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Determinants of the Emergence of 'White Spots' and Tooth Hypersensitivity in Orthodontic Patients

▷ **Background.** Decalcification of the enamel, which manifests as "white-spot lesions" localized around fixed orthodontic appliances, is a serious issue during and after the orthodontic treatment. At a certain moment, this process can provoke painful sensations, aka sensitivity, which leads patients to experience physical and psychological discomfort.

This research aims to establish the determinants of the emergence of white-spot lesions and critical time limits during treatment with fixed orthodontic appliances.

Methods. To analyze the degree to which the teeth were impacted, our team examined 58 patients, ages 18–44, who were referred to the Dental Medical Center of the National Medical University of O. O. Bogomolets in the years 2023–2024 for alternating reasons, including the prospect of orthodontic treatment.

Results. White-spot lesions were detected in 53% of patients with fixed orthodontic appliances. They occur primarily on the buccal surface of teeth around brackets and archwire, especially in the area nearest to the gums. In particular, the labio-gingival region of the upper incisors and premolars is the most common place of appearance. The analysis of the frequency of white-spot lesion emergence depending on the time limits of the orthodontic treatment demonstrated that the most rapid spread of the damage is registered three months after its beginning (62%). This period is characterized by a significant increase in the average Oral Hygiene Index (OHI) value and intensifying painful sensations. The gradual decrease in these factors is observed after 6 months since the treatment was administered.

Conclusions. A sharp rise in the number of white-spot lesions and hyperesthesia in patients proves the conduction of critical evaluations of the oral cavity to be essential during the first three months of treatment with fixed orthodontic appliances. The crucial strategy in preventing the occurrence of white-spot lesions is to ensure that demineralization processes are absent, the biofilm is not being formed, and appropriate methodology is used to remineralize the damaged areas.

Keywords: *"white-spot" lesion, demineralization of the enamel, hyperesthesia, orthodontic treatment, prevention.*

Evidently, orthodontic treatment aims to improve the aesthetic appearance of teeth and the face. Patients with dental and maxillary anomalies' opinions on orthodontics vary in correlation to the aesthetic impact of the pathology, views on orthodontic correction, reasonably expected discomfort, and anticipated absence of pain during procedures.

Decalcification of the enamel, in the form of white-spot lesions on the surface of the tooth around the fixed appliance, can be a hindrance during and after fixed orthodontic treatment, considering that patients are strongly willing to see the objective improvement of their condition (Fig. 1) [1, 2]. Additionally, the process might involve painful sensations and hyperesthesia, which are undoubtedly uncomfortable for the patient both mentally and physically [12, 13].

Based on data from literary resources, the indicators of prevalence of occurrence of and predisposition to white-spot lesions (WSL) can be considered rather high in patients undergoing orthodontic treatment, and reach up to 46–68.4% [1–4]. On average, such decalcifications are discovered in 15,5–40% of patients before, and 30–70% during treatment [4–6, 10, 13].

White-spot lesions are areas of initial caries where superficial demineralization occurs under the undamaged layer of enamel. These areas reflect light differently from the healthy, normal enamel, resulting in a chalk-white spot—the "white-spot" lesion.

White-spot lesions found before the beginning of orthodontic treatment are interpreted as a risk factor for the development of new deterioration sites. Poor oral hygiene, excessive consumption of fermented carbohydrates, and sugary drinks all contribute to this (Fig. 2) [6, 7, 9, 12].

This research aimed to establish the determinants of the emergence of white-spot lesions and critical

Fig. 1. White-spot lesions around brackets

Fig. 2. White-spot lesions on the buccal surfaces of premolars

time limits during treatment with fixed orthodontic appliances.

Therefore, the determination of these risk factors, together with mechanisms of the demoralization control before and after the treatment, and preventative measures in the protocol regarding orthodontic patients, remains a relevant task.

Materials and Methods

To analyze the degree to which the teeth were impacted, our team examined 58 patients, ages 18–44, who were referred to the Dental Medical Center of the National Medical University of O. O. Bogomolets in the years 2023–2024 for alternating reasons, including the prospect of orthodontic treatment. Among them, 38 patients, 20 female and 18 — male (average age — 25.3 ± 8.3 years), underwent fixed orthodontic treatment. The control group included 20 people (10 female, 10 male) ages 18–44, with the average age being 23.7 ± 6.2 years, to whom removable orthodontic treatment was administered.

Patients with generalized somatic pathologies, large dental arch defects (multiple teeth absent in a row), generalized stage 2 and stage 3 periodontitis, distinct mental abnormalities, and alcohol and drug addictions were excluded from this research.

The level of oral hygiene was graded using the simplified Greene-Vermillion Index (OHI-S), whilst the Decayed/Missing/Filled Teeth (DMFT) Index was utilized to determine the condition of the teeth.

Additionally, our team implemented a visual analog scale (VAS) to collect data on painful sensations as responses to stimuli. Patients independently described their well-being on a scale of 1 to 4: 1 stood for no pain, 2 for minor pain, 3 for considerable pain, and 4 for intolerable pain.

Statistical analysis of the matter involved working with the *MedStar* analytical package. Information collected is demonstrated as Average Deviation (AD) ± Standard Deviation (SD) for continuous variables in the case of normal data distribution and median (25% quartile; 75% quartile) in the opposite case. Data distribution was checked using the Shapiro-Wilk criteria.

Student and Mann-Whitney criteria were used to compare groups studied by quantitative characteristics for qualitative characteristics—the χ^2 test. A probability value of $p < 0.05$ was considered statistically significant.

Results and their discussion

In 34 patients with fixed orthodontic appliances, caries was found; the average value of the DMFT Index equaled 8.84 ± 4.19.

In the control group, 17 participants (90%) had caries; the average DMFT Index value yielded a result of 4.95 ± 2.87, which was statistically noticeably lower ($p < 0.001$) than that of a group of patients undergoing orthodontic treatment (Table 1).

The average value of the Greene-Vermillion Index in patients to whom orthodontic treatment was administered amounted to 2.38 ± 0.23. On the contrary, in the control group, the value of it equaled 1.31 ± 0.16, which is statistically, undoubtedly, lower ($p < 0.01$), than in patients with fixed orthodontic appliances (Table 2).

In 20 patients (53%) treated using fixed orthodontic appliances, white-spot lesions were detected. In the control group, white-spot lesions were apparent in 5 patients (25%), which is statistically considerably lower ($p < 0.001$) than the main group, where fixed devices were implemented. White-spot lesions usually occur on the buccal surfaces of teeth around brackets and archwire, especially in the area nearest to gums. In particular, the labio-gingival region of the upper lateral incisors and premolars is the most common place of emergence (Fig. 3).

Fig. 3. White-spot lesions on upper lateral incisors

Table 1.

Indicators of the damage to the hard tissues of the teeth done by caries

Indicator	Patients with fixed orthodontic appliances (*n* = 38)	Patients who hadn't undergone orthodontic treatment (*n* = 20)	Level of significance of difference, *p*
Prevalence of caries (%)	90	85	< 0.001
Average DMFT Index Value	8.84 ± 4.19	4.95 ± 2.87	

Table 2.

The indicators of the level of oral hygiene

Indicator	Patients with fixed orthodontic appliances (*n* = 38)	Control group (Patients who hadn't undergone orthodontic treatment, *n* = 20)	Level of the significance of difference, p
Average value of the Greene-Vermillion Index	2.38 ± 0.23	1.31 ± 0.16	< 0.01

Table 3.

Indicators of the damage to the hard tissues of teeth done by white-spot lesions

Indicator (%)	Patients with fixed orthodontic appliances (*n* = 38)	Control group (Patients who hadn't undergone orthodontic treatment, *n* = 20)	Level of the significance of difference, *p*
Prevalence of white-spot lesions	53	25	< 0.001
Damage to upper incisors	28	15	
Damage to lower incisors	1	2	
Damage to upper premolars	40	32	
Damage to lower premolars	12	24	
Damage to upper molars	7	8	
Damage to lower molars	4	9	
Damage to upper canines	3	3	
Damage to lower canines	5	7	

Table 4.

Indicators of hyperesthesia

Indicator	Patients with fixed orthodontic appliances (*n* = 38)	Control group (Patients who hadn't undergone orthodontic treatment) (*n* = 20)	Level of the significance of difference, *p*
Average intensity of the painful sensations, expressed using a VAS	2.7 ± 0.21	1.3 ± 0.18	< 0.01

In the VAS questionnaire, 26 surveyed individuals complained about increased sensitivity of teeth. Based on the diagnostic tests involving streams of cold water or air and probing, the diagnosis of hyperesthesia was confirmed in 5 patients. In the control group, 6 patients complained about hypersensitivity of the hard tissues of teeth, whilst the respective diagnosis was established in 3 participants.

The objective analysis of the prevalence of white-spot lesions in correlation to time limits of the treatment with fixed orthodontic appliances elucidated that the biggest increase in deterioration of teeth was registered after three months of its duration (up to 62%). This period is characterized by a rapid elevation of the average value of the Oral Hygiene Index, followed by an upraise in the intensity of painful sensations and teeth sensitivity. Gradual decrease

Table 5.

Indicators of the level of damage during 18 months of treatment with fixed orthodontic appliances

Indicator	After 1 month	After 3 months	After 6 months	After 12 months	After 18 months	Level of the significance of difference, *p*
Prevalence of white-spot lesions (%)	26	62	51	36	25	< 0.01
Average value of the Greene-Vermillion Index	1.63 ± 0.16	3.28 ± 0.17	2.78 ± 0.23	2.38 ± 0.2	1.62 ± 0.16	< 0.01
Average intensity of painful sensations expressed using VAS	2.7 ± 0.21	2.9 ± 0.2	2.1 ± 0.16	1.8 ± 0.2	2.0 ± 0.21	< 0.01

of these factors is observed after 6 months since the start of the treatment (Table 5).

Evidently, the utilization of fixed orthodontic appliances hugely contributes to the decrease in the quality of oral hygiene, which, consequently, leads to decalcification of the enamel, formation of white-spot lesions, and hyperesthesia.

Conclusions

A precipitate elevation of the number of white-spot lesions and hyperesthesia in patients during the first three months of fixed orthodontic treatment proves the conduction of critical evaluations of the oral cavity to be essential during this period. The crucial strategy in preventing the occurrence of white-spot lesions is to ensure that demineralization processes are absent, the biofilm is not being formed, and appropriate methodology is used to remineralize the damaged areas.

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Детермінанти виникнення «білих плям» і надмірної чутливості зубів у ортодонтичних пацієнтів

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Резюме: Декальцинація емалі, що проявляється у вигляді білих плям навколо незнімної ортодонтичної апаратури, є серйозною проблемою під час і після незнімного ортодонтичного лікування. У певний момент цей процес може викликати виникнення больової реакції зубів — так званої чутливості, що викликає фізичний та психологічний дискомфорт у пацієнта.

Метою цього дослідження стало визначення детермінант виникнення «білих плям» та критичних термінів під час ортодонтичного лікування незнімною апаратурою.

Матеріали та методи. З метою проведення аналізу рівня ураження зубів «білими плямами» ми обстежили 58 пацієнтів віком від 18 до 44 років (38 осіб основної та 20 осіб контрольної групи), які звернулися до Стоматологічного медичного центру НМУ ім. О. О. Богомольця у 2023–2024 роках із різних причин, зокрема з метою ортодонтичного лікування.

Результати та їх обговорення. У 53 % пацієнтів з незнімною ортодонтичною апаратурою були виявлені «білі плями». БП зазвичай з'являються на щічній стороні зубів навколо брекетів, особливо в області ясен, причому лабіо-гінгівальна область верхніх бічних різців та премолярів є найбільш поширеною. Аналіз поширеності БП залежно від термінів лікування незнімною ортодонтичною апаратурою показав найбільше зростання кількості уражень через 3 місяці (до 62 %). В цей термін спостерігається значне збільшення середнього значення гігієнічного індексу та збільшується больова чутливість зубів. Поступове зменшення показників спостерігалося через 6 місяців від початку обстеження.

Висновки. Різке збільшення кількості БП та гіперестезії у пацієнтів, протягом перших 3 місяців лікування незнімною ортодонтичною апаратурою, свідчать про необхідність проводити критичні оцінки гігієни порожнини рота протягом перших 1–3-х місяців лікування. Найважливішою стратегією профілактики виникнення «білих плям» є запобігання демінералізації та утворенню біоплівки, а також використання методології для ремінералізації уражень.

Ключові слова: «білі плями», демінералізація емалі, гіперестезія, ортодонтичне лікування, профілактика.

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