CLINICAL STUDY OF CERVICAL CARIES TREATMENT THE EFFECTIVENESS BY ASSESSING COMPOSITE RESTORATIONS CONDITION

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ABSTRACT

Background. Cervical caries is a fairly common teeth pathology and its treatment is carried out in complicated clinical conditions. Therefore, increasing the term of functioning of composite restorations is an urgent task.

Aim. Identification of the effectiveness of a differential approach to dissection of hard dental tissues depending on the depth of enamel microcracks and implementation of professional hygiene in the treatment of cervical caries in the short- and long-term periods.

Materials & Methods. The study involved 50 people (average age [23.28±5.52] years) in whom cervical caries was treated in 72 teeth. All patients were divided into three equal groups based on the number of restorations according to the selected dissection technique and the characteristics of professional hygiene. The dissection technique depended on the depth of the enamel microcracks in Main Group I (MG I), the dissection was carried out within the limits of clinically intact hard dental tissues in Control Group (CG) and Main Group II (MG II). The dental biofilm was removed from the vestibular surface of the teeth by the method of air-abrasive cleaning using the erythritol-based powder in MG I and MG II, the vestibular surface of the tooth was cleaned of dental deposits with a polishing paste without fluoride in CG. The quality of restorations was assessed based on the United States Public Health Service (USPHS) criteria on the day of restoration, 6 and 12 months later. The effectiveness of the prescribed treatment was identified by the dynamic indicators of the dental pulp electroexcitability and the electrical conductivity of the enamel.

Results. There were no partial or completely destroyed restorations in all terms of the observation period. Composite restorations were preserved according to the criteria of "anatomical shape" and "color matching". One year later restoration defects were absent in 61 teeth (84.72%): in MG I – in 22 (91.67%), in CG – in 19 (79.17%), in MG II – in 20 (83.33%). Recurrent caries and symptoms of hypersensitivity were not identified in MG I. A slightly greater effectiveness of the treatment was noted in MG II group in comparison with CG (by 4.16%) that confirms the importance of removing the dental biofilm before restoration by the method of air-abrasive cleaning using erythritol.

Conclusions. The analysis of the state of restorations in the long-term period showed that the dissection technique and the features of professional hygiene affected their quality before restoration. The number of high-quality composite restorations was by 10.42% more on average in MG I than in the other groups. The obtained results make it possible to recommend the proposed method for using in practical dentistry.

Keywords: *electroodontology, electroodontometry, microcracks.*

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INTRODUCTION

Dental caries remains an unsolved contemporary problem despite scientific achievements [1]. The absence of its timely and, most importantly, high-quality treatment can lead to development of complicated forms, loss of teeth and development of systemic diseases. All this reduces the quality of life of the population and turns the problem of

dental caries into a general medical problem [2–4]. The most vulnerable and prone area to pathological changes is the cervical part of the teeth [4]. It can be explained by many factors but primarily by its structural features [2].

Numerous scientists pay attention to the problem of tooth restoration with Cervical Caries (CC) that has not been fully resolved yet [4]. From the point of view of retention and isolation from moisture invasive treatment of CC occurs in complicated clinical conditions [3]. All this can cause aesthetic problems, development of clinical symptoms of dentine hypersensitivity and it can significantly shorten the period of restoration functioning [3]. Thus, according to data [3], the average term of functioning of such restorations is slightly more than 3 years that is significantly less than for restorations of other localizations. This indicator for restoration does not reliably differ from glass ionomer cements and composite materials [5]. In contrast to durability, the clinical effectiveness of composite restorations is higher than with glass ionomers by the criteria of retention, marginal color change and marginal adaptation, but it is similar to recurrent caries, abrasion and development of hypersensitivity [5]. Although it is known that subgingival regions of composites contribute to increased accumulation of dental biofilm and they cause gingival irritation [6]. But taking into account patients' aesthetic requirements light-curing materials are more often used for direct restorations of CC [3; 6]. In addition, these filling materials also attract doctors owing to the possibility of minimal dissection of hard dental tissues without taking into account biomechanical and functional requirements [7]. Short-term preservation of restorations leads to repeated surgical interventions, loss of intact tissues and the dentist's additional time [8]. Therefore, the problem of improving the effectiveness of treating CC remains relevant having general medical and social importance for preserving the health and quality of life of the population, and it requires further research [1].

Today there are no objective criteria, the compliance of which would allow us to consistently achieve success in the invasive treatment of CC. In our opinion, which is also shared by Peumans M. et al. [9], such a criterion can be the state of hard dental tissues and the method of their preparation for restoration. The results of modern research demonstrate a high prevalence of microcracks in the enamel of permanent teeth which reaches almost one hundred percent on the vestibular surface [10]. The development of cracks is associated with many reasons, one of which is the structural features of the cervical region of the teeth [10; 11]. The danger of their presence is in the fact that they can be the ways of penetration of microorganisms that can cause the development of other pathologies including the carious process and hypersensitivity of the dentin [10]. Thus, underestimation of the factor of the presence and depth of enamel cracks can lead to a violation of the marginal fit of restoration, its partial or complete destruction and, therefore, a decrease in the quality of treatment [9]. The authors offered a method of treating CC which involves a differential approach to advanced dissection of hard tissues depending on the depth of enamel microcracks on the vestibular surface of the teeth [9].

Aim. Identification of the effectiveness of the proposed differential approach to dissection of hard dental tissues depending on the depth of enamel microcracks on the vestibular surface and implementation of professional hygiene in treating CC in young patients in the near and long-term periods.

Materials & Methods

The study involved 50 patients (30 women, 20 men) treated at the Department of Dentistry No.2 of Donetsk National Medical University. The selection criteria were young age according to the WHO classification (2017), absence of bad habits, pregnancy and lactation period, neoplasms, peculiarities of the household and work history, diagnosed CC, good oral hygiene condition; the obtained written consent to participate in the study. The number of CCs in one patient was from one to four. 72 teeth of frontal and lateral groups with viable pulp were treated under the same clinical conditions, rubber dam and retraction thread were used for isolation.

The examined patients were divided into three equal groups based on the number of restorations according to the principle of randomness depending on the technique of dissection of hard dental tissues and the characteristics of professional hygiene before restoration: Main Group I (MG I) (16 patients), Control Group (CG) (15 patients) and Main Group II (MG II) (19 patients). The formed groups did not differ in age (average age [23.28±±5.52] years), sex, level of oral hygiene (according to the Oral Hygiene Index-Simplified (OHI-S) (Green-Vermillion, 1964) [0.56±0.40] points), Decayed, Missing and Filled Teeth (DMFT) indices (10.24±4.66), Papillary-Marginal-Alveolar index (PMA) (Parma, 1960) [20.18±17.81]%, pH of oral fluid [6.65±0.51], ($p>0.05$) [12].

According to the proposed method a differential approach to dissection technique of hard dental tissues was used depending on the depth of enamel microcracks in the MG I [9]. If microcracks were diagnosed on the vestibular surface of the tooth with the naked eye under normal lighting, prophylactic dissection of hard tissues, which reached 1.5–2.0 mm, was carried out on the periodontal wall of the carious defect, and on the occlusal wall – on 0.5–1.0 mm. If there were enamel microcracks on the vestibular surface of the tooth, which were identified with the help of additional illumination or magnification or with the use of coloring substances, preventive dissection of hard tissues was carried out on the occlusal wall of the carious defect by 1.5–2.0 mm, and on the periodontal wall – by 0.5–1.0 mm [9]. Dissection was made within clinically intact hard tissues of the teeth in CG and MG II. The gingival wall of CC was located above or at the level of the gingival margin in all restorations.

Preparation of the teeth for restoration included professional hygiene that depended on the observation group. The dental biofilm was removed from the vestibular surface of the teeth by the method of air-abrasive cleaning with AIR-FLOW device using the erythritol-based powder Air-Flow®Plus (EMS, Switzerland) in MG I and MG II [10]. The vestibular surface of the tooth was thoroughly cleaned of dental deposits with the help of polishing paste without fluorine Cleanic (Kerr, USA) in CG. The teeth were washed with water and dried after professional hygiene. Medical treatment of the formed cavities was carried out with a 2% aqueous solution of chlorhexidine bigluconate. The adhesive system of total etching of the 5th generation (AdperTM Single Bond 2 [3M ESPE]) and the light-hardening microhybrid composite material Filtek Z-250 (3M ESPE) were used in accordance with the manufacturer's recommendations. Microhybrid composites are currently effective materials due to their chemical and physical characteristics [13]. The method of "impulse" polymerization was chosen that has certain advantages. Final grinding and polishing was performed using Sof-lex discs (3M ESPE, St Paul, Mn, USA), the effectiveness of which was experimentally proven by modern investigations [14].

The assessment of the quality of composite restorations was carried out at least 30 minutes later after their final processing and in the long-term periods (6 and 12 months later). The clinical examinations included interviews, history taking, visual and instrumental examination of restorations according to the modified United States Public Health Service (USPHS) quality criteria: anatomical shape, marginal adaptation, surface roughness, marginal staining, color matching, discomfort/sensitivity, presence of recurrent caries. The effectiveness of the prescribed treatment was identified by the dynamics of indicators of the electroexcitability of the dental pulp (the method of ElectroODontometry (EOD) using the electroodontometer EOT-01 [OSP 1.1 MODIS, Averon]) and the electrical conductivity of the enamel at the tooth-restoration boundary (the method of electrometry (EOM) using the "DentEst" device ["Geosoft Dent"]) and the greatest value [10] was taken into account. The marginal staining of restorations was detected using Schiller-Pysarev solution.

Statistical analysis was performed using Microsoft Office Excel spreads heet editor and Wolfram Alpha online calculator. The correspondence of quantitative indicators to a normal distribution was assessed with the help of Shapiro-Wilk test. After confirming the normality of the distribution with the use of Excel ver. 2312 (Microsoft, USA), Wolfram Alpha was applied for further analysis in order to identify the reliability of differences between the groups according to the studied indicators. When comparing average indicators in normally distributed populations, Student's t-test was calculated. Differences at $p \leq 0.05$ were considered statistically significant.

Results

The observation groups did not differ reliably before treatment and after restoration of CC according to the objective criteria, $p>0.05$ (*Tables 1, 2*). The best results were obtained immediately after treatment. Restorations met aesthetic quality criteria. The complaints about the sensitivity of the teeth due to the irritant effects were absent that was confirmed by EOM and EOD indicators.

A slight reliable decrease in the average EOD indicators and an increase in EOM were determined in all groups 6 months later. Restoration defects were also diagnosed according to clinical criteria. The differences between EOM indicators were greater (by 3.6%, $p=0.0015$) in CG 6 months later after treatment and on the day of restoration than in MG I and MG II (by 2.3%, $p=0.012$ and by 2.8%, $p=0.0058$, respectively). The difference between the average indicators of CC in MG I and CG was significant ($p=0.05$). There were no differences between MG II and MG I and CG ($p=0.19$ and $p=0.18$, respectively). The complaints were absent in MG I, but during the electrometric

Table 1. Electrometric assessment of the quality of marginal fit of restorations at different periods of observation (indicator of marginal permeability, μA) (M±m)

Terms of the observation period	Observation groups		
	Main I	Control	Main II
On the day of restoration	0.087±0.074	0.117±0.076	0.108±0.078
6 months later	0.283±0.393*	0.546±0.634*	0.412±0.538*
12 months later	0.571±0.509**	1.045±1.465*	0.887±1.081**

Notes: * – significant differences in comparison with OEM indicators on the day of restoration (p≤0.05);
** – significant differences compared to OEM indicators 6 months later after restoration (p≤0.05).

Table 2. EOD indicators of teeth at different periods of observation (μA) (M±m)

Terms of the observation period	Observation groups		
	Main I	Control	Main II
On the day of restoration	6.75±0.53	6.54±0.51	6.67±0.48
6 months later	6.45±0.51*	6.08±0.50*	6.29±0.48*
12 months later	6.08±0.28**	5.75±0.44**	5.91±0.28**

Notes: * – significant differences in comparison with EOD indicators on the day of restoration (p≤0.05);
** – significant differences compared to EOD indicators 6 months later after restoration (p≤0.05).

assessment of restorations in one tooth (4.2%), the marginal fit had the signs of an initial integrity violation (EOM 2.1μA). In CG there was an increase of EOM up to 2.1–2.2 μA in three teeth (12.5%), in MG II – in two teeth (8.3%) that corresponded to a violation of the marginal fit of restorations.

EOD indicators of the teeth in CG were significantly lower than those of the other groups. The difference between EOD indicators of the teeth was greater (by 7.0%, p=0.0015 and by 5.7%, p=0.008, respectively) in CG and MG II than in MG I (by 4.4%, p=0.029) 6 months later after treatment and on the day of restoration. Differences in EOD indicators were significant between CG and MG I and MG II (p=0.0048 and p=0.02, respectively). There was no difference between CG and MG II (p=0.179). The decrease in EOD indicators up to 5μA in two patients of CG (8.3%) and one patient of MG II (4.2%) corresponded to the appearance of complaints about tooth sensitivity to temperature stimuli.

12 months after treatment, there was a further increase in EOM indicators that corresponded to the deterioration of the marginal fit of restorations both in comparison with the day of restoration and with the previous observation period. The differences were significant in comparison with the day of restoration (p≤0.002) in all groups. The difference between the mean EOM indicators was significantly greater (7.9% and 7.2%, respectively) in CG and MG II than in MG I (5.6%) 12 months later after treatment and on the day of restoration. Comparing EOM indicators with the previous observation period (6 months) one year later after treatment, significant differences were identified in MG I and MG II (p=0.017 and p=0.031, respectively). There was no difference in the average indicators of CC in CG (p=0.06).

One year later a further slight decrease in EOD indicators was determined both in comparison with the day of restoration (p<0.001) and with the observation period of 6 months (p≤0.009). At the same time, significant differences were observed in EOD indicators between MG I and CG and MG II (p=0.003 and p=0.043, respectively). There was no difference between CG and MG II (p=0.179). Therefore, during all observation periods EOD indicators differed significantly in the groups (p≤0.03).

Based on both purely clinical and aesthetic criteria the deficiencies were identified among restoration defects. However, there were more often diagnosed defects that had their combination. The patients of MG I had no complaints, but during the clinical examination a slight roughness of the surface of restoration was determined in one restoration (4.2%). This restoration corresponded to an in-

crease in EOM indicators up to 2.1 μA. Another restoration (4.2%) had a poorly expressed marginal staining in combination with a violation of the marginal fit (electrical conductivity at the tooth-restoration boundary was equal to 2.3 μA and increased by 0.2 μA compared to the previous observation period) that corresponded to the initial degradation of the surface restoration The patients of CG had a violation of marginal adhesion (EOM=[2.2–5.4] μA) in four restorations (16.7%) half of which were associated with minor marginal staining and the other half – with sensitivity to temperature stimuli. In combination with the symptoms of sensitivity and increased marginal permeability of restorations the signs of recurrent caries were diagnosed in two teeth (8.3%). In addition, during the clinical examination a slight roughness of the surface of the material was determined in one restoration (4.2%). Three restorations (12.5%) with impaired marginal adaptation were diagnosed in MG II. In one clinical case the increase in marginal permeability was associated with slight marginal staining, in another case EOM increased from 2.1 μA to 5.3 μA compared to the previous observation period that corresponded to the development of recurrent caries. In addition, one restoration (4.2%) had slight surface roughness and two restorations (8.3%) had the symptoms of hypersensitivity in MG II. Certain restorations with surface roughness did not require any replacement, the aesthetic defect was eliminated by polishing the changed areas.

Discussion

Thus, a year later, 61 teeth with CC (84.72%) had high-quality composite restorations: in MG I – in 22 teeth (91.67%), in CG – in 19 teeth (79.17%), in MG II – in 20 teeth (83.33%). The preservation of composite restorations was identified according to the criteria of "anatomical shape" and "color matching" which depended to a greater extent on the properties of the filling material and the level of its polymerization. There were no restorations that were partially or completely destroyed. There were no objective signs of the development of recurrent caries and the appearance of the symptoms of hypersensitivity in MG I. During the year there was an increase in the amount of current that was conducted at the tooth-restoration boundary. At the same time, there was a smaller increase in current in MG I compared to both the previous observation period (6 months) and the day of restoration ($p<0.001$). In our opinion the better results obtained in MG I indicate that the presence and depth of enamel microcracks on the vestibular surface of the teeth must be taken into account when treating CC. The use of a differential approach to advanced dissection (removal of the areas of changed enamel with microcracks, overhanging edges) made it possible to increase the efficiency of restorations, as the filling material was fixed to unchanged hard tissues [9]. A greater number of restoration defects in CG of the study and slightly better results in MG II (by 4.16%) confirm the opinion about the importance of removing dental biofilm before restoration.

Monitoring dental caries treatment is an effective way to assess its quality. However, the interval of individual examinations should be determined carefully since their greater frequency can lead to an increase in the frequency of interventions [15]. The complaints about hypersensitivity were accompanied by a decrease in EOD and they were identified in the patients with significantly worse indicators of oral hygiene index ($t=0.0007$). Cervical restorations can contribute to the increased accumulation of dental plaque that potentially leads to the development and progression of recurrent caries and periodontal diseases [13]. A violation of the marginal fit of restorations was determined in the patients not only with higher indicators of the hygiene index, but also of PMA index ($t=0.002$ and $t<0.001$, respectively). Probably, it can be explained by insufficiently effective individual oral hygiene measures in these patients. Besides, the stresses that occur in the hard tissues of the cervical region of the teeth after restoration often cause the formation of cracks in the enamel and dentin, a violation of the tightness and marginal fit of fillings [4; 5]. Cervical edges showed more microleakage than occlusal edges [16]. Violations of the marginal fit of the material, especially on the periodontal wall, quite often lead to the development of marginal staining at the boundary of the material with enamel [3]. The patients with a diagnosed violation of marginal adaptation of restorations did not always have complaints. Other researchers also did not observe any relationship between discomfort and the value of marginal permeability. One of the disadvantages of an aesthetic nature was the development of marginal staining at the tooth-restoration boundary for the prevention of which it was suggested to remove the causative factor namely plaque accumulation and high-quality polishing of restorations [17]. The surface roughness identified in some restorations probably depended on the level of their polymerization, polishing, as well as the state of oral hygiene. Therefore, the effectiveness of treat-

ment depends not only on the features of the cavity dissection or on the material that was used for restoration, but also on the patient's characteristics [13].

Conclusions

The analysis of the state of tooth composite restorations with CC according to the USPHS criteria showed that a differential approach to the technique of dissection of hard dental tissues depending on the depth of enamel microcracks affects their quality that was confirmed by the dynamics of clinical, biophysical and statistical indicators. Its application and removal of dental biofilm by the method of air-abrasive cleaning with AIR-FLOW device using an erythritol-based powder contributed to an increase in the effectiveness of treating CC in MG I, on average, by 10.42% one year later compared to other observation groups where dissection was carried out according to generally accepted requirements. The obtained results make it possible to recommend the proposed method of treatment for using in practical dentistry.

DECLARATIONS:

Disclosure Statement

The authors have no potential conflicts of interest to disclosure, including specific financial interests, relationships, and/or affiliations relevant to the subject matter or materials included.

Data Transparency

The data can be requested from the authors.

Statement of Ethics

The authors have no ethical conflicts to disclosure.

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Consent for publication

All authors give their consent to publication.

References

1. Abdelaziz M. Detection, Diagnosis, and Monitoring of Early Caries: The Future of Individualized Dental Care. Diagnostics (Basel). 2023;13(24):3649. DOI: 10.3390/diagnostics13243649. PMID: 38132233.

2. Masna ZZ, Yakymovych DV. Features of the cervical area structure of permanent teeth of different groups. Bukovinian Medical Herald. 2023;27(1):15-9. DOI: 10.24061/2413-0737.27.1.105.2023.3. [In Ukrainian].

3. Udod OA, Afonina VV. Clinical evalution of cervical restorations of teeth. Bulletin of Problems in Biology and medicine. 2019;2(1):324-7. DOI 10.29254/2077-4214-2019-2-1-150-324-327. [In Ukrainian].

4. Yakimovych DV, Masna ZZ. Analysis of the frequency of cemento-enamel junction caries in permanent teeth of different groups. Reports of Vinnytsia National Medical University. 2024;28(1):42-5. DOI: 10.31393/reports-vnmedical-2024-28(1)-08. [In Ukrainian].

5. Namgung C, Rho YJ, Jin BH, Lim BS, Cho BH. A retrospective clinical study of cervical restorations: longevity and failure-prognostic variables. Oper Dent. 2013;38(4):376-85. DOI: 10.2341/11-416-C. PMID: 23215544.

6. Balhaddad AA, Garcia IM, Mokeem L, Ibrahim MS, Collares FM, Weir MD, et al. Bifunctional Composites for Biofilms Modulation on Cervical Restorations. J Dent Res. 2021;100(10):1063-71. DOI: 10.1177/00220345211018189. PMID: 34167373.

7. El-Marakby AM, Al-Sabri FA, Alharbi SA, Halawani SM, Yousef MTB. Noncarious cervical lesions as abfraction: etiology, diagnosis, and treatment modalities of lesions: a review article. Dentistry. 2017;7(6):438. DOI: 10.4172/2161-1122.1000438.

8. Brailko NM, Tkachenko IM. Study of the stress-deformed state of the filling-tooth system in cervical defects of teeth. Actual problems of modern medicine. Bulletin of the Ukrainian Medical Stomatological Academy. 2020;20(4):108-14. DOI: 10.31718/2077-1096.20.4.108. [in Ukrainian].

9. Yarova SP, Zabolotna II, inventors. Ukrainian Utility Model Patent No.104318 "A method of treating neck tooth decay". In force from 25 Jan 2016, action has been terminated. Publ. 25 Jan 2016, Bull. No.2. Available at: https://base.uipv.org/searchINV/search.php?action=viewdetails&IdClaim=219865 [in Ukrainian].

10. Zabolotna II, Bohdanova TL. Clinical study of treatment effectiveness of microcracks of teeth by the method of deep enamel fluoridation". Intermedical Journal. 2024;1:100-5. DOI: 10.32782/2786-7684/2024-1-15. [In Ukrainian].

11. Badavannavar AN, Ajari S, Nayak KUS, Khijmatgar S. Abfraction: Etiopathogenesis, clinical aspect, and diagnostic-treatment modalities: A review. Indian J Dent Res. 2020;31(2):305-11. DOI: 10.4103/ijdr.IJDR_863_18. PMID: 32436913.

12. Kaskova LF, Amosova LI, Karpenko OO. Prevention of dental diseases: textbook. Kharkiv: Fact; 2011. 392 p. Available at: http://repository.pdmu.edu.ua/handle/123456789/5758 [in Ukrainian].

13. Carlo B, Barabanti N, Piccinelli G, Faus-Matoses V, Cerutti A. Microbiological characterization and effect of resin composites in cervical lesions. J Clin Exp Dent. 2017;9(1):e40-5. DOI: 10.4317/jced.52978. PMID: 28149461.

14. Yildirimoglu G, Hubbezoglu I. Efficacy of Different Finishing and Polishing Systems on Surface Roughness and Microhardness of Highly Aesthetic Composites, Cumhuriyet Dental Journal. 2023;26(4):417-25. DOI: 10.7126/cumudj.1409127.

15. Wierichs RJ, Kramer EJ, Meyer-Lueckel H. Risk factors for failure in the management of cervical caries lesions. Clin Oral Investig. 2017;21(6):2123-31. DOI: 10.1007/s00784-016-2002-1.

16. Ahmed DRM, Shaath DG, Alakeel JB, Samran AA. Influence of Diode Laser for the Treatment of Dentin Hypersensitivity on Microleakage of Cervical Restorations. Biomed Res Int. 2021;2021:9984499. DOI: 10.1155/2021/9984499. PMID: 33997052.

17. Peumans M, Politano G, Van Meerbeek B. Treatment of noncarious cervical lesions: when, why, and how. Int J Esthet Dent. 2020;15(1):16-42. PMID: 31994534.

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