric relation and maximum intercuspation were associated with more severe forms of periodontal involvement, suggesting a distinct biomechanical role of this type of repetitive occlusal overload. Although this observation contrasts with certain views that consider eccentric occlusal interferences to exert a more destructive effect on the periodontium, it contributes to clarifying the mechanisms through which occlusal trauma may act as an aggravating factor in the progression of periodontal disease.

This finding may be explained by the fact that:

- premature contacts are applied to teeth under maximal muscular contraction (in IM), repetitively (in RC), particularly during swallowing, and are generally transmitted axially but occur with much higher frequency;
- occlusal interferences, which involve non-functional contacts between antagonistic teeth during eccentric movements (protrusion and lateral excursions) and interfere with mandibular pathways, are transient and occur only during mandibular movements.

Therefore, premature contacts may generate a more persistent biomechanical load on the periodontal ligament over the course of a day, leading to cumulative effects on the marginal periodontium over time.

Another applied contribution is the evaluation of CPITN evolution under chlorhexidine use in the absence of occlusal adjustments. This supports the role of inflammatory control through antiseptic agents as an adjunctive step, while simultaneously highlighting the limitations of such an approach when biomechanical factors remain unmodified (Thesis, Chapter 6.6; Chapter 7.1).

In accordance with the directions proposed within the scientific research, future investigations may focus on: longitudinal studies involving larger cohorts; evaluation of the effects of occlusal adjustments on periodontal stability and recurrence rates; integration of salivary and crevicular fluid biomarkers for monitoring inflammatory activity; incorporation of three-dimensional imaging (CBCT) for accurate quantification of periodontal defects; and standardization of digital occlusal contact analysis protocols (Thesis, Chapter 7.3; Chapter 1.3).

Clinical Recommendations:

- Inclusion of occlusal screening in the evaluation of patients presenting with tooth mobility and/or pathologic tooth migration, particularly when these findings cannot be explained solely by inflammatory factors.

- Use of digital occlusal analysis for objective quantification, monitoring, and guidance of occlusal adjustments when indicated.

- Biofilm and inflammation control as the foundation of periodontal therapy, with short-term use of chlorhexidine as an adjunctive measure.

- Interdisciplinary management of biomechanical factors (occlusal adjustments, control of parafunctional habits, selective temporary splinting) according to clinical indications and the staging and grading of periodontitis (Thesis, Chapter 5.6; Chapter 6.7)

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List of Published Scientific Papers

1. **Nicolae XA**, Preoteasa E, Murariu Magureanu C, Preoteasa CT. Cross-Sectional Study of Occlusal Loading and Periodontal Status of Teeth with Deflective Occlusal Contacts. Bioengineering (Basel) 2025 Jul 16; 12(7):766. Doi: 10.3390/bioengineering12070766. PMID:40722458; PMCID: PMC12293018 (see Appendix 1 and Chapter 5, pg. 64-93) – Bioengineering: FI 3.7/2024, Q2

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2. **Nicolae XA**, Preoteasa E, Murariu Măgureanu C, Moraru R, Preoteasa CT. Evolution of CPITN Index in Relation to Chlorhexidine Mouthwash Use in Patients with Deflective Occlusal Contacts. Bioengineering (Basel) 2025 Oct 22;12(11):1140. Doi:10.3390/bioengineering12111140.PMID:41301097; PMCID: PMC12649252 (see Appendix 2 and Chapter 6, pg. 94-110) – Bioengineering: FI 3.7/2024, Q2

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3. Dumitriu AS, Păunică S, **Nicolae XA**, Bodnar DC, Albu ȘD, Suciu I, Ciongaru DN, Giurgiu MC. The Effectiveness of the Association of Chlorhexidine with Mechanical Treatment of Peri-Implant Mucositis. Healthcare (Basel). 2023 Jul 3;11(13):1918. doi:10.3390/healthcare11131918. PMID: 37444752; PMCID: PMC10341060. (see Appendix 3 and Chapter 6, pg. 94) -Healthcare: FI 2.8/2022, Q2

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4. Dumitriu AS, Didilescu AC, Giurgiu MC, Albu ȘD, Pădure CE, **Nicolae XA**, Păunică S. The efficiency of using enamel matrix derivative in therapeutic approach of periodontal furcation defects of maxillary and mandibular molars. Rom J Morphol Embryol. 2021 Apr-Jun;62(2):401-409. doi: 10.47162/RJME.62.2.06. PMID: 35024728; PMCID: PMC8848286. (see Appendix 4 and Chapter 3, pg. 53) -Romanian Journal of Morphology and Embryology: FI 0.83/2021, Q4

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5. The influence of the intensity of occlusal contacts on the results of periodontal regenerative therapy- case report Drd. **Ximena Anca Nicolae**, Conf. Dr. Stana Păunică, Șef lucr. Dr. Marina Cristina Giurgiu, Prof. Dr. Anca Silvia Dumitriu. The Bucharest Congress of Dentists 6-8 oct 2021- oral presentation, (see Appendix 5)

6. Clinical efficacy of Er:YAG laser applications in the management of the advanced forms of periodontal diseases - case presentation Drd. **Ximena Anca Nicolae**, Conf. Dr. Stana Păunică, Șef lucr. Dr. Marina Cristina Giurgiu, Prof. Dr. Anca Silvia Dumitriu. The Bucharest Congress of Dentists 21-23 oct 2021- oral presentation, (see Appendix 6)