

## THE EFFECT OF THE OCCLUSAL DISCREPANCIES FROM THE ECCENTRIC MOVEMENTS OF THE MANDIBLE ON THE PERIODONTAL AND HARD TOOTH STRUCTURE

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### ABSTRACT

**Aim of the study.** To investigate the correlation between occlusal trauma caused by occlusal discrepancies during the eccentric movements of the mandible and the type of guidance, loss of attachment, and non-carious lesions.

**Materials and methods.** The study involved 45 subjects aged between 25 and 70 years, each presenting with at least two non-carious lesions. Comprehensive odontal, occlusal, and periodontal evaluations were carried out. The odontal assessment identified the location and dimensions of the abfractions. The attachment loss was measured during the periodontal examination, while the occlusal examination allowed the detection of premature contacts and interferences in the teeth with abfractions in the excursion movements of the mandible. A series of parameters were analyzed such as the location and size of abfractions, the amount of attachment loss, occlusal discrepancies in the teeth included in the study, the type of guidance and the patient's age. Correlations between the values obtained in determining these parameters were performed by using Student test (T) 2-tailed and the mathematical regression lines. **Results.** Abfractions were observed most frequently in group guidance (50%), followed by canine guidance (31%) and anterior guidance (19%). Posterior teeth with active interferences during laterality movements exhibited a mean attachment loss of 0.88 mm ( $p < 0.01$ ). Teeth with premature contacts showed a mean attachment loss of 0.60 mm ( $p < 0.01$ ). Additionally, anterior teeth with premature contacts active during propulsion demonstrated a mean attachment loss of 1.24 mm ( $p < 0.01$ ). **Conclusions** The findings highlight a significant association between occlusal discrepancies and progressive attachment loss, underscoring the importance of precise occlusal adjustments in preserving periodontal health and preventing structural tooth damage. This pivotal connection emphasizes the need for a multidisciplinary approach to early diagnosis and management, advancing both clinical practice and patient outcomes.

**Key words:** abfraction, attachment loss, occlusal guidance, premature contact, occlusal interference, mandibular movement, periodontal health

### INTRODUCTION

Non-carious lesions, consisting of loss of tooth hard structure at the amelo-cementary junction, have their onset as a slowly progressing incisures [1]. The etiology of non-carious lesions is complex. Chemical

degradation, friction and dental flexion are among the factors involved in the initiation and progression of the dental erosion, abrasion and abfraction, which represent distinct variants of non-carious lesions [2-4]. Cervical lesions are diagnosed based on a detailed

medical history, visual inspection and tactile examination.

Abfraction, a term introduced in the literature by Grippo, was defined as a loss of hard dental substance, caused by biomechanical loading forces that lead to bending and loss of enamel and dentin at a distance from the point of application [2]. Typically, abfraction type lesions are described as cuneiform defects, taking the form of sharp angles, being well-expressed and with possible expansion below the subgingivally [4].

The size and depth of these injuries increase with age, as does the number of injuries, meaning that the oral environment through its local factors plays a significant role in the evolution of these lesions [5]. Moreover, cuneiform defects are more common than those with round appearance and these defects are more often located on the front/anterior teeth and premolars, on the buccal surface. These lesions were also observed on the oral surface at a rate of 2% [6]. The literature provides much data on the occlusal etiology of the above-described lesions, specifying that lateral occlusal forces may have a role in causing the lesions and may be the dominant factor in their progression [7]. It has been observed that the direction of the lateral force dictates the position of the lesion, while the size of the lesion is associated with the strength and duration of the force.

During eccentric movements, the teeth are stressed in the horizontal direction and tensions accumulate in the cervical junction, causing the dental flexion. Traction forces arise that break the bonds between hydroxyapatite crystals within the enamel [8].

To obtain robust evidence about the involvement of occlusion in the origin of non-carious lesions and that of the periodontal disease, increased occlusal forces must be applied during excursive movements at the

occlusal surface level [9-11]. When the tooth contact is applied at a slope, the resultant force is not directed along the longitudinal axis, and a horizontal component appears which tends to cause tilting. The vertical forces resulting from tooth contact are well tolerated by the periodontal ligament, but horizontal forces cannot be efficiently dissipated, thus an increase in the pathological effects on the tooth and tissues being present [12].

Periodontal disease represents a major factor for tooth loss, with significant implications for both oral and general health [13]. Ensuring a proper balance between occlusion and periodontal structures is critical for maintaining the overall health of the stomatognathic system. Notably, an increase in occlusal interferences in the premolars and molars during lateral and anterior guidance can influence both the occurrence and severity of gingival recession [14]. Kern and Vagner reported that practitioners should consider occlusal trauma as a co-factor with a role in the progression of attachment loss [15]. It was shown that the occlusal trauma is responsible for the loss of attachment as a result of excessive occlusal forces, acting on a tooth of normal periodontal height [16].

Glickman [17] noted that the teeth showing occlusal trauma seemed to present a different progression of periodontal tissue loss, as opposed to those which did not undergo occlusal trauma. He also stated that the sites exposed to abnormal occlusal forces would develop angular bone defects and bone pockets. Waerhung [18], however, rejected the hypothesis that occlusal trauma played a role in the gum lesion progression, the connective attachment loss and the bone resorption around the tooth being the exclusive result of inflammatory lesions associated with the subgingival plaque.

Thus, studies have demonstrated that both interference and premature contacts represent

a risk factor for both the non-carious lesion initiation and the progression of the periodontal disease.

The aim of this study was to correlate the occlusal trauma caused by the interferences and premature contacts during eccentric movements with the type of guidance, the loss of attachment and, last but not least, with non-carious lesions.

## MATERIALS AND METHODS

This study adhered to the ethical guidelines of the 'Iuliu Hațieganu' University of Medicine and Pharmacy, as well as the principles outlined in the Helsinki Declaration of 1975, as revised in 2008.

A total of 45 subjects, aged between 25 and 70 years, participated effectively in the study. All participants in this study provided written informed consent, ensuring their voluntary and anonymous participation. Anonymity was strictly maintained throughout the study, and participants did not receive any financial compensation for their involvement. The subjects included in the study were patients seeking prosthetic treatments at the Prosthodontics Clinic of the Faculty of Dental Medicine, "Iuliu Hațieganu" University of Medicine and Pharmacy in Cluj-Napoca, between October 1, 2023, and October 1, 2024.

Following eligibility criteria were established:

Inclusion Criteria:

1. Teeth with cervical non-carious lesions.
2. Teeth with antagonistic pairs, free from mobility or coronal restorations.
3. A minimum of two non-carious cervical lesions per dentition, each with a depth of at least 1 mm. The periodontal examination involved measuring attachment loss using a periodontal probe at six points (mesial-, central-, distal-buccal, and mesial-, central-, distal-oral) for each tooth included in the

study.

The occlusal examination focused on detecting premature contacts and interferences in the teeth with abfractions during mandibular excursion movements. Dynamic occlusal analysis was conducted by guiding the mandibular movement in both protrusion and lateral directions, starting from the maximum intercuspation position. Contact points were recorded using Bausch (Bausch Company, Solingen, Germany) 40-micron joint paper.

Based on the recorded data, various correlations were established, considering factors such as the location and size of the abfractions, the degree of attachment loss, the presence of occlusal discrepancies in the teeth involved, as well as the type of occlusal guidance and the patients' age.

Statistical analysis was performed using IBM SPSS Statistics 28. The data were analyzed using the two-tailed Student's t-test to compare means between groups, and bivariate regression analysis was conducted to examine the relationships between the measured parameters.

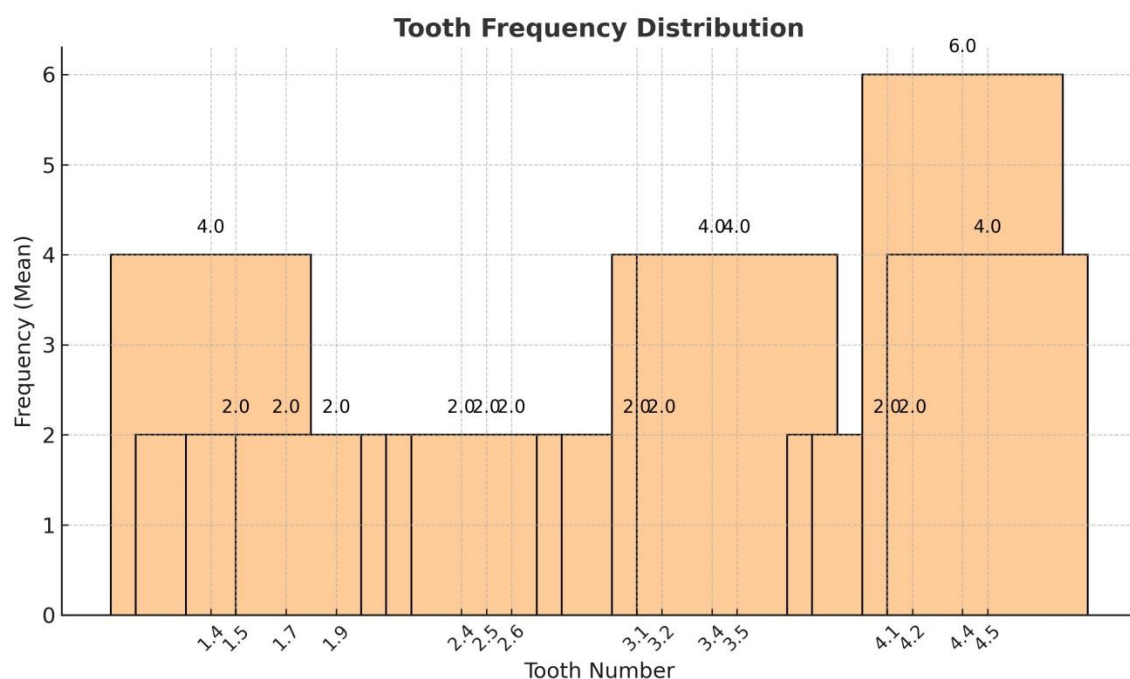
## RESULTS AND DISCUSSIONS

100 teeth were included in this study. Descriptive analysis methods were employed, aggregating all the measurements obtained during the study.

The abfractions were primarily located on the buccal surface in the cervical third of the crown. The average size of the lesions, resulting from the loss of hard dental tissue, varied across the different types of occlusal guidance: 2.02 mm for canine guidance, 2.33 mm for group guidance, and 0.87 mm for anterior guidance. Notably, the largest losses of hard tooth tissue were observed in the group guidance.

In terms of dental topography, the most affected teeth were 4.4, followed by 4.5, 3.4, and 3.5, as illustrated in the graph below (Fig.

1).



**Figure 1. Frequency of abfractions in certain teeth**

Based on the type of tooth guidance, it was observed that non-carious lesions mostly appeared in the teeth that were part of the that took part in the protrusion movement (19%).

Out of the 100 examined teeth, the majority presented premature contacts which

group guidance (50%), followed by the laterally active teeth that were part of the canine guidance (31%) and in the front teeth were active in the lateral movement. Also, the concurrent presence of both premature contacts and active interference in the lateral movement was observed (Table 1).

**Table 1 Frequency and percentage of occlusal discrepancies in the teeth with abfractions**

| Occlusal Discrepancy | Frequency | Percent | Valid Percent | Cumulative Percent |
|----------------------|-----------|---------|---------------|--------------------|
| API                  | 3         | 3.2     | 7.1           | 7.1                |
| APPC                 | 3         | 3.2     | 7.1           | 14.3               |
| ALI                  | 3         | 3.2     | 7.1           | 21.4               |
| ALPC                 | 18        | 18.9    | 42.9          | 64.3               |
| ALI+ALPC             | 12        | 12.6    | 28.6          | 92.9               |
| API+APPC             | 2         | 2.1     | 4.8           | 97.6               |
| ALPC+PLI+PLPC        | 1         | 1.1     | 2.4           | 100.0              |
| Total                | 42        | 44.2    | 100.0         |                    |
| System               | 53        | 55.8    |               |                    |
| Total                | 95        | 100.0   |               |                    |

**Abbreviation list - Table 1 and 5:**

API – active propulsive interference;  
 APPC – active propulsive premature contact;  
 ALI – active laterotrusive interference;  
 ALPC – active laterotrusive premature contact ;  
 PLI - passive laterotrusive interference;  
 PLPC - passive laterotrusive premature contact.

The analysis of the correlations between the different variables involved in the study (e.g. between the loss of attachment, type of guidance and age of the patient) was achieved in statistical terms, using the Student 2-tailed test. The strength values of

the test, p, in all the situations researched and the correlation coefficients, R are presented in Table 2. Also, the evolution of the attachment loss was estimated by mathematical regression.

Following the measurements made in the six points, an average was calculated of the losses of attachment dependent on the eccentric movements in which the tooth was involved. Thus, a greater loss of attachment was observed in the group guidance teeth compared to those in the canine or anterior guidance (see Table 3).

**Table 2. The correlation coefficient and the strength of the test in the vestibular and oral points, depending on the guidance**

| Place Attachement<br>Los | Canine<br>Guidence |       | Lateral Guidance  |                   | Anterior<br>Guidence |       |
|--------------------------|--------------------|-------|-------------------|-------------------|----------------------|-------|
|                          | p                  | R     | p                 | R                 | p                    | R     |
| A <sub>loss</sub> MV     | < 0.01             | 73.7% | < 0.01            | 69.6%             | < 0.01               | 83.1% |
| A <sub>loss</sub> CV     | < 0.01             | 53.7% | No<br>correlation | No<br>correlation | < 0.01               | 88.1% |
| A <sub>loss</sub> DV     | < 0.01             | 83.9% | < 0.01            | 49.1%             | < 0.01               | 90.7% |
| A <sub>loss</sub> MO     | < 0.01             | 85.5% | = 0.049           | 28.5%             | < 0.01               | 78.6% |
| A <sub>loss</sub> CO     | < 0.01             | 84.3% | < 0.01            | 46%               | < 0.01               | 85.7% |
| A <sub>loss</sub> DO     | < 0.01             | 88 %  | = 0.004           | 41.2%             | < 0.01               | 84.8% |

**Table 3. Averages of attachment losses in the selected points of the interfering teeth in relation to the type of guidance**

| Place Attachement<br>Los | Canine Guidance | Lateral Guidance | Anterior Guidance |
|--------------------------|-----------------|------------------|-------------------|
| A <sub>loss</sub> MV     | 2.1458          | 2.4375           | 0.7292            |
| A <sub>loss</sub> CV     | 2.6458          | 2.9792           | 1.0833            |
| A <sub>loss</sub> DV     | 1.8333          | 2.3750           | 0.7708            |
| A <sub>loss</sub> MO     | 1.7292          | 2.0729           | 0.8125            |
| A <sub>loss</sub> CO     | 1.9583          | 2.0833           | 0.9792            |
| A <sub>loss</sub> DO     | 1.7917          | 2.0208           | 0.8333            |

**Abbreviation list - Table 2 and 3:**A<sub>loss</sub>MV-attachment loss mesial-buccalA<sub>loss</sub>CV-attachment loss central-buccalA<sub>loss</sub>DV-attachment loss distal-buccalA<sub>loss</sub>MO-attachment loss mesial-oralA<sub>loss</sub>CO-attachment loss central-oralA<sub>loss</sub>DO-attachment loss distal-oral

It should be noted that, regardless of the point where the measurement was taken, the teeth in the canine guidance had a smaller average loss than those in the group guidance, but significantly higher than those in the protrusion. Within the group guidance, the greatest loss of attachment occurred in the central-vestibular point, which coincided in most cases with the clinical findings. Moreover, within the group guidance, the

amount of attachment losses on the vestibular side was greater than on the oral side. Even in the canine and anterior guidance, where attachment losses were lower, it was found that the attachment loss was increased in the same central-vestibular point.

A dependent relationship between age and attachment loss, influenced by the type of

occlusal guidance, was determined based on regression lines. A progressive increase in attachment loss was observed with advancing age (calculated at one-year intervals) in cases of canine and anterior guidance. However, no such correlation was identified for group guidance (Table 4).

**Table 4. Attachment loss of the teeth involved in the canine and anterior guidance at a one year interval**

| Place Attachment Loss | Canine Guidance | Anterior Guidance |
|-----------------------|-----------------|-------------------|
| $A_{lossMV}$          | 0.042 mm        | 0.043 mm          |
| $A_{lossCV}$          | 0,042 mm        | 0.067 mm          |
| $A_{lossCD}$          | 0.05 mm         | 0.048 mm          |
| $A_{lossMO}$          | 0.053 mm        | 0.047 mm          |
| $A_{lossCO}$          | 0.058 mm        | 0.059 mm          |
| $A_{lossDO}$          | 0.056 mm        | 0.05 mm           |

The findings indicate that anterior teeth exhibited greater attachment loss compared to those involved in canine guidance. Posterior teeth with interferences active during laterality movements demonstrated an attachment loss of 0.88 mm ( $p < 0.01$ ). Teeth with premature

contacts showed a loss of 0.60 mm ( $p < 0.01$ ), while anterior teeth with active premature contacts presented the highest attachment loss of 1.24 mm ( $p < 0.1$ ). These results were determined using the Student's t-test and regression analysis (Table 5).

**Table 5. Attachment loss in the teeth with occlusal discrepancies**

| Occlusal Discrepancy | P      | R     | Attachement Loss (mm) |
|----------------------|--------|-------|-----------------------|
| ALPC                 | P<0.01 | 96.1% | 0.60                  |
| ALI                  | P<0.01 | 92.4% | 0.88                  |
| ALI+ALPC             | P<0.01 | 94.5% | 0.91                  |
| APPC                 | P<0.01 | 94.6% | 1.20                  |

The main findings of this study align with previous research [19 - 21] demonstrating that abfractions occur as a consequence of excessive forces, premature contacts, and interferences. Specifically, 28.6% of the teeth examined in this study exhibited both active premature contacts and active interferences during laterotrusive movements, while 42.9% of teeth showed active laterotrusive premature contacts. These results support the hypothesis that horizontal stresses contribute to cervical tension and tooth flexion, consistent with earlier studies [22-24].

For instance, Rees utilized finite element analysis to examine a lower premolar under a point force of 500 N applied to the occlusal surface. His findings revealed that vertical occlusal forces generated approximately 50 MPa of tension, whereas oblique forces produced 250 MPa in the cervical region—exceeding the threshold for enamel fracture [26, 27]. This highlights the significant impact of vertical forces on tooth integrity. Similarly, during root canal preparation, vertical forces applied through the endodontic file also generate stress and strain in the root canal dentin. These forces can lead to deformations in the root structure, and if excessive, may result in microcracks and eventually fractures in the dentin [28]. Both the occlusal loading, as well as the forces applied during root canal shaping or emphasize the critical role of vertical stress in compromising the structural

integrity of the

tooth, potentially leading to fractures in both the enamel and the root dentin.

Similarly, Nohl et al. used planar transducers on cervical and buccal surfaces to measure stress under axial and lateral forces. Their study showed that forces mimicking laterotrusive movements induced significantly greater cervical stress compared to axial loading [29]. These oblique forces, acting outside the tooth's longitudinal axis, caused torsional stress in the cervical region, potentially leading to the breakdown of the enamel's crystalline structure [28, 29].

Tooth tissue loss is influenced by the magnitude, duration, direction, frequency, and location of applied forces. Previous research has identified premolars as being most susceptible to cervical stress, findings corroborated by the current study, which recorded the highest prevalence of abfractions in lower premolars, particularly the second premolar.

The relationship between occlusal discrepancies and non-carious cervical lesions has been debated. Some studies [12, 30] suggest that cervical stress contributes to lesion formation, while others [15, 31-33] refute occlusion's role in their progression. In this study, analysis of occlusal guidance revealed that most affected teeth were associated with group guidance. This observation is consistent with Miller et al.'s

research, which reported that 95% of patients with abfractions exhibited group guidance, with 73% of those cases occurring in the active side during laterality [34]. Further studies confirm that abfractions are six times more frequent in patients with group guidance compared to canine guidance [35, 36].

Group guidance is particularly detrimental because the teeth on the active side remain in contact during laterotrusion, whereas canine guidance prevents premolars and molars from contacting during this movement. The canine, due to its robust root structure, volume, and dense alveolar bone support, is better suited to absorb and dissipate horizontal forces while ensuring posterior disocclusion [26].

The study also explored the correlation between premature contacts, interferences in eccentric movements, and attachment loss. A significant association was identified between attachment loss, occlusal discrepancies, and the type of guidance [37]. Notably, premature contacts and interferences were linked to increased probing depths. Harrel and Nunn reported that teeth with unresolved occlusal discrepancies experienced an annual probing depth increase of 0.066 mm compared to teeth where adjustments were performed [38–41].

In this study, probing depths at six reference points demonstrated age-related attachment loss in cases of canine and anterior guidance. However, group guidance was not influenced by age; instead, attachment loss in these cases was directly related to occlusal contact intensity.

Reinhardt's work further supports the association between premature contacts and probing depth. For instance, premature contacts in retruded contact position (RC) were associated with a depth of 0.89 mm, posterior protrusive contacts with 0.51 mm, are susceptible to abfractions due to significant stress concentrations under occlusal loading and vertical misalignments. These teeth

and balancing-side contacts with 1.01 mm [36]. Similarly, this study observed posterior teeth with active interferences in laterotrusive movements experiencing attachment losses of 0.88 mm, while teeth with premature contacts had losses of 0.60 mm. Teeth with both premature contacts and active interferences had the highest losses.

The data suggest that combined premature contacts and interferences exacerbate attachment loss compared to isolated occlusal discrepancies. A cross-sectional study has also reported that the severity of attachment loss correlates with the number of active and passive premature contacts [41].

Burgett et al. highlighted the benefits of occlusal adjustments, reporting a 0.4 mm reduction in mean probing depth over six years in patients receiving occlusal adjustments compared to those without [43]. These findings align with the current study, where anterior teeth with premature contacts during protrusion exhibited the highest attachment losses. Occlusal adjustment, in conjunction with periodontal therapy, has been shown to improve patient comfort and functional outcomes [44].

Nonetheless our study has several limitations. It was conducted in a single clinical setting, limiting generalizability. Baseline data on initial gingival attachment levels were unavailable. Furthermore, selective grinding was not performed, which could have provided additional insights into the effects of occlusal adjustment on attachment loss.

## **CONCLUSIONS**

1. Vulnerability of mandibular second premolars: The second premolars were found to be particularly showed higher rates of enamel damage, highlighting the need for focused preventive measures in these areas.

2. Abfraction risk based on dental topography: The study identified a clear pattern in the dental topography, with premolars in the fourth quadrant being the most affected by abfractions, followed by premolars in the third quadrant. This finding underscores the importance of considering the positioning of these teeth when assessing the risk of abfractions.

3. Impact of occlusal discrepancies: Vertical occlusal interferences were strongly linked to the development of abfractions, especially in the second premolars. Misalignments and premature contacts create concentrated stress that contributes to enamel wear and the formation of abfraction lesions.

4. Age and occlusal factors in attachment loss: Attachment loss due to abfractions was found to increase with age, particularly in teeth involved in anterior and canine guidance.

However, for teeth in group guidance, attachment loss was more closely associated with the presence of occlusal discrepancies, rather than age, indicating the critical role of occlusal factors in the progression of abfractions.

5. Impact of guidance type on regional variations in attachment loss: Anterior teeth exhibit greater attachment loss compared to teeth involved in canine guidance, suggesting their heightened vulnerability.

6. Correlation between interferences and attachment loss: The findings of this study highlight the correlation between occlusal interferences, premature contacts, and both abfraction formation and increased attachment loss. This suggests that addressing occlusal discrepancies is essential in preventing both enamel damage and further periodontal degradation.

## REFERENCES

1. Kolak V, Pešić D, Melih I, Lalović M, Nikitović A, Jakovljević A. Epidemiological investigation of non-carious cervical lesions and possible etiological factors. *J Clin Exp Dent*. 2018 Jul 1;10(7):e648-e656. doi: 10.4317/jced.54860. PMID: 30057705; PMCID: PMC6057075.
2. Grippo JO, Simring M, Coleman TA. Abfraction, abrasion, biocorrosion, and the enigma of noncarious cervical lesions: a 20-year perspective. *Journal of Esthetic and Restorative Dentistry*. 2012;24(1):10-23. <http://dx.doi.org/10.1111/j.1708-8240.2011.00487.x>.
3. Bartlett DW, Shah P. A critical review of non-carious cervical (wear) lesions and the role of abfraction, erosion, and abrasion. *Journal of Dental Research*. 2006;85(4):306-312. doi:10.1177/154405910608500405.
4. Grippo JO, Simring M, Schreiner S. Attrition, abrasion, corrosion and abfraction revisited: a new perspective on tooth surface lesions. *Journal of the American Dental Association*. 2004;135(8):1109-1118. <http://dx.doi.org/10.14219/jada.archive.2004.0369>.
5. Levitch LC, Bader JD, Shugars DA, et al. Non-carious cervical lesions. *Journal of Dentistry*. 1994;22:195-207 Abstract.
6. Radentz WH, Barnes GP, Cutright DE. A survey of factors possibly associated with cervical abrasion of tooth surfaces. *Journal of Periodontology*. 1976;47(3):148-154. <http://dx.doi.org/10.1902/jop.1976.47.3.148>.
7. Hanaoka ND, Mitusi K, et al. A biomechanical approach to the etiology and treatment of carious dental cervical lesions. *Den Col*. 1998;26:103-113.
8. Grippo JO. Abfractions: a new classification of hard tissue lesions of teeth. *Journal of Esthetic Dentistry*. 1991;3(1):14-19.

9. Bernhardt O, Gesch D, Schwahn C, et al. Epidemiological evaluation of the multifactorial etiology of abfractions. *Journal of Oral Rehabilitation*. 2006;33(1):17-25. <http://dx.doi.org/10.1111/j.1365-2842.2006.01532.x>.
10. Takehara J, Takanot J, Akhter R, Morita M. Correlation of non-carious cervical lesions and occlusal factors determined by using pressure-detecting sheet. *Journal of Dentistry*. 2008;36(10):774-779. <http://dx.doi.org/10.1016/j.jdent.2008.05.009>.
11. Reyes E, Hildebolt C, Langennwalter E, Miley D. Abfraction and attachment loss in teeth premature contacts in centric relation: clinical observation. *Journal of Periodontology*. 2009;80(12):1955-1962. <http://dx.doi.org/10.1902/jop.2009.090149>.
12. Okeson JP. *Criteria for Optimum Functional Occlusion. Management of Temporomandibular Disorders and Occlusion*. Elsevier Canada; 2013.
13. Iosif, L.; Preoteasa, C.T.; Preoteasa, E.; Ispas, A.; Ilinca, R.; Murariu-Măgureanu, C.; Amza, O.E. Oral Health Related Quality of Life and Prosthetic Status among Institutionalized Elderly from the Bucharest Area: A Pilot Study. *Int. J. Environ. Res. Public Health* 2021, 18, 6663. <https://doi.org/10.3390/ijerph18126663>.
14. Gürbüz, S., Bakhishov, H., Koçyiğit, E. G., Işık, A., Tuncer, B. B., Özdemir, B. Evaluation of mid-buccal gingival recessions and occlusal interferences. *Journal of oral rehabilitation*, 2023, 50(10), 1058-1069.
15. Kern M, Wagner B. Periodontal findings in patients 10 years after insertion of removable partial dentures. *Journal of Rehabilitation*. 2001;28(11):991-997. doi:10.1111/j.1365-2842.2001.00788.x.
16. Lindhe N, Thorkild L. Trauma from Occlusion: Periodontal Tissues. *Clinical Periodontology and Implant Dentistry*. United Kingdom; 2008:350-359.
17. Glickman I. Clinical significance of trauma from occlusion. *Journal of the American Dental Association*. 1965;70(3):607-618. <http://dx.doi.org/10.14219/jada.archive.1965.0261>.
18. Waerhaug J. The infrabony pocket and its relationship to trauma from occlusion and subgingival plaque. *Journal of Periodontology*. 1979;50(7):355-365. doi:10.1902/jop.1979.50.7.355.
19. Smith WA, Marchan S, Rafeek RN. The prevalence and severity of non-carious cervical lesions in a group of patients attending a university hospital in Trinidad. *Journal of Rehabilitation*. 2008;35(2):128-134. <http://dx.doi.org/10.1111/j.1365-2842.2007.01763.x>.
20. Nascimento M, Dilbone D, Pereira P, Duarte W, Geraldeli S, Delgado A. Abfraction lesions: etiology, diagnosis, and treatment options. *Clinical, Cosmetic and Investigational Dentistry*. 2016;8:79. doi:10.2147/CCIDE.S63465.
21. Collio W, Martínez M, Oñate R. Relationship between presence of abfractions and premature contacts. *International Journal of Interdisciplinary Dentistry*. 2021;14(2):131-134. <https://dx.doi.org/10.4067/S2452-55882021000200131>.
22. Grippio JO. Noncarious cervical lesions: the decision to ignore or restore. *Journal of Esthetic Dentistry*. 1992;(Supplement 4):55-64.
23. Rees JS, Hammadeh M, Jagger DC. Abfraction lesion formation in maxillary incisors, canines, and premolars: a finite element study. *European Journal of Oral Science*. 2003;111(2):149-154. doi:10.1034/j.1600-0722.2003.00018.x.
24. Wood ID, Kassir AS, Brunton PA. Effect of lateral excursive movements on the progression of abfraction lesions. *Operative Dentistry*. 2009;34(3):273-279. <http://dx.doi.org/10.2341/08-100>.
25. Brandini DA, Trevisan CL, Panzarini SR, Pedrini D. Clinical evaluation of the association between noncarious cervical lesions and occlusal forces. *The Journal of Prosthetic Dentistry*. 2012;108(5):298-303. [http://dx.doi.org/10.1016/S0022-3913\(12\)60180-2](http://dx.doi.org/10.1016/S0022-3913(12)60180-2).
26. Rees JS. The biomechanics of abfraction. *Journal of Engineering in Medicine*. 2006;220(1):69-80.

doi:10.1243/095441105X69141.

27. Rees JS. The effect of variation in occlusal loading on the development of abfraction lesions: a finite element study. *Journal of Oral Rehabilitation*. 2002;29(2):188-193. doi:10.1046/j.1365-2842.2002.00836.x.
28. Iosif L, Dimitriu B, Nițoi DF, Amza O. Endodontic Dentistry: Analysis of Dentinal Stress and Strain Development during Shaping of Curved Root Canals. *Healthcare*. 2023;11(22):2918. <https://doi.org/10.3390/healthcare11222918>.
29. Nohl FS, McCabe JF, Walls AWG. The effect of load angle on strains induced in maxillary premolars in vitro. *British Society of Dental Research Meeting*. 1999;Abstract p 200.
30. Spranger H. Investigation into the genesis of angular lesions at the cervical region of teeth. *Quintessence International*. 1995;26(2):149-154.
31. Benazzi S, Grosse IR, Gruppioni G, et al. Comparison of occlusal loading conditions in a lower second premolar using three-dimensional finite element analysis. *Clinical Oral Investigations*. 2014;18(2):369-375. <http://dx.doi.org/10.1007/s00784-013-0973-8>.
32. Bernhardt O, Gesch D, Schwahn C, et al. Epidemiological evaluation of the multifactorial etiology of abfractions. *Journal of Oral Rehabilitation*. 2006;33(1):17-25. <http://dx.doi.org/10.1111/j.1365-2842.2006.01532.x>.
33. Estafan A, Furnari PC, Goldstein G, Hittelman EL. In vivo correlation of noncarious cervical lesions and occlusal wear. *The Journal of Prosthetic Dentistry*. 2005;93(3):221-226. <http://dx.doi.org/10.1016/j.prosdent.2004.12.012>.
34. Miller N, Penaud J, Ambrosini P, et al. Analysis of etiologic factors and periodontal conditions involved with 309 abfractions. *Journal of Clinical Periodontology*. 2003;30(9):828-832. doi:10.1034/j.1600-051X.2003.00378.x.
35. Heymann HO. Future restorative needs in the light of tooth biodynamics. 1st International ESPE Dental Symposium. Munich, Germany, 1998.
36. Aw TC, Lepe X, Johnson GH & al (2002) Characteristics of noncarious cervical lesions: a clinical investigation. *The Journal of the American Dental Association* 133(6):725-733. <http://dx.doi.org/10.14219/jada.archive.2002.0268>
37. Reinhardt RA & Killeen AC (2015) Do Mobility and Occlusal Trauma Impact Periodontal Longevity? *Dental clinics of North America* 59(4): 873–883, <http://dx.doi.org/10.1016/j.cden.2015.06.003>
38. Nunn ME & Harrel SK (2001) The effect of occlusal discrepancies on periodontitis. I. Relationship of initial occlusal discrepancies to initial clinical parameters. *Journal of Periodontology* 72(4):485–494, <http://dx.doi.org/10.1902/jop.2001.72.4.485>
39. Harrel SK, Nunn ME & Hallmon WW (2006) Is there an association between occlusion and periodontal destruction? Yes—occlusal forces can contribute to periodontal destruction. *The journal of the American Dental Association* 137(10):1380-1394, <http://dx.doi.org/10.14219/jada.archive.2006.0049>
40. Harrel SK & Nunn ME (2001) The effect of occlusal discrepancies on periodontitis. II. Relationship of occlusal treatment to the progression of periodontal disease. *Journal of Periodontology* 72(4):495–505. <http://dx.doi.org/10.1902/jop.2001.72.4.495>
41. Harrel SK & Nunn ME (2009) The association of occlusal contacts with the presence of increased periodontal probing depth. *Journal of Clinical Periodontology* 36(12):1035–1042. <http://dx.doi.org/10.1111/j.1600-051X.2009.01486.x>
42. Bernhardt O, Gesch D, Look JO & al (2006) The influence of dynamic occlusal interferences on probing depth and attachment level: results of the Study of Health in Pomerania (SHIP). *Journal of*

*Periodontology* 77(3):506–516. <http://dx.doi.org/10.1902/jop.2006.050167>

43. Burgett FG, Ramfjord SP, Nissle RR & al (1992) A randomized trial of occlusal adjustment in the treatment of periodontitis patients. *Journal of Clinical Periodontology* 19(6):381–387, doi: 10.1111/j.1600-051X.1992.tb00666.x
44. Foz AM, Artese HP, Harolina AC & al (2012) Occlusal adjustment associated with periodontal therapy-A systematic review. *Journal of Dentistry* 40(12):1025-35. <http://dx.doi.org/10.1016/j.jdent.2012.09.002>