

Study of the Border Adjustment of Indirect and Direct Restorations by Thermo cycling Method with Following Staying

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Abstract

According to modern concepts, the marginal permeability of restorations, the presence or absence of micro leaks, are the main factors determining the service life of the restoration. The restoration of teeth is subjected to several different types of stress - one of which is temperature fluctuations in the oral cavity. It is known that when eating food, brushing teeth, etc. the temperature in the oral cavity changes and affects the physical and mechanical properties of the hard tissues of the teeth, as well as of the restorative material, and in some cases leads to deformation of the zone of connection of the restorative material with the tooth surface up to its destruction. The thermal cycling procedure makes it possible to simulate the influence of this factor on the conditions of functioning of the reducing material; this is achieved by exposing the sample to a limited number of thermal cycles, which means of an artificial "aging" of the sample in laboratory conditions.

Keywords: *Direct restoration, Indirect restoration, Inlay, Thermal cycling, Micro leakage, Marginal fit.*

Introduction

An important success factor for the treatment of pathology of hard dental tissues using the method of aesthetic restoration is the optimal choice of filling materials. [1-3, 4] The urgent task of modern, restorative, therapeutic dentistry is to make an informed decision, in each specific clinical case, from aesthetic, medical, economic, as well as biomechanical and ergonomic points of view [5-7, 8].

According to many authors, the key to successful restorative treatment of hard tissue defects of any genesis is understanding the etiological causes and conditions of their occurrence, as well as assessing the size of the defect and the level of material and technical base of modern dentistry [9-16]. The quality of adhesion of the restoration material to the tooth tissues is one of the factors that determine the durability and clinical efficiency of dental restoration. Today, progress in adhesive dentistry has led to an improvement in the marginal fit, and,

consequently, the clinical efficiency of dental restorations [17-23]. For the treatment of various dental defects in an area with increased stress, the choice of restoration technique remains a controversial issue, since the failure of restorations in this area is observed quite often [24-28]. Long-term results of aesthetic restoration of teeth by the direct method, various composite materials indicated a large number of complications, such as inconsistency in the color and transparency of the filling, violation of the marginal adherence, the appearance of marginal staining along the border of the composite material with the tooth tissues, both during and at different times.

After treatment [29-34]. It is known that in order to create a biocompatible tooth restoration, it is important to create an airtight connection with the tooth tissues. The aim of restorative dentistry is to replace the lost structure of the tooth with a material

that is similar in structure and physical properties to natural tooth tissues. This goal is achieved by CAD / CAM technology. In recent years, there has been an increased interest in hybrid materials in dentistry. [35-41] Hybrid ceramics, due to their chemical stability, have good mechanical and optical properties as well as excellent biocompatibility. Hybrid ceramics combine the positive properties of traditional ceramics and CAD / CAM resin. This allows it to be used in places with increased stress [42-47]. The aim of the study was to study the marginal permeability of the joint "tooth-indirect" restoration and "tooth-straight" restoration, which was carried out by the method of thermal cycling with subsequent staining.

Materials and Methods

This work was done at Sechenov University with supported by the "Russian Academic Excellence Project 5-100". For the study, 30 extracted teeth with defects in the cervical region were prepared. These samples were chosen because the area of the region is subject to increased stress in different directions. The samples were divided into two groups depending on the restoration method: Group 1 (15 teeth) - defects restored by indirect restoration with hybrid ceramics. Group 2 (15 teeth) - defects restored with filling material.

Some of the samples from each group were subjected to thermal cycling in order to achieve an imitation of artificial "aging" of the sample. The purpose of this method is to increase the relevance between in vitro laboratory testing of a sample and in vivo use of the restorative material in a patient's oral cavity. When carrying out a direct restoration, the cavity formed in the area of increased stress was prepared taking into account the principles and rules of preparation. The adhesive preparation was performed using the total etch and wet adhesion technique. The defect was restored with the selected shades of the composite material layer by layer. In the case of an indirect restoration, the preparation and

processing of the cavities was carried out as described above. Then the cavities were scanned using the Blue Cam intraoral scanner. The next step was milling the inlays, after which the finished inlay was fixed on a laboratory specimen. After restoration, all samples were immersed in a thermostat in distilled water + 37 ± 1 ° C for 24 hours, which simulated the environment of the oral cavity. For thermal cycling, the samples were placed in a thermostat with water + 5 ± 0.5 ° C for 30 seconds.

Afterward they were removed and kept at room temperature for 20 seconds. Then the samples were immersed in a thermostat with water + 60 ± 0.5 ° C for 30 seconds, after which they were removed and kept at room temperature for 20 seconds. The performed complex of manipulations was taken as one cycle.

In total, 1500 cycles were performed within 2 weeks in accordance with GOST R51202-98, P.6.3 (the load corresponds to the one-year life of the restoration of this localization). To reveal the edge permeability, all samples were stained before and after thermal cycling. Coloring was achieved by immersion in 2% methylene blue solution for two hours at 37 ° C. The teeth were then sawn off in the sagittal plane and examined at 20x magnification.

Results and Discussions

The results of the study were evaluated on a scale:

- 0 points - No staining;
- 1 Point - Staining only along the edge of the restoration;
- 2 Points - The penetration of the dye to the entire side wall;
- 3 Points - Staining the bottom of the cavity under the restoration.

Based on the staining results, a comparative analysis of the penetration depth of the dye into the space between the restorations and the tooth wall was carried out, the results of which are presented in the table.

Table 1: Staining along the "restoration-tooth" border.

Samples		group I indirect restoration	group II direct restoration
No thermal Cycling	0 points	0%	0%
	1 point	0%	0%
	2 points	0%	0%
	3 points	0%	0%

After thermal Cycling	0 points	0%	1%
	1 point	0%	23%
	2 points	0%	35%
	3 points	0%	41%

According to the results of the study, the following results were obtained: in the samples of both groups that were not subjected to thermal cycling, staining along the "restoration-tooth" border was not detected. After thermal cycling, staining along the border of the restoration was detected in the "direct restoration" group, in 99% of the samples with different staining depths. In the group of indirect restorations, staining of the samples was not recorded.

Conclusions

Thus, the results of the study confirmed that in the process of functional loads on the tooth, the loss of the filling can be predicted with direct dental restorations, since in this group, staining was more often recorded along the "restoration-tooth" border. This indicates a violation of the marginal adherence of the filling to the tooth. In the group of indirect restoration, the violation of the marginal fit was not detected in both cases (without thermal cycling and with its use), which allows predicting the long-term functioning of the restoration without losing its quality.

References

- Baez, Rosales A (2013) Direct composite restoration with an integrated approach to treatment / A. Baez Rosales, R. Schlieper Cacciuttolo, M. Gajardo Guineo // Medical alphabet, T. 2 (7): S. 43-44.
- Danshina S D, Markov A Huldani, Achmad H (2020) Causes, symptoms, diagnosis and treatment of melanoma. International Journal of Pharmaceutical Research, 12(3): 903-909.
- Della Bona A, Korazza P Kh, Zhang J (2014) Description of the material characteristics of a mesh made of polymeric cerium. Dental Materials, 30 (5): 564-9.
- Timoshin A, Sevbitov A, Ergesheva E, Mironov S, Kozhemov S, Pustokhina I, Danshina S (2019) Experience in the use of collagen phytoplates in the treatment of gingivitis. Opcion. T. 35 (21): 582-598.
- Ergesheva E V, Davidiants A A, Dorofeev A E, Sevbitova M A, Timoshina M D (2018) Evaluation of effectiveness of an alternative method in complex treatment of diseases of endodont. Asian Journal of Pharmaceutics, 12(3): S933-S936.
- Ershov KA, Sevbitov AV, Dorofeev AE, Pustokhina IG (2018) Evaluation of elderly patients adaptation to removable dentures. Indo American Journal of Pharmaceutical Sciences, T. 5 (3): C.1638-1641.
- G Werling (2014) VITA ENAMIC hybrid ceramics: fabrication of functional and esthetic restorations directly in the patient chair. New in dentistry, 6 S. 74-81
- Timoshin AV, Sevbitov AV, Drobot GV, Yumashev AV, Timoshina MD (2018) Use of bioresorbable plates on the basis of collagen and digestase for treatment of diseases of oral mucosa (review of clinical cases). International Journal of Green Pharmacy, 12(1): 290-96.
- Jakupović S, Anić I, Ajanović M, Korać S, Konjhodžić A, Džanković A, Vuković A (2016) Biomechanics of cervical tooth region and noncarious cervical lesions of different morphology; three-dimensional finite element analysis. Eur. J. Dent., 10 (3): 413-8.
- Kuznetsova MY, Sevbitov AV, Brago AS (2017) Dental morbidity of patients exposed to low doses of radiation. Stomatologiya, 96 (6-2): 110-111.
- Mamedov A, Morozova N, Yumashev A, Dybov A, Nikolenko D (2019) Criteria for provisional restorations used in preparation for comprehensive orthodontic and orthopedic rehabilitation. Periodico Tche Quimica, 16(32): 647-655.
- Mörmann W, Stawarczyk B, Ender A, Sener B, Attin T, Mehl A (2013) Wear characteristics of current aesthetic dental restorative CAD / CAM materials: Two-body wear, gloss retention, roughness and Martens hardness. In: J. Mech. Behav Biomed Mater., 20 (4): S. 113-125.
- Timoshin AV, Sevbitov AV, Ergesheva EV, Boichuk AV, Sevbitova MA (2018) Experience of treatment of aphthous lesions of oral mucosa by preparations on the basis of collagen and digestase. Asian Journal of Pharmaceutics T. 12(1): 284-287.
- Utyuzh AS, Yumashev AV, Lushkov RM (2016) A clinical example of orthopedic treatment of a patient after resection of the lower jaw for sarcoma using dental implants. Clinical Dentistry, 4(80): 56-8.
- Utyuzh AS, Yumashev AV, Mikhailova MV (2016) Spectrographic analysis of titanium

- alloys in prosthetic dentistry. *Journal of Global Pharma Technology*, 8(12): 7-11.
16. Utyuzh AS, Yumashev AV, Isakov EIU, Makarov AL, Matveeva EA (2020) Diagnosis and treatment of inflammatory periodontal diseases. // *Periodico Tche Quimica*, T. 17. (34): S. 343-351.
17. Riakhovskii AN, Zheltov SI, Kniaz' VA, Iumashev AV (2000) A hardware and software complex for producing 3D models of the teeth(Article) [Apparatno-programmnyi kompleks polucheniia 3D-modelei zubov.] *Stomatologiya*, 79 (3): 41-45.
18. Salova AB, Rekhachev VM (2008) Features of aesthetic restoration in dentistry. SPb. Man, 160.
19. Samusenkov VO, Tsarev VN, Ippolitov EV, Borisov VV, Tsareva TV (2020) Substantiation of use of photodynamic therapy in experimental research in vitro with strains of periodontopathogenic bacteria and fungi *Candida*. *Journal of Global Pharma Technology*.
20. Sevbitov A, Kuznetsova M, Dorofeev A, Borisov V, Mironov S, Iusupova I (2020) Dental anomalies in people living in radionuclide-contaminated regions. *J. Environ. Radioact.*, 216: 106-190. doi:10.1016/j.jenvrad.2020.106190
21. Utyuzh A, Nikolenko D, Yumashev A, Volchkova I, Samusenkov V (2019) Adhesion of periodontal pathogens to materials used for long-term temporary crowns. *Periodico Tche Quimica*, 16 (33): 60-69.
22. Utyuzh AS, Yumashev AV, Lang HW, Zekiy AO, Lushkov RM (2018) Comprehensive treatment and rehabilitation of patients with osteosarcoma of the mandible *Implant Dentistry*, 27 (3): 332-341.
23. Yablokova NA, Sevbitov AV (2012) Role of radiation factor in pediatric dental morbidity. *Russ. Bull. Perinatol. Pediatr.* 57 (6): 82-87
24. Sevbitov A, Pankratova N (1998) Frequency of distribution of anomalies of the dentoalveolar system in children exposed to radioactivity. *Orthodont-info*, 2: 30-31.
25. Sevbitov AV, Davidyants AA, Balykin RA, Timoshin AV, Kuznetsova M Yu (2020) Analysis of the effectiveness of immunotherapy using an autologous complex of immunopeptides in the surgical treatment of periodontitis. *Periodico Tche Quimica*, T. 17 (35): 381-390.
26. Sevbitov AV, Enina Yu I, Derevyanchenko SP, Dorofeev AE (2019) Comparative evaluation of effectiveness of restorations in cervical teeth region by direct and indirect method. *International Journal of Civil Engineering and Technology*, T. 10 (3): S. 3099-3105.
27. Sevbitov AV, Tikhonov VE, Kuznetsova M Yu, Dorofeev AE, Timoshin AV (2020) Effect of retention of results on patient satisfaction with orthodontic treatment. *Journal of Global Pharma Technology*, T. 12 (9): 27-31.
28. Yumashev A, Berestova A, Karapetyan A (2020) Cervical Caries: Modern Methods of Diagnosis and Treatment. *Journal of Global Pharma Technology*, 12(1): 89-96.
29. Sevbitov AV, Timoshin AV, Ergesheva EV (2018) Analysis of effectiveness of use of bioresorbable plates on the basis of collagen and digestase for treatment of inflammatory diseases of parodontium in adolescents. *Indo American Journal of Pharmaceutical Sciences*, T 5 (1): 1-5.
30. Sevbitov AV, Skatova EA (2005) Factors of individual radiation sensitivity in caries prevalence in population of radiation polluted regions. *Stomatologiya*, 84(2): 15-20.
31. Sevbitov, A (2005) Dental characteristics of clinical manifestations of delayed effects of radiation exposure. Abstract of the dissertation for the degree of doctor of medicine. Central research Institute of dentistry of the Ministry of health of the Russian Federation. Moscow.
32. Sevbitov A V (2004) Remote effects of the Chernobyl accident: evaluation of the maxillo dental status of the children. *Stomatologiya*, 83(1): 44.
33. Sevbitov A V, Brago A S, Enina Y I, Dorofeev A E, Mironov S N (2018) Experience in the application of hybrid ceramic restorations in the cervical region. *Asian Journal of Pharmaceutics*, 12(3): S1106-S1109.
34. Yumashev A, Karapetyan A, Garnova N, Berestova A (2020) Characteristics of Biocompatible Coatings on Dental Implants. *Journal of Global Pharma Technology*, 12(1): 30-37
35. Sevbitov A, Danshina S, Platonova V, Borisov V, Kuznetsova M (2020) Icon as a method of choice for injectable treatment of initial caries in patients with fibrodysplasia ossificans progressive: A clinical case. *Journal of Global Pharma Technology*, 12(2):0 c. 270-274.
36. Sevbitov A, Davidyants A, Kuznetsova M, Dorofeev A, Mironov S (2019) Analysis of electronic microscopy results based on combining the infiltration method with different restoration technologies and in vitro investigation of enamel focal demineralization treatment at the defect stage. *Periodico Tche Quimica*, 16(33): 53-59.
37. Sevbitov A, Dorofeev A, Ershov K, Enina Y, Pustokhina I, Zhadko S (2020) Rationale for

- the preservation of vital pulp in the use of fixed dentures in the experiment. [Justification de la preservación de la pulpa vital en el uso de prótesis fijas en el experimento] *Opcion*, 36(Special Edition 26), 953-968.
38. Sevbitov A, Dorofeev A, Kuznetsova M, Timoshin A, Ershov K (2019) Comparative characteristics of the crystallogram of the oral fluid in patients who use heroin and methadone. *Periodico Tche Quimica*, 16(33): 94-101.
39. Sevbitov A, Emelina G, Kuznetsova M, Dorofeev A, Emelina E (2019) A study of the prevalence of non-carious dental lesions related to production factors in residents of the city of Penza. *Georgian Medical News*, (295): 42-47.
40. Sevbitov A, Ergesheva E, Sirak S, Enina Y, Mallkov S, Kuznetsova M (2020) Clinical and laboratory analysis of the efficiency of hirudotherapy in complex treatment of endodontal diseases. *Journal of Global Pharma Technology*, 12(1): 253-260
41. Yumashev AV, Gorobets TN, Admakin OI, Kuzminov GG, Nefedova IV (2016) Key aspects of adaptation syndrome development and anti-stress effect of mesodiencephalic modulation. *Indian Journal of Science and Technology*, 9(19): 93911.
42. Sevbitov A, Mitin N, Kuznetsova M, Dorofeev A, Ershov K (2020) A new modification of the dental prosthesis in the postoperative restoration of chewing function. [Una nueva modificación de la prótesis dental en la restauración postoperatoria de la función masticatoria] *Opcion*, 36(Special Edition 26): 864-875.
43. Sevbitov A, Persin L, Slabkobskaia A, Pankratova N (1999) The morphological status of the maxillo dental system in children living in an area contaminated by radionuclides as a result of the accident at the chernobyl atomic electric power station. *Stomatologiya*, 78(6): 41.
44. Sevbitov A, Timoshin A, Dorofeev A, Davidyants A, Ershov K, Kuznetsova M (2020) Comparative characteristics of the state of hard dental tissues in drug-dependent patients who use heroin, and methadone as replacement therapy. [Características comparativas do estado de tecidos dentários duros em pacientes dependentes de drogas que usam heroína, e metadadona como terapia de substituição] *Periodico Tche Quimica*, 17(34): 135-146.
45. Sevbitov A, Zhadko S, Ershov K, Borisov V, Mironov S (2019) Rationale for the use of therapeutic and prophylactic complex to prevent intolerance to acrylates in patients with hyperfunction of the thyroid glands. *Periodico Tche Quimica* 16(33): c. 266-276.
46. Sevbitov AV, Kuznetsova MY, Davidiants AA, Dorofeev AE, Timoshin AV (2019) The training manual skills of students of stomatologist on simulators of a different level of realism. *Espacios*, 40(8): c. 1-5.
47. Yumashev A, Mikhaylov A (2020) Development of polymer film coatings with high adhesion to steel alloys and high wear resistance. *Polymer Composites*, 41 (7): 2875-2880.