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Assessment of the oral cavity condition in patients undergoing orthodontic treatment

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SUMMARY

The desensitizer creates a reliable hermitization of the dentine tubules and forms a film on the surface of the tooth, which prevents further erosion and destruction of dentine. Tokuyama Shield Force Plus has an instant desensitizing effect and reliably protects the tooth from further damage. In patients undergoing orthodontic treatment, due to the complexity of hygienic procedures, the processes of caries formation may be more active. The use of a desensitizer in such patients can significantly reduce the risk of developing this pathological condition.

Aims. Evaluation of the effect of desensitizer on the oral cavity condition in patients undergoing orthodontic treatment.

Materials and methods. The study involved 120 patients aged 18-30 years. Each patient underwent a general clinical and dental examination. The study participants were randomly divided into 4 equal groups depending on the bracket system and desensitizer used: group 1 - ceramic bracket systems without pretreatment of enamel with a desensitizer (n=30), group 2 – ceramic bracket systems with enamel desensitizer treatment (n=30), group 3 – metal bracket systems without the use of a desensitizer (n=30), group 4 – metal braces using a desensitizer (n=30).

The assessment of the oral cavity was carried out before treatment, 1, 3, 6 and 12 months after the start of orthodontic treatment. Universal Bond adhesive system (Tokuyama Dental), SHIELD FORCE PLUS desensitizer (Tokuyama Dental), double-curing adhesive fixing cement ESTECM PLUS (Tokuyama Dental) were used for gluing bracket systems.

Results. The presence of a desensitizer on the surface of the enamel of teeth does not affect the state of oral hygiene of patients undergoing orthodontic treatment. The desensitizer on the surface of the tooth enamel has caries-protective properties, and therefore can be used to prevent caries formation.

Conclusions. Despite the fact that in our study, the presence of a desensitizer on the enamel surface does not reduce the degree of oral hygiene, further studies are needed to assess the safety and effectiveness of its use.

KEYWORDS. Orthodontic treatment, desensitizer, enamel condition, oral hygiene.

CONFLICT OF INTEREST. The authors declare that there is no conflict of interest.

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Introduction.

The prophylactic use of varnishes to prevent caries lies in their ability to penetrate directly into the enamel demineralization zones and dentinal tubules [**Error! Reference source not found.**]. They overlap the mouths of the dentinal tubules, as a result of which the processes of further damage to the tooth enamel are suspended. Enamel becomes more resistant to the thermal, mechanical and chemical effects of food on the teeth, which significantly reduces the risk of caries. The physicochemical properties of varnishes depend on their composition. Hydroxyethyl methacrylate in their composition performs the function of dentin moisturizing, which reduces the bonding of collagen fibers and prevents their collapse. This drug has the ability to penetrate to a depth of 50 microns, filling the open channels of dentin with resinous substances.

Unfilled varnishes contain glutaraldehyde, which causes the formation of solid precipitates of protein compounds in the dentin tubules, and also prevents the growth of pathogenic microflora. However, it is classified as a toxic substance, and special care must be taken when working with preparations containing it, protecting oral tissues from direct contact with it. In this regard, there are a number of inconveniences in its use, which limits its use.

The Shield Force Plus by Tokuyama Dental has gained particular popularity. The drug is produced using a special three-dimensional technology (3D-SK technology) [**Error! Reference source not found.**]. This technology was first used in self-etching adhesives of the VII generation Bond Force. Shield Force Plus also contains phosphoric acid, nona, alcohol, water, Bis-GMA and other substances that improve the properties of these varnishes. The composition of fluorine is also involved in the processes of hybridization of dentin, preventing the processes of tissue erosion and the development of caries [**Error! Reference source not found.**].

The mechanism of action of Shield Force Plus has the effect of a "double block". Once on the surface of dentin, the drug enters into a chemical interaction with calcium in the hard tissues of the tooth [4]. As a result, chelate compounds are formed, which overlap the lumen of the dentinal tubules. As a result of polymer

bonds, heavy resinous cords are formed, which contribute to the additional sealing of the dentinal tubules. Due to the presence of Hema, the moisture content of dentin is maintained at the proper level, which allows the drug to penetrate deeper into the tubules [5]. A dense layer forms on the surface of the dentin, which stops the process of tooth erosion and destruction of tooth tissues [**Error! Reference source not found.**].

Sultanov R.R. et al. (2015) studied the effectiveness of the use of varnishes with orthodontics and found that the use of varnishes is the most effective and painless way to reduce tooth sensitivity at the stage of orthodontic treatment [**Error! Reference source not found.**].

Kilardzhieva E.B. et al. (2014) also considered the effectiveness of varnishes, and therefore studied various types of desensitizers used in dentistry to address issues of tooth hypersensitivity [**Error! Reference source not found.**]. The authors found that Shield Force Plus (Tokuyama Dental, Japan) has good performance among its competitors and can be used in dental patients.

Thus, patients on orthodontic treatment often face problems of dental hypersensitivity and caries formation. The physicochemical properties, as well as the mechanism of action of the drug Shield Force Plus make it possible to use it not only to reduce dental hypersensitivity, but also to prevent caries.

The purpose of the study is to evaluate the effect of varnish on oral health in patients undergoing orthodontic treatment.

Materials and methods:

The clinical study involved 120 patients aged 18 to 30 years. All patients underwent a general clinical examination. The diagnosis of dentofacial anomaly was made by a dental orthodontist.

Criteria for inclusion of patients in the study: availability of signed informed voluntary consent to participate in the study, compliance with age restrictions, availability of indications for treatment with braces, continuous dentition without partially removable dentures in the oral cavity. Criteria for non-inclusion in the study: non-compliance with the criteria for inclusion in the study.

After solving the issue of orthodontic treatment by random numbers, all patients are divided into 4 groups depending on the type of bracket system used and the presence/absence of tooth surface treatment with varnish (Table. 1):

Group No.	1	2	3	4
Material of bracket systems and varnish	Ceramic braces with varnish	Ceramic bracket systems without varnish	Metal braces with varnish	Metal bracket systems without varnish
Number of persons	30	30	30	30

To assess the state of the oral cavity in all study participants, the following was determined: DMF index, PMA index, PBI gum bleeding index, OHI-S oral hygiene index. The assessment was carried out before the start of orthodontic treatment and after 12 months. To determine the oral hygiene index according to Green-Vermilion IHR-U, the teeth were stained using “Dinal” tablets. Then, the teeth were examined for the presence of plaque and calculus. The DMF index was determined for each patient. The teeth were assessed in a specific sequence: from the 1st quadrant to the 4th from one tooth and interdental space to the adjacent one. The DMF index (caries, filling, removed) was determined as the sum of teeth with caries excluding the spot stage, filled and removed teeth. The papillary-marginal-alveolar index PMA allows to assess the extent and severity of gingivitis. The papillary bleeding index PBI (papilla bleeding index) allows to determine gum inflammation with high efficiency, and its implementation is not difficult and does not require much time. To assess the condition of the enamel after removing the braces, a macro photograph was taken with a camera (Magnum, Olympus, India Pvt., Ltd., New Delhi) at 20x magnification using the Adhesive Remnant Index (ARI) (adhesive residue index). Data collection and processing were carried out in the Microsoft Excel spreadsheet editor.

Results.

The results of the index assessment of the oral cavity before orthodontic treatment and after a year are presented in Table 2.

Table 2 – Summary table of indices for assessing the state of the oral cavity

Indicator	Without varnish				P	With varnish				P
	Ceramic		Metallic			Ceramic		Metallic		
Time, months	0	12	0	12		0	12	0	12	
OHI-S Index	1.5±0.25	1.7±0.45	1.6±0.41	1.8±0.41	0.3	1.5±0.12	1.6±0.36	1.4±0.47	1.5±0.46	0.2
PBI Index	1.8±0.84	1.1±1.03	1.8±1.02	1.0±0.09	0.8	1.9±0.89	0.9±1.02	1.7±0.83	0.9±1.05	0.3
DMF index	1.3±0.15	3.1±0.28	1.6±0.14	3.4±0.4	0.13	1.7±0.22	1.8±0.16	1.4±0.14	1.5±0.23	0.0012
PMA Index (%)	27.3±0.17	34.6±0.23	31.4±0.15	33.9±0.11	0.24	29.4±0.21	30.8±0.18	28.5±0.14	29.8±0.19	0.68
P	0.18	0.84	0.37	0.12		0.1	0.43	0.91	0.336	

As can be seen from the table, in the group of patients with ceramic bracket systems whose enamel was not treated with varnish, the average value of the oral hygiene index was 1.5 ± 0.25 . After 12 months from the beginning of orthodontic treatment, the average value of the index was 1.7 ± 0.45 ($p > 0.05$). In the group of metal bracket systems whose enamel was not treated with varnish, the OHI-S index was 1.6 ± 0.41 before the start of treatment. After 12 months, the index was calculated again, the average value was 1.8 ± 0.41 ($p > 0.05$). In this group, there was a slight increase in the average values of the oral hygiene index, but this was not statistically significant. As can be seen from the table, there is no statistically significant difference in the OHI-S indices between ceramic and metal bracket systems without the use of varnish, which indicates the homogeneity of the groups. In the group of ceramic bracket systems whose enamel was treated with varnish, the average value of the oral hygiene index before the start of the study was 1.5 ± 0.12 , after 12 months 1.6 ± 0.36 ($p = 0.003$). In the group of patients with metal bracket systems whose enamel was treated with varnish, the value of the oral hygiene index was 1.4 ± 0.47 before the start of treatment, after 12 months -

1.5±0.46 (p=0.014). The data in the table show that there is no statistically significant difference in the OHI-S indices between ceramic and metal bracket systems with the use of varnish, which indicates the homogeneity of the groups.

To evaluate the severity of gingival bleeding, the PBI index was determined for all participants in the study at each visit. The average value of this index before the start of the study in the group of patients with ceramic bracket systems whose enamel was not treated with varnish was 1.8±0.84. In the group of patients with metal bracket systems whose enamel was not treated with varnish, the average value of the bleeding index before the start of the study was 1.8±1.02, after 12 months 1.1±1.03 (p>0.05). In the group of patients with ceramic bracket systems whose enamel was treated with varnish, the average value of the bleeding index before the start of the study was 1.9±0.89, after 12 months - 0.9±1.02 (p=0.003). In the group of patients with metal bracket systems whose enamel was treated with varnish, the bleeding index was measured before the start of the study and the average value in the group was calculated. This indicator was 1.7±0.83 after 12 months, the average value of the PBI index was 0.9±1.05 (p=0.012).

Before the start of orthodontic treatment and after 12 months during treatment, the intensity of caries in the study participants was diagnosed. In the group of ceramic bracket systems without varnish, the DMF index before the start of the study was 1.3±0.15 on average, after 12 months the DMF index value was 3.1±0.28 (p=0.012). In the group of metal bracket systems not treated with varnish, the KPU index before the start of the study was 1.6±0.14 on average, after 12 months - 3.4±0.4 (p=0.009). There is a moderate statistically significant increase in the intensity of this indicator in both groups. In the group of ceramic bracket systems with varnish, the DMF index before the start of the study was 1.7±0.22 on average. After 12 months, the value of this index was 1.8±0.16 (p=0.003). In the group of patients with metal bracket systems with varnish, the DMF index before the start of the study was 1.4±0.14 on average. After 12 months, the average value of the DMF index was 1.5±0.23 (p=0.002). The lowest value of this index was observed in the

fourth group of patients who underwent treatment with ceramic braces installed using varnish. The highest DMF index was observed in the group of patients with ceramic braces installed without the use of varnish (3.4 ± 0.4 after 12 months from the start of treatment).

To assess the intensity of inflammation, all participants in the study were diagnosed with the papillary-marginal-alveolar index PMA. In the group of patients with ceramic bracket systems not treated with varnish, the value of this index before the start of the study was $27.3\% \pm 0.17\%$ on average. After 12 months, the average value of the PMA index was $34.6 \pm 0.23\%$ ($p > 0.05$), which indicates a moderate increase in the inflammation indicator in patients in this group. In the group of patients with metal bracket systems whose enamel was not treated with varnish, the average value of the PMA index before the start of the study was $31.4\% \pm 0.15\%$. After 12 months, the index value was 33.9 ± 0.11 ($p > 0.05$). In the group of patients with ceramic bracket systems treated with varnish, the PMA index value before the start of the study was $29.4\% \pm 0.21$ on average. After 12 months, the average value of the PMA index was 30.8 ± 0.18 ($p > 0.05$). There is no increase in the intensity of the inflammation indicator in this group. In the group of patients with metal bracket systems whose enamel was treated with varnish, the PMA index before the start of the study was $28.5\% \pm 0.14\%$ on average. After 12 months, the average value of the PMA index was 29.8 ± 0.19 ($p > 0.05$). There was no increase in the inflammation index in this group during the observation period. Thus, the PMA index values were determined 12 months after the start of treatment. In the first and third groups, where varnish was not used, the inflammation indicators in the long term were moderately higher. The lowest inflammation rates were found in the fourth group of study participants, where the average inflammation index values were 29.8 ± 0.19 after 12 months.

After removing the braces, the residual amount of adhesive ARI was assessed. The average ARI index values in all four groups did not differ significantly. Almost all participants in the study had a separation at the contact boundary of the bracket

fixing material and the tooth enamel. The results of the study are presented in Table 3.

Table 3 - Indicators of the residual amount of adhesive on the enamel surface of the study participants

Group No	Average ARI
1. Ceramic brackets without varnish	0,91±0,61
2. Metal brackets without varnish	0,58±0,76
3. Ceramic brackets with varnish	1,02±0,91
4. Metal brackets with varnish	0,81±0,83
P1-2	0,37
P1-3	0,51
P1-4	0,34
P2-3	0,85
P2-4	0,14
P3-4	0,16

There was no statistically significant difference between the groups ($p>0.05$). The residual adhesive index values on the tooth surface showed that the presence of varnish on the enamel surface did not reduce the adhesive properties of the bonding systems.

Discussion

Dewan H et al (2022) conducted a study that evaluated the effect of varnishes on enamel condition in patients on orthodontic treatment. The authors used Gluma, Shield Force Plus and Telio CS varnishes [**Error! Reference source not found.**]. It was found that the use of any of these three varnishes can successfully reduce the risks of developing dentin diseases of the tooth against the background of the installation of orthodontic structures, as well as increase the durability and strength of the connection.

Elizalde-Hernández A et al. (2022) studied the effect of varnishes on the state of enamel, and concluded that the use of varnishes plays a protective role on the state of enamel without affecting the adhesion strength of bracket systems [**Error! Reference source not found.**].

According to the results of previous studies, our study shows the role of varnishes in maintaining cavity hygiene in patients on orthodontic treatment. A statistically significant decrease in the DMF index was noted in patients with ceramic and metal bracket systems, the enamel surface of which was treated with varnish. The DMF index in the group of patients whose teeth surface was varnished was 1.8 ± 0.16 by the end of the study. The value of the DMF index in the group with ceramic bracket systems, the teeth surface of which was not varnished, was 3.1 ± 0.28 . In the group of patients with metal braces whose teeth surface was treated with varnish, the value of the DMF index by the end of the study was 1.5 ± 0.23 , $p = 0.003$, in the group without varnish treatment, its value by the end of the study was 3.4 ± 0.4 , $p = 0.006$. The values of the remaining indices in all four groups were statistically insignificant, $p > 0.05$.

When comparing the indices for assessing the state of the oral cavity of patients with metal and ceramic bracket systems, it was found that in the group of metal bracket systems installed with pretreatment of the tooth surface with varnish, the DMF index is statistically significantly higher. The DMF index in the group with ceramic bracket systems was 1.8 ± 0.16 by the end of the study, in the group with metal bracket systems - 1.5 ± 0.23 , $p = 0.001$. All other index values are clinically comparable.

The results obtained indicate that the use of varnishes significantly improves the condition of the oral cavity in patients on orthodontic treatment, which is confirmed by the index values in groups of patients with braces systems installed with the use of varnish.

Conclusion

Thus, the presence of varnish on the surface of the enamel of the teeth affects the state of oral hygiene of patients on orthodontic treatment. This study showed that

shield force plus has a caries inhibitory effect and its use in patients on orthodontic treatment significantly reduces the risk of developing this pathological process. The study showed a statistically significant caries-protective role of varnishes in patients treated with braces. Therefore, further studies are needed to assess the impact of varnishes on oral health in orthodontic patients.

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