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FEATURES OF DIRECT PHOTOCOMPOSITION RESTORATION OF TEETH WITH DIFFERENT ENAMEL CARIES RESISTANCE

Purpose of the study. The aim of the study was a clinical evaluation of direct restorations of chewing teeth with viable pulp, made of photocomposite at different times of acid etching of enamel, depending on the level of its caries resistance, which was evaluated by structural and functional acid resistance. **Research methods.** In 105 patients, 105 chewing teeth with Black Class I cavities direct recovery using a nanohybrid photocomposite was performed. In 38 patients of group I with high and medium structural and functional acid resistance of enamel and in 36 patients of group III with low and very low acid resistance, total etching of hard dental tissues was carried out for 15 seconds, in 31 patients of group II with high and medium acid resistance, enamel was etched for 30 seconds, dentin – 15 seconds. Recovery status was assessed according to criteria related to marginal discoloration, marginal adaptation and secondary caries. **Scientific novelty.** After 6 months, according to the criteria of «marginal discoloration», «marginal adaptation» and «secondary caries» in patients of group I, violations were found in 3 restorations (7.89%), in patients of group II – in 2 restorations (5.56%), in group III patients – in 4 recoveries (12.90%), in 12 months, violations were found, respectively, in 7 restorations (20%), in 2 (5.88%) and 11 restorations (40.74%). Secondary caries was diagnosed only in patients of group III, according to terms, in 1 (3.23%) and 3 restored teeth (11.11%). The total number of restorations with disorders in patients of group III at 12 months was 1.6 and 5.5 times higher than in patients of group I and II, while in patients of group I of recovery with disorders it was 3.5 times more than in patients of group II, in which the time of its etching was increased due to high or medium acid resistance of enamel. To reduce the risk of complications and prolong the duration of patients restorations with a high or medium level of structural and functional acid enamel resistance, the time of enamel acid etching should be increased to 30 seconds. In patients with a low or very low level of acid resistance, an examination of the restorations condition should be carried out every 6 months, special attention

should be paid to the secondary caries in the restored teeth diagnosis. **Conclusions.** When carrying out direct photocomposite teeth restoration, it is necessary to take into account caries resistance of enamel by structural and functional acid resistance and differentially approach the time of its etching.

Key words: teeth, enamel, caries resistance, etching, restoration, photocomposite material.

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ОСОБЛИВОСТІ ПРЯМОГО ФОТОКОМПОЗИЦІЙНОГО ВІДНОВЛЕННЯ ЗУБІВ З РІЗНОЮ КАРІЄСРЕЗИСТЕНТНІСТЮ ЕМАЛІ

Мета дослідження. Клінічна оцінка прямих реставрацій жувальних зубів з життєздатною пульпою, виконаних з фотокомпозиційного матеріалу за різного часу кислотного протравлення емалі, залежно від рівня її карієсрезистентності, яку оцінювали за структурно-функціональною кислотостійкістю. **Матеріали і методи дослідження.** У 105 пацієнтів наногібридним фотокомпозитом було проведено пряме відновлення 105 жувальних зубів з порожнинами I класу за Блеком. У 38 пацієнтів I групи з високою та середньою структурно-функціональною кислотостійкістю емалі та у 36 осіб III групи з низькою та дуже низькою кислотостійкістю тотальне протравлення твердих тканин зубів проводили 15 секунд, у 31 пацієнта II групи з високою та середньою кислотостійкістю емаль протравлювали 30 секунд, дентин – 15 секунд. Стан відновлень оцінювали за критеріями, які стосувалися крайового забарвлення, крайового прилягання та вторинного карієсу. **Наукова новизна.** Через 6 місяців за критеріями «крайове забарвлення», «крайове прилягання» та «вторинний карієс» у пацієнтів I групи порушення були виявлені у 3 реставраціях (7,89%), в осіб II групи – у 2 відновленнях (5,56%), у пацієнтів III групи – у 4 відновленнях (12,90%), у 12 місяців порушення встановлені, відповідно, у 7 відновленнях (20%), у 2 (5,88%) і 11 реставраціях (40,74%). Вторинний карієс був діагностований тільки в осіб III групи, відповідно до термінів, в 1 (3,23%) та 3 відновлених зубах (11,11%). Загальна кількість відновлень з порушеннями у пацієнтів III групи у 12 місяців була у 1,6 та 5,5 рази більшою, ніж у пацієнтів I та II групи, при цьому в осіб I групи відновлень з порушеннями було у 3,5 рази більше, ніж у пацієнтів II групи, в яких за високої або середньої кислотостійкості емалі час її

протравлення був збільшений. Для зниження ризику розвитку ускладнень і пролонгації термінів функціонування відновлень у пацієнтів з високим або середнім рівнем структурно-функціональної кислотостійкості емалі слід збільшити час кислотного протравлення емалі до 30 секунд. В осіб з низьким або дуже низьким рівнем кислотостійкості обмеження стану реставрації необхідно проводити кожні 6 місяців, особливу увагу слід приділяти діагностиці у відновлених зубах вторинного карієсу. **Висновки.** При проведенні прямого фотокомпозитного відновлення зубів необхідно враховувати карієсрезистентність емалі за структурно-функціональною кислотостійкістю та диференційовано підходити до часу її протравлення.

Ключові слова: зуби, емаль, карієсрезистентність, протравлення, відновлення, фотокомпозитний матеріал.

Problem statement. For direct restoration of teeth with carious lesions, modern restorative materials are widely used, among which the most common are photocomposites. The use of these innovative materials makes it possible to achieve new opportunities in restoring not only the anatomical and functional, but also the aesthetic characteristics of natural teeth [1, p. 234]. In the process of direct restoration of teeth using photocomposite materials, several important stages can be distinguished. One of these stages is the etching of enamel and dentin, which is carried out in order to increase the roughness of their surface, which, in turn, provides conditions for a strong adhesive connection and reliable fixation of materials [2, p. 210]. The etching of hard tissues and the use of various adhesive systems is a necessary measure, since photocomposites do not have independent adhesive properties [3, p. 12].

The depth of microdefects in hard tissues due to acid exposure depends on a number of factors, in particular, the concentration of acid and the time of its contact with hard tissues, the structure and composition of the enamel and dentin of the restored teeth, the age of patients, which, among others, determines the degree of mineralization of hard tissues, and so on. [2, p. 180, 4, p. 275]. Recently, these factors include dental fluid, which in the hard tissues of teeth with viable pulp is constantly moving in the direction from the pulp to the surface of the enamel at a certain speed [5, p. 117, 6, p. 31]. Researchers associate such centrifugal movement of dental fluid, which is controlled, in their opinion, by the degree of functional activity of the pulp, with enamel caries resistance, that is, its ability to withstand the action of cariogenic acid factors [6, p. 31]. Decisive in caries resistance of enamel is structural-functional acid resistance of enamel (SFARE).

Until now, when carrying out etching of tooth enamel with viable pulp, as one of the stages of direct

restoration with photocomposites, the individual level of its acid resistance was not taken into account. In all cases of direct restoration of teeth with carious cavities, standard accepted recommendations for etching time were followed, with variations only depending on the concentration of the acid agent used. However, it can be assumed that in patients with different levels of SFARE, the time of its acid etching to achieve the required depth of microdefects should be different. Insufficient strength of the adhesive bond, in turn, can affect the marginal adaptation of the restoration material to the enamel, the appearance of marginal discoloration, and the development of secondary caries.

Purpose of the study. The aim of the study was a clinical evaluation of direct restorations of chewing teeth with a viable pulp, made from a photocomposite at different times of acid etching of the enamel, depending on the level of its caries resistance, which was evaluated by structural and functional acid resistance.

Research methods. The study was conducted in the clinic of the Department of Dentistry № 1 of the Donetsk National Medical University. Inclusion criteria: outpatient dental patients aged 35 to 44 years, examined posterior teeth with viable pulp and Black class I carious cavities, diagnosis of acute and/or chronic media caries, intact maxillary central incisor. In total, 105 patients were examined, in whom 105 posterior teeth with Class I cavities according to Black were restored using the direct method using the universal light-curing nanohybrid restorative material Filtek Z550, 3M ESPE.

The study did not include patients in whom the studied chewing teeth had carious cavities and/or fillings on any surface other than the occlusal one, or they were previously endodontically treated, persons with complete or partial overlap of the vestibular surface of the upper central incisor with a restoration material, with artificial orthopedic or orthodontic appliances, patients with poor oral hygiene, periodontal pathology (periodontitis or periodontal disease), salivary gland disease, complete dentition, mental illness, including those associated with alcohol or drug use, cognitive impairment, recent myocardial infarction or stroke, patients with pregnancy or lactation, as well as if patients planned to leave during the observation period.

Before the study, the state of oral hygiene was determined in each patient according to the simplified Green-Vermillion index (OHI-S) and the level of SFARE of teeth according to the enamel resistance test (TER), the evaluation of the test results was

carried out according to an improved method using the computer software product "CompTER" [7, p. 18]. To do this, a digital intraoral photograph was taken in the "macro" mode, after which the program automatically determined the microdefect staining intensity in points.

Depending on the test indicators, all examined were divided into three groups. Groups I and II included, respectively, 38 (36.2% of the total number of examined) and 36 patients (34.3%), who had a high (TER score of 1-3 points) or an average (TER score of 4-5 points) SFARE level. The patients of these groups were restored, respectively, 38 (36.2%) and 36 chewing teeth (34.3%). Group III included 31 patients (29.5%) with a low (6-7 points) or very low (8-10 points) level of acid resistance, in these patients 31 teeth (29.5%) of the masticatory group were restored.

All patients underwent professional oral hygiene and selected the shades of the photocomposite material using the standard tooth color visual perception scale Vita classical A1-D4, VITA Zahnfabrik, in the presence of natural or artificial lighting. Then, infiltration or conduction anesthesia was performed and the working field was isolated with a rubber dam. The preparation of carious cavities in the chewing teeth of patients of all groups was carried out within healthy hard tissues with the formation of cavities for photocomposites, in accordance with the requirements [1, p. 235]. During the restoration was used adhesive system Adper Single Bond 2, 3M ESPE. Before its application in patients of groups I and III, a total etching of hard tissues on the bottom and walls of the cavities was performed using 35% phosphoric acid gel Scotchbond Universal Etchant, 3M ESPE, within 15 seconds. In patients of group II, enamel was etched for 30 seconds, dentine etched for 15 seconds. Restorative material Filtek Z550, 3M ESPE, for modeling the anatomical shape of the teeth, was introduced in portions with a thickness not exceeding 2 mm, and each layer was polymerized with a light flux of an LED photopolymerizer with a gradually increasing intensity of the light flux up to 1400 mW/cm² in the "soft start" mode for 20 seconds. Next, the restorations were finished and polished to give the restoration a "dry sheen".

The control examination of the restorations was performed the next day after the restoration, after 6 and 12 months. Restorations were assessed visually and instrumentally, using a dental mirror and a sharp angled probe, in accordance with modified criteria G. Ryge: marginal discoloration, marginal adaptation, secondary caries [8, p. 216]. According to the criteria "marginal discoloration" and "marginal adaptation",

marks were given from A to C or D. In case of an excellent state of restoration without violations, a grade A was recorded according to these criteria. If during the examination according to the criterion "marginal discoloration", a surface color change was detected at the border of the restoration material and enamel, such restoration deserved a rating of B; if the staining spread deeper towards the pulp, score C was recorded; if the defect reached the dentin or the base of the restoration - grade C; in case of partial absence of restoration material with exposure of the bottom of the cavity, a score of D was given. If, next to the restoration, signs of secondary caries were detected in the tooth, then its presence was ascertained and, with the consent of the patient, appropriate treatment was carried out.

The results of clinical studies were processed using the methods of variation statistics, calculation of average values and assessment of their reliability using a statistical software package for Microsoft Excel 2010. We took into account the absolute and relative indicators of the number of restorations without violations and with violations with certain estimates for each criterion.

Before the start of the study, informed voluntary consent was obtained from all patients for diagnostics, treatment, surgery and anesthesia (medical documentation – form № 003-6/o, approved by the Ministry of Health of Ukraine). The studies were approved by the Commission on Bioethics of the Donetsk National Medical University, they were carried out in accordance with the principles of the Declaration of Helsinki adopted by the General Assembly of the World Medical Association (1997-2000), the Council of Europe Convention on Human Rights and Biomedicine (1997) and the legislation of Ukraine. The results of the examination were recorded in the medical records of the dental patient (medical documentation – form № 043/o, approved by the Ministry of Health of Ukraine).

Research results and their discussion. Before the restoration of teeth in patients of all three studied groups, oral hygiene in terms of the OHI-S index was satisfactory, and the corresponding indicators did not differ significantly ($p > 0.05$) from each other – 1.48 ± 0.10 points, 1.33 ± 0.08 points and 1.35 ± 0.09 points, in accordance with the ordinal numbering of the groups. The indicators of SFARE of teeth according to TER in patients of groups I and II also did not differ significantly ($p > 0.05$) and amounted to 3.04 ± 0.09 points and 3.12 ± 0.07 points, respectively. Significantly ($p < 0.05$), this indicator was worse in patients of group III – 7.36 ± 0.12 points.

The examination of the restorations, which was carried out the day after they were carried out, showed that all 105 restorations (100%) in the persons of the three groups had no violations, therefore, they were rated with the highest grade A.

After 6 months, a follow-up examination was carried out, in which 105 restorations (100%) were again examined, i.e. the same number as at the beginning of the study. In patients of group I, only in 1 restoration ($2.63 \pm 2.60\%$ of the number of restorations in patients of this group) a complication was found according to the criterion "marginal discoloration". This damage was superficial, localized within the enamel, so this restoration was rated B. All the remaining 37 restorations ($97.37 \pm 2.60\%$) had no marginal staining, as a result of which they received an A rating. The same evaluation according to the criterion "marginal adaptation" in patients of this group received 35 restorations ($92.11 \pm 4.37\%$), no violations were detected in them. In 3 restorations ($7.89 \pm 4.37\%$), a marginal gap was found between the material and enamel without dentin exposure, which corresponds to the assessment of B.

In patients of group II, the results of the study according to the criteria "marginal discoloration" and "marginal adaptation" were similar to those of persons in group I. Only 1 ($2.78 \pm 2.74\%$ of the number of restorations in the examined patients of this group) and 2 restorations ($5.56 \pm 3.82\%$), respectively, received a grade B according to these criteria. All violations were within the enamel. Grade A, which means the absence of any violations, was given to 35 ($97.22 \pm 2.74\%$) and 34 restorations ($94.44 \pm 3.82\%$), respectively. There were no cases of secondary caries in patients of groups I and II. During this period, only 4 complications were found in patients of group I, and 3 in patients of group II.

Most of all violations according to the studied criteria after 6 months were detected in the restorations of patients of group III, there were, in particular, 7. Grade B, which corresponds to marginal discoloration along the perimeter of the restoration with a depth within the enamel, was set to 1 restoration ($3.23 \pm 3.17\%$ of the number of works in this group). In another 1 restoration ($3.23 \pm 3.17\%$), discoloration extended along the margin of the material in the direction of the pulp, such a violation deserved a C score. No marginal discoloration was detected in 29 performed works ($93.55 \pm 4.41\%$), all of them received an A grade. The marginal adaptation of the material to the enamel was impaired in a total of 4 restorations ($12.90 \pm 6.02\%$), and in 3 restorations ($9.68 \pm 5.31\%$) the violations were localized to

enamel-dentinal border (grade B), in 1 restoration ($3.23 \pm 3.17\%$) the defect deepened into the dentin (grade C). 27 restorations ($87.10 \pm 6.02\%$) without violations received an A rating according to the "marginal adaptation" criteria.

It should be noted that it was in patients of this group that signs of secondary caries were recorded in 1 restored tooth ($3.23 \pm 3.17\%$) after 6 months. Accordingly, 30 patients ($96.77 \pm 3.17\%$) did not have secondary caries.

In general, within 6 months in patients of all studied groups, 14 complications were detected in 9 restorations (8.57% of the total number of restorations), including in patients of group I in 3 restorations (7.89% of the number of works in patients of this group), in patients of group II in 2 restorations (5.56% of the number of restorations in individuals of this group), in patients of group III in 4 restorations (12.90% of the number of restorations of patients in this group). Such quantitative indicators are explained by the fact that in one restoration, not one, but two or more violations were often detected. Patients whose restored teeth were found to have any abnormalities according to these criteria were excluded from further study. With their consent, corrections or replacements of the damaged restorations were carried out.

After 12 months, 96 patients (91.4% of the initial total number) were examined, among which there were 35 people in group I (92.1% of the initial number), in group II – 34 people (94.4%), in group III – 27 patients (87.1%).

Examination of the restorations showed that in patients of group I, according to the criteria "marginal discoloration", 32 restorations ($91.43 \pm 4.37\%$ of the number of restorations in the persons of this group in this period) were in excellent condition and received the highest grade A. In 2 restorations ($5.71 \pm 3.92\%$), discoloration was detected at the border of the photocomposite – enamel, for which they were rated B, another 1 work ($2.86 \pm 2.82\%$) was rated C due to the fact that the discoloration extended deeper into the dentin, i.e. with marginal discoloration, there were a total of 3 restorations ($8.57 \pm 4.73\%$). The number of restorations with a violation of the marginal adaptation of the material to the enamel during this period increased to 6 ($17.14 \pm 6.37\%$), among them in 4 works ($11.43 \pm 5.38\%$) the defects were within the enamel, in 2 restorations ($5.71 \pm 3.92\%$) the disorders deepened into the dentin, for which the restorations, respectively, received grades B and C. At the same time, 29 restorations ($82.8 \pm 6.37\%$) were without violations, therefore they received an A grade.

In patients of group II, after 12 months, 32 restorations (92.14±4.04% of the number of examined restorations in a given period) were in excellent condition according to the criteria "marginal discoloration" and corresponded to grade A, grade B was received by 2 works (5.88±4.04%). Violation of the marginal adaptation of the material was found only in 1 restoration (2.94±2.90%). All the remaining 33 restorations (97.06±2.90%) corresponded to the highest grade A. There were no cases of secondary caries in patients of the first two groups, as in the previous study period. In general, in patients of groups I and II, 9 and 3 complications were found, respectively.

In persons of group III, the situation according to all the studied criteria was worse. In 4 restorations (14.81±6.84% of the number of restorations in this period), marginal discoloration was detected, and in 3 restorations (11.11±6.05%) the discoloration was localized within the enamel, in 1 restoration (3.70±3.63%) it went deep into the dentin, which corresponded to grades B and C. Grade A was given to 23 restorations (85.19±6.84%). The marginal adaptation of the material within the enamel was broken in 4 restorations (14.81±6.84%), this corresponds to grade B, in 1 restoration (3.70±3.63%) the defect extended beyond the enamel-dentin border, this is the grade C, 1 more restoration (3.70±3.63%) turned out to be partially missing, the defect deepened almost to the bottom of the cavity, for which the restoration was rated D. In general, violations according to the "marginal adaptation" criteria were found in 6 restorations (22.22±8.00%). Excellent marginal adaptation was retained by 21 restorations (77.78±8.00%) with an A grade.

Secondary caries was diagnosed in 3 restored teeth (11.11±6.05%) of patients in this group, and no signs of secondary caries were found in 24 restored teeth (88.89±6.05%). According to all the studied criteria, patients in this group had 13 disorders.

After 12 months, according to the studied criteria, in general, 25 violations were found in 20 restorations (20.83% of the number of restorations in this period), among them, in particular, violations in patients of group I were in 7 restorations (20% of the number of restorations in persons of this group during this period), in the examined group II – in 2 restorations (5.88% of the corresponding number), in patients of group III – in 11 restorations (40.74% of the number of restorations in persons of this group), that is, the number of restorations with disorders was the largest in patients of group III.

Thus, despite numerous attempts to increase the effectiveness of direct restoration of teeth

with photocomposite materials by modifying the design of carious cavities, optimizing the adhesive technique, light polymerization of materials, and so on, the number of complications remains quite high [9, p. 387, 10, p. 205]. Thus, after 1 year, violations of the marginal adaptation of restorative materials are found in 57.4±6.7% of restorations, secondary caries – in 22.2±5.7% of restored teeth [11, p. 25].

The study showed that the marginal adaptation of the photocomposite material and marginal discoloration, as well as the development of secondary caries in the restored teeth, are in a certain way related to the initial level of caries resistance, which reflects the structural and functional acid resistance of the enamel. This is confirmed by the total number of disorders in patients of group III according to clinical criteria directly related to marginal adaptation and marginal discoloration, which at 6 months was 1,7 and 2,3 times higher than similar indicators in patients of groups I and II, respectively. In the period of 12 months, the number of violations according to the specified criteria in the restorations of patients of group III, compared with the other two, was also greater by 1,4 and 4,3 times, respectively. Particularly convincing are the results regarding secondary caries, which during the entire study period was registered only in the restored teeth of patients of group III, which is a consequence of the corresponding low or very low initial level of SFARE. The most important result of the study is that after 12 months, the total number of violations according to the relevant criteria in patients of group I turned out to be 3 times more than in patients of group II, in whom, in the presence of a high or medium level of SFARE, the enamel etching time was increased to 30 seconds. A differentiated approach to determining the enamel etching time depending on its acid resistance will reduce the risk of complications and extend the life of direct restorations of teeth from photocomposite materials.

Conclusions. When conducting direct photocomposite restoration of teeth using total etching of hard tissues prior to applying the adhesive system, it is necessary to take into account caries resistance of enamel, which is determined by its structural and functional acid resistance. In patients with a high or medium level of structural and functional acid resistance of the enamel, the acid etching time of the enamel should be increased to 30 seconds. In persons with low or very low levels of acid resistance, follow-up examinations of the condition of direct restorations should be carried out every 6 months, with particular attention to the diagnosis of secondary caries in the restored teeth.

Bibliography:

1. Jing Xue Factors influencing clinical application of bulk-fill composite resin. *Hua Xi Kou Qiang Yi Xue Za Zhi*. 2020. Jun 1;38(3). P. 233-239. doi: 10.7518/hxkq.2020.03.001. PMID: 32573127 PMID: PMC7296366.
2. Zafar MS, Ahmed N. The effects of acid etching time on surface mechanical properties of dental hard tissues. *Dent Mater J*. 2015. 34(3). P. 315-20. doi: 10.4012/dmj.2014-083. Epub 2015 Apr 23. PMID: 25904167.
3. Sofan E, Sofan A, Palaia G, Tenore G, Romeo U, Migliau G. Classification review of dental adhesive systems: from the IV generation to the universal type. *Ann Stomatol (Roma)*. 2017. Jul 3;8(1). P. 1-17. doi: 10.11138/ads/2017.8.1.001. PMID: 28736601; PMID: PMC5507161.
4. Campos M.F.T.P, Moura D.M.D., Borges B.C.D., Assuncao I.V., Caldas M.R.G.R., Platt J.A., Özcan M, Souza R.O.A.E. Influence of Acid Etching and Universal Adhesives on the Bond Strength to Dentin. *Braz Dent J*. 2020. Jun 31(3). P. 272-280. doi: 10.1590/0103-6440202002884. Epub 2020 Jul 13. PMID: 32667522.
5. Tanapitchpong R., Chunchacheevachaloke E., Ajcharanukul O. In vivo and in vitro study of enamel fluid flow in human premolars. *Arch Oral Biol*. 2020. Sep. P. 117:104795. doi: 10.1016/j.archoralbio.2020.104795. Epub 2020 Jun 6. PMID: 32540555.
6. Ajcharanukul O. Effect of the pulpal hydrostatic pressure on the morphological data of the fluid droplets emerging from dental enamel in human teeth. *Data Brief*. 2020. Jun 20. P. 31:105901. doi: 10.1016/j.dib.2020.105901. PMID: 32676525; PMID: PMC7352052.
7. Удод О. А., Сироткіна О. В. Сучасні погляди на прогнозування карієсу зубів. *Вісник проблем біології і медицини*. 2012. Вип. 3, том 1 (94). С. 18-22.
8. Schmalz G., Ryge G. Reprint of Criteria for the clinical evaluation of dental restorative materials. *Clin Oral Invest*. 2005. 9. P. 215-232. <https://doi.org/10.1007/s00784-005-0018-z>.
9. Chandrasekhar V., Rudrapati L., Badami V., Tummala M. Incremental techniques in direct composite restoration. *J Conserv Dent*. 2017. Nov-Dec 20(6). P. 386-391. doi: 10.4103/JCD.JCD_157_16. PMID: 29430088; PMID: PMC5799982.
10. Uzey Koc Vural, Arlin Kiremitçi, Saadet Gökalp Clinical Performance and Epidemiologic Aspects of Fractured Anterior Teeth Restored with a Composite Resin: A Two-Year Clinical Study. *J Prosthodont*. 2019. Jan 28(1). P. 204-209. doi: 10.1111/jopr.12645. PMID: 2896076.
11. Ожоган І. А., Герелюк В. І., Ожоган З. Р. Аналіз експертної оцінки реставрацій бічних зубів. *Український стоматологічний альманах*. 2014. № 4. С. 25.

References:

1. Jing, Xue (2020). Factors influencing clinical application of bulk-fill composite resin. *Hua Xi Kou Qiang Yi Xue Za Zhi*, 1;38(3), 233-239. doi: 10.7518/hxkq.2020.03.001. PMID: 32573127 PMID: PMC7296366.
2. Zafar, M.S., & Ahmed, N. (2015). The effects of acid etching time on surface mechanical properties of dental hard tissues. *Dent Mater J*, 34(3), 315-20. doi: 10.4012/dmj.2014-083.
3. Sofan, E., Sofan, A., Palaia, G., Tenore, G., Romeo, U., & Migliau, G. (2017). Classification review of dental adhesive systems: from the IV generation to the universal type. *Ann Stomatol (Roma)*, 3, 8(1), 1-17. doi: 10.11138/ads/2017.8.1.001.
4. Campos, M.F.T.P, Moura, D.M.D., Borges, B.C.D., Assuncao, I.V., Caldas, M.R.G.R., Platt, J.A., Özcan, M, & Souza R.O.A.E. (2020). Influence of Acid Etching and Universal Adhesives on the Bond Strength to Dentin. *Braz Dent J*, 31(3), 272-280. doi: 10.1590/0103-6440202002884.
5. Tanapitchpong, R., Chunchacheevachaloke, E., & Ajcharanukul, O. (2020). In vivo and in vitro study of enamel fluid flow in human premolars. *Arch Oral Biol*, 117:104795. doi: 10.1016/j.archoralbio.2020.104795.
6. Ajcharanukul, O. (2020). Effect of the pulpal hydrostatic pressure on the morphological data of the fluid droplets emerging from dental enamel in human teeth. *Data Brief*, 31, 105901. doi: 10.1016/j.dib.2020.105901.
7. Udod, O. A., & Sirotkina, O. V. (2012) Suchasni poglyadi na prognozuvannya kariesu zubiv [Modern views on predicting dental caries] *Visnik problem biologii i medicini – Bulletin of problems of biology and medicine*, 3 (94), 18-22 [in Ukrainian].
8. Schmalz G., & Ryge G. (2005). Reprint of Criteria for the clinical evaluation of dental restorative materials. *Clin Oral Invest*, 9. 215-232. <https://doi.org/10.1007/s00784-005-0018-z>.
9. Chandrasekhar, V., Rudrapati, L., Badami, V., & Tummala, M. (2017). Incremental techniques in direct composite restoration. *J Conserv Dent*, 20(6), 386-391. doi: 10.4103/JCD.JCD_157_16.
10. Uzey Koc Vural, Arlin Kiremitçi, & Saadet Gökalp (2019). Clinical Performance and Epidemiologic Aspects of Fractured Anterior Teeth Restored with a Composite Resin: A Two-Year Clinical Study. *J Prosthodont*, 28(1), 204-209. doi: 10.1111/jopr.12645.
11. Ozhogan, I. A., Gerelyuk, V. I., & Ozhogan, Z. R. (2014) Analiz ekspertnoi ocinki restavracij bichnih zubiv [Analysis of expert evaluation of lateral tooth restorations] *Ukrains'kij stomatologichnij al'manah – Ukrainian dental Almanac*, 4, 25 [in Ukrainian].