

RETROSPECTIVE ANALYSIS OF THE STATE OF DIRECT DENTAL RESTORATIONS AFTER ENDODONTIC TREATMENT

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Abstract

Endodontic treatment is accompanied by the loss of a significant amount of tooth crowns, which leads to a significant decrease in their strength characteristics. The restoration of endodontically treated teeth, as a rule, is carried out by the direct method, however, a unified approach regarding direct or indirect restoration has not yet been determined.

The aim – retrospective analysis of the clinical condition of direct restorations of endodontically treated teeth.

Materials and methods. 284 patients aged 25 to 60 years were examined; they studied the state of 888 previously performed direct restorations of the anterior and posterior teeth after endodontic treatment in a period of 2 to 10 years. Restorations were evaluated according to the adapted clinical criteria “integrity of the restoration”, “marginal fit of the material”, “marginal staining”, “anatomical shape”, “colour correspondence for the restoration”, “roughness of the surface of the material”, as well as the criterion “condition of the contact point” for located on the contact surfaces of the teeth of the restorations.

Results. Of the 888 examined direct restorations, 760 restorations (85.6±1.18 %) were located in the posterior teeth, with 562 restorations in the molars (63.3±1.62 % of the total) and 198 in the premolars (22.3±1.40 %), and 128 restorations (14.4±1.18 %) were detected in the anterior teeth, while in the incisors – 80 restorations (9.0±0.96 %), in the fangs – 48 (3.5±0.76 %). 720 restorations (81.1±1.31 %) were made from photocomposite materials, 97 restorations (10.9±1.05 %) from chemical curing composites, 71 (8.0±0.91 %) from glass-ionomer cements. The most common violations were colour mismatch – in 511 restorations (57.5±1.66 %), marginal staining – in 470 restorations (52.9±1.68 %), surface roughness – in 357 restorations (40.2±1.0, 65 %). More often than others, in the reconstructions of their photocomposites and glass ionomers there was a colour mismatch, and surface roughness for chemical composites.

Conclusions. For direct tooth restoration after endodontic treatment in 81.1±1.31 % of cases, photocomposite materials are used, less often chemical curing composites and glass ionomers. Of the violations of such restorations, the most frequent are colour mismatch, surface roughness and edge staining.

Keywords: endodontically treated teeth, direct restorations, photocomposites, chemocomposites, glass ionomers, retrospective assessment.

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1. Introduction

Untimely or poor-quality treatment of dental caries, as you know, leads to the development of complications, as a result of which endodontic intervention or tooth extraction becomes necessary. Innovative technologies of endodontic treatment, including the use of an endomotor, heavy-duty and flexible instruments with shape memory, optical zoom, providing the possibility of instrumental processing of curved and obliterated, additional and rudimentary root canals, as well as systems and materials ensuring their reliable and durable obstruction, allow you to save teeth, the removal of which, it would seem, is almost inevitable [1, 2].

After successful endodontic treatment, the inevitable task of adequately restoring the crown of the teeth arises. In most cases, the treatment of caries complications, be it pulpitis or periodontitis, is accompanied by the loss of a significant part of the volume of the tooth crown, regardless of whether it is an anterior tooth or a lateral one. Removal of hard tissues pathologically altered due to the carious process and creation of free access to the root canal mouths for their full instrumental

processing and obturation, often the search for additional canals or removal of the material of the previous restoration, if necessary, repeated endodontic intervention leads to a significant decrease in the strength characteristics of such teeth [3, 4]. The weakened and thinned walls of the cavities after endodontic manipulations, especially in the teeth of the lateral group, need hardening in order to withstand high chewing pressure.

Regarding the restoration of tooth crowns after endodontic treatment, a single approach has not yet been determined. Of course, the leading role in the selection must be assigned to the factor of the degree of destruction of the crown [5]. However, quite often in clinical practice, direct restoration of such teeth is carried out without taking into account the volume of lost hard tissues, localization and cavity configuration, and different designs are used for hardening, including intracanal pins, stump inserts and so on [6, 7]. The choice of materials for direct restoration, of course, is very wide, but often clinical feasibility fades into the background, giving way to financial motivation, which, in terms of the durability of the functioning of such recovery, cannot be dominant [8]. The use of indirect restorations from innovative materials using digital technologies, as a certain alternative, seems more promising in terms of the duration of their operation, but very costly [9].

The discussion on the use of a direct or indirect method of restoration should be based, first of all, on an evidence-based clinical factual base regarding the state and duration of the operation of direct tooth restorations after endodontic interventions.

The aim – retrospective analysis of the clinical condition of direct restorations of endodontically treated teeth.

2. Materials and methods

A survey of 284 patients aged 25 to 60 years was carried out in 2018–2019 in the clinic of the Department of Dentistry No. 1 of the Donetsk National Medical University and in a private dental clinic (Kharkov). Patients, among whom were 120 men (42.3 ± 2.9 % of the total number examined) and 164 women (57.7 ± 2.9 %), turned to clinics for dental care; they examined the state of 888 previously performed direct restoration of teeth of the lateral and frontal groups after endodontic treatment in a period of 2 to 10 years. All patients gave informed consent to participate in the study, which was carried out in accordance with the principles of the Helsinki Declaration adopted by the General Assembly of the World Medical Association, the Council of Europe Convention on Human Rights and Biomedicine (1997), relevant standards of WHO, the International Council of Medical scientific communities, International Code of Medical Ethics (1983), which is confirmed by the bioethics commission of the Donetsk National Medical University No. 21, 09.11.2017.

In patients, the intensity index of carious lesions of the teeth and the hygienic condition of the oral cavity were determined by the Fedorov-Volodkina index [10]. In the course of assessing the state of direct restorations, their localization, as well as their belonging to a particular class of cavities according to Black, was studied, then restorations were assessed using the adapted clinical criteria “restoration integrity”, “marginal fit of the material”, “marginal staining”, “anatomical shape”, “color correspondence of the restoration”, “surface roughness of the material”, as well as according to the additional criterion “state of the contact point”, which was used in case of restoration of the contact surfaces of the teeth [11]. The presence or absence of violations was determined by each of the criteria.

Statistical processing of the results of the index estimation was carried out using variation statistics and the software product MS Excel XP. The differences between the indicators at $p < 0.05$ were considered statistically significant, in accordance with Student's criterion. The results obtained during the assessment of restorations according to clinical criteria were presented in the form of absolute and relative indicators.

3. Results

During the dental examination, it was found that the index of intensity of carious lesions of the teeth in all patients participating in the study was 9.78 ± 0.85 , the state of oral hygiene in them was satisfactory, the hygiene index was 1.92 ± 0.25 points.

In total, in the course of the study, 888 patients restored after endodontic treatment of teeth were identified, in men there were 328 such teeth (37.0 ± 1.62 % of the total), in women – 560 (63.0 ± 1.62 %) (difference is reliable, $p < 0.05$). Most of the restorations were in the teeth of the upper jaw – 516 (58.1 ± 1.66 %), in the teeth of the lower jaw there were 372 restorations (41.9 ± 1.66 %) ($p < 0.05$). Similar ratios were also established during the analysis of indicators depending on the gender of the examined, in men 180 restorations were found (54.9 ± 2.75 % of the total number in males) in the teeth of the upper jaw and 148 restorations (45.1 ± 2.75 %) in the teeth of the lower jaw, in women – 336 (60.0 ± 2.07 % of the number of recoveries in females) and 224 (40.0 ± 2.07 %), respectively.

Of the total number of teeth after endodontic treatment, the absolute majority ($p < 0.05$) were lateral – 760 out of 888 (85.6 ± 1.18 %), frontal teeth only 128 (14.4 ± 1.18 %), this, women revealed significantly ($p < 0.05$) more restored lateral teeth, there were 474 (53.4 ± 1.67 % of the total number), and the front teeth, which were 86 (9.7 ± 0.99 %), in men these indicators amounted to 286 (32.2 ± 1.57 %) and 42 (4.7 ± 0.71 %).

The distribution of restored lateral and frontal teeth depending on belonging to a particular jaw was as follows: the lateral teeth of the upper jaw were 426 (48.0 ± 1.68 %), the lateral teeth of the mandible – 334 (37.6 ± 1.63 %), anterior teeth – 90 (10.1 ± 1.01 %) and 38 (4.3 ± 0.68 %), respectively.

As for the number of restored lateral teeth of the upper and lower jaw in men and women, in males there were slightly more such teeth on the upper jaw – 153 (17.2 ± 1.15 % of the total number of examined teeth) than on the lower, – 133 (15.0 ± 1.09 %), the ratio of these indicators was approximately the same for females – 273 (30.7 ± 1.38 %) and 201 (22.6 ± 1.27 %). The number of restored upper frontal teeth in women was more than 2 times higher than that in men – 63 (7.1 ± 4.83 %) and 27 (3.0 ± 4.83 %), respectively, significantly less was restored lower anterior teeth – 23 (2.6 ± 2.18 %) and 15 (1.7 ± 2.18 %).

Most of all ($p < 0.05$) restorations were in molars – 562 (63.3 ± 1.62 % of the total), while molars of the upper jaw prevailed, there were 308 (34.7 ± 1.06 %), restored molars of the lower jaw were 254 (28.6 ± 1.06 %). Further, in decreasing order of the number of restorations, premolars are located, their total number was almost three times less ($p < 0.05$) than molars, that is, the total number of restored premolars was 198 (22.3 ± 1.40 %), premolars of the upper jaw – 118 (13.3 ± 0.37 %), lower jaw – 80 (9.0 ± 0.37 %). Even fewer ($p < 0.05$) restorations were detected in the incisors – only 80 (9.0 ± 0.96 %), 59 restorations in the maxillary incisors were revealed (6.6 ± 0.13 %), which is almost three times more than in the incisors of the lower jaw, these teeth had 21 restoration (2.4 ± 0.13 %). The fangs were the least frequently ($p < 0.05$) fangs endodontically treated, as the teeth most resistant to caries, 48 restored fangs (3.5 ± 0.76 %) were found after this intervention, and if there were 31 such fangs on the upper jaw (3.5 ± 0.09 %), then on the bottom – only 17 (1.9 ± 0.09 %), that is, almost two times less.

Analysis of the restoration structure depending on the localization of the carious cavities in the teeth showed that their greatest number was reliably ($p < 0.05$) class 2 according to Black, that is, with contact and chewing surfaces of molars and premolars, such restoration was revealed in the examined patients 623 (70.2 ± 1.54 %), and more of them were in the teeth of the lateral group of the upper jaw than the lower – 349 (39.3 ± 1.17 %) and 274 (30.9 ± 1.17 %), respectively. More than four times less ($p < 0.05$) teeth were found with restorations due to Black class 1 carious cavities; there were 137 restorations of such localization (15.4 ± 1.21 %) in the teeth of the upper and lower jaw they were almost equally divided – 75 (8.4 ± 0.26 %) and 62 (7.0 ± 0.26 %). Restorations with localization of class 4 according to Black were slightly less revealed – only 113 (12.7 ± 1.12 %), of which 77 (8.7 ± 0.2 %) – in the front teeth of the upper jaw, 36 (4.1 ± 0.2 %) – in the teeth of the lower jaw, which is half as much. Fifteen restorations were also located in the cavities of class 3 according to Black (1.7 ± 0.43 %), this minimum number ($p < 0.05$) of restorations was distributed as follows: in the front teeth of the upper jaw – 10 (1.1 ± 0.03 %), the lower jaw – only 5 (0.6 ± 0.03 %). Not a single case of localization of cavities and restorations of the 5th and, especially, 6th class according to Black in the examined teeth has not been established.

The most interesting fragment of the study is devoted to the analysis of the structure of the entire array of tooth restorations after endodontic treatment and violations in them, depending on

the materials used. Of all 888 examined restorations, 720 restorations (81.1 ± 1.31 %) were made from photocomposite materials ($p < 0.05$), 97 (10.9 ± 1.05 %) were made from chemical curing composites, in 71 restorations (8.0 ± 0.91 %) used glass ionomer cements, these materials were the least popular.

Photocomposite materials for direct restoration were used for localization of carious cavities in class 1, according to Black's classification, in 97 teeth (13.5 ± 1.27 % of the total number of restorations from photocomposites), in class 4 – in 89 teeth (12.4 ± 1.23 %), in class 3 – only in 8 teeth (1.1 ± 0.39 %), but most often ($p < 0.05$) photocomposite restorations were performed for carious cavities of class 2, there were 526 (73.1 ± 1.65 %).

Chemical curing composites were used to restore 66 teeth with class 2 cavities (68.0 ± 4.73 % of the number of restorations from these materials) ($p < 0.05$), 24 teeth (24.7 ± 4.38 %) – with cavities of class 4, 7 teeth (7.2 ± 2.63 %) – with cavities of class 3.

Restorations in 40 teeth (56.3 ± 5.89 % of the number of restorations from glass ionomers) with localization of carious cavities of class 1 and in 31 teeth (43.7 ± 5.89 %) with cavities of class 2 were made of glass ionomer cements.

As for the violations revealed during the examination of the state of restorations from all restoration materials, the most frequent ($p < 0.05$) discrepancy was observed between the colour of the restoration and hard tissues of the restored teeth, such violations were found in 511 restorations (57.5 ± 1.66 % of their total number). The number of cases of marginal staining at the border of the material and tooth enamel was slightly less, although there were more than half of all examined patients with restorations with these disorders – 470 (52.9 ± 1.68 %). The increased surface roughness of the material was found in 357 restorations (40.2 ± 1.65 %) ($p < 0.05$). Almost the same number of restorations had violations of the marginal fit of the material and the anatomical shape, in particular, there were, respectively, 277 (31.2 ± 1.55 %) and 275 (31.0 ± 1.55 %). Violation of the integrity was found in 105 restorations (11.8 ± 1.08 %), it is the least number of such violations ($p < 0.05$).

The clinical criterion regarding the condition of the contact point was used to evaluate only those restorations that covered the contact surfaces; there were 751 such restorations (84.6 ± 1.21 % of the total). Contact point violations were detected in 260 restorations (34.6 ± 1.53 % of the number of restorations of the specified location).

Most often, photocomposite materials are used in clinical practice for direct restoration of teeth after endodontic treatment. This is also evidenced by the results of a retrospective analysis. However, a significant number of violations in direct photocomposite reconstructions identified during this study should be noted. Half of all restorations from photocomposites do not correspond to the hard tissues of teeth by colour; there were 365 of them (50.7 ± 1.86 % of the number of all photocomposite restorations). A little less ($p > 0.05$) was restoration with regional staining along the perimeter – 340 restorations (47.2 ± 1.86 %). Disorders in the following three clinical criteria differed slightly from each other ($p > 0.05$): 208 restorations (28.9 ± 1.69 %) were found with increased roughness of the surface of the material, 193 restorations were found with a broken edge of the photocomposite (26.8 ± 1.65 %), with violation of the anatomical form – 179 restorations (24.7 ± 1.61 %). The integrity was completely or partially violated in 68 restorations (9.4 ± 1.09 %) ($p < 0.05$). Of all the photocomposite restorations, 623 restorations (86.5 ± 1.27 %) covered, along with others, contact surfaces; therefore, they were examined with respect to the contact point, while it was insolvent in 165 cases (26.5 ± 1.54 % of the number of restorations of a given location).

In the recoveries from chemical curing composites, the structure of the disturbances was somewhat different. The highest values were according to three clinical criteria: increased roughness of the material was found in 88 restorations out of 97 (90.7 ± 2.95 % of the number of restorations from these materials), edge staining at the border with enamel was found in 84 restorations (86.6 ± 3.46 %), and only 1 less restoration with colour mismatch – 83 (85.6 ± 3.57 %) ($p > 0.05$). Almost two times less ($p < 0.05$) there were restorations with a broken marginal fit of the composite – 43 restorations (44.3 ± 5.04 %). Violation of the anatomical form was detected in 62 restorations (63.9 ± 4.88 %), integrity was broken in 18 restorations (18.6 ± 3.95 %) ($p < 0.05$). All 97 restorations from chemical curing composites were located on the contact and other surfaces of the teeth, of which the contact point was broken in 69 restorations (71.1 ± 4.6 %).

Glass ionomer cements were most used to restore teeth after endodontic treatment, and these restorations were only in the posterior teeth. Almost all the restorations had a colour mismatch and high roughness, in particular, there were 63 such restorations (88.7 ± 3.75 % of their total number) and 61 (85.9 ± 4.13 %) ($p > 0.05$). Broken marginal fit and marginal staining were detected, respectively, in 46 (64.8 ± 5.67 %) and 41 restorations (57.7 ± 5.86 %) ($p > 0.05$). A little less ($p > 0.05$) was anatomical disorders; they were found in 34 restorations (47.9 ± 5.93 %). The integrity was completely or partially violated in 19 recoveries (26.8 ± 5.25 %) ($p < 0.05$). Defects of the contact point were found in 26 out of 31 restorations located on the contact surfaces, this amounted to 83.9 ± 6.61 % of the number of restorations of this localization.

4. Discussion

A retrospective analysis, first of all, showed that the vast majority of direct restorations were located on the chewing and contact surfaces of endodontically treated lateral teeth, while direct restoration of teeth with such localization of cavities is a complex and not always feasible clinical task. Nevertheless, direct restorations were used more often than indirect ones, and this is connected with photocomposite materials, the use of which allows to recreate the lost anatomical shape and aesthetic characteristics of teeth in one visit. This can explain such a large proportion of photocomposite restorations, especially since they demonstrate a fairly high “survival rate”. So, after 3 years, on average, 90.7 % of restorations maintained their integrity, after 5 years – 89.5 % of restorations, however, these results are given without differentiating the restorations performed in teeth with viable pulp or after endodontic treatment [12]. When localization on the chewing and contact surfaces of the teeth of the lateral group, the safety of the restorations after 3 years was fixed at 93 % and 95 % [13, 14], and after 7–8 years – at 85 % [15], which, in general, is consistent with the data obtained in our study, in particular, the integrity was established in 95.6 ± 1.09 % of photocomposite restorations, but this indicator did not take into account the terms of their functioning.

In photocomposite restorations of the lateral teeth after their endodontic treatment with localization in grade 2 after 12 months, marginal staining was found in 11.6 % of cases, impaired marginal adaptation – in 10 %, increased roughness – in 18.3 % of cases [16]. Given the short observation period, these indicators are quite comparable with the results obtained in our study. In another study, within 24 months, the number of restorations from the photocomposite in unsatisfactory condition was significantly lower – only 2.3 ± 0.16 %, but these data relate only to the anterior teeth after endodontic treatment [17].

High strength parameters of photocomposites ensure the preservation of restorations, but the frequency of color mismatch of restorations from a photocomposite and restored teeth is noteworthy. Photocomposite materials are color stable enough, probably the discrepancy is due to the color change of the endodontically treated teeth, which progresses over time. Nearly half of the restorations from photocomposites recorded edge staining, however, in restorations from other materials, this violation, as well as color mismatch, was much more common. It should also be noted that more than 70 % of the restorations from chemical curing composites and almost 84 % of glass ionomer restorations localized on the contact surfaces had contact point defects, and photocomposition restorations with contact point violations were only a quarter, despite the fact that in other studies contact failure of the item was registered within 24 months in 78.3 ± 1.5 % of restoration of posterior teeth from photocomposites, in the period of 36 months – in 80.3 ± 1.25 % of restorations [18].

Nevertheless, the advantages of direct restorations of endodontically treated teeth from photocomposites over restorations from other materials are obvious. However, it would be correct to compare them with indirect restorations from the same photocomposites, ceramic or other innovative materials.

Study limitations. The study did not include patients whose age was less than 25 years and more than 60 years, as well as patients with terms of tooth restoration after endodontic treatment of less than 2 years and more than 10 years. Patients were not included in the study if there were two or more fillings in the teeth restored after endodontic treatment; if these teeth were previously coated or prepared for covering with artificial crowns; if the restored tooth was abnormally located in the

dentition or did not have antagonist teeth; if periodontal or bite pathology was diagnosed, increased tooth abrasion, bruxism; if the level of oral hygiene was unsatisfactory. Persons suffering from mental illness were not admitted to the study, including in the case of alcohol or mental dependence.

Prospects for further research. The results of a retrospective assessment of the state of direct restoration of teeth after endodontic treatment revealed their most frequent violations. In the course of further long-term comparative clinical research, it seems appropriate to study the effectiveness of direct photocomposite tooth restoration and indirect restoration using digital technologies and innovative materials. The results of the study will form the basis of recommendations for practical implementation.

5. Conclusions

Direct restorations after endodontic treatment are most often performed in the posterior teeth, of which 760 were reconstructed from 888 examined (85.6±1.18 %), 128 restorations were revealed in the frontal teeth (14.4±1.18 %).

Of all the examined restorations, 720 restorations (81.1±1.31 %) were made from photocomposite materials, 97 restorations (10.9±1.05 %) were made from chemical curing composites, 71 (8.0±0, 91 %) – from glass ionomers.

Among the violations in direct restorations, the most frequent were the colour mismatch found in 511 restorations (57.5±1.66 % of the total), marginal staining revealed in 470 restorations (52.9±1.68 %), and roughness surface found in 357 restorations (40.2±1.65 %).

Conflicts of interest

The authors declare that they have no conflicts of interest.

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CHANGES IN THE MORPHOLOGIC STATE OF RED BLOOD CELLS IN PATIENTS WITH POLYTRAUMA

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Abstract

The measurement of RBC indices is of particular importance as an indirect intermediate component of the recovery process after exposure to hypoxia, ischemia, hypothermia in patients with traumatic disease due to polytrauma.

The aim of this study was to evaluate the parameters of the morphologic state of red blood cells as a reaction of patients with traumatic disease.

Materials and methods. A prospective study was carried out evaluation of 120 patients suffering from polytrauma. The patients were divided into 3 groups according to the principle of using additional substances as a part of IC. The parameters of morphologic state of red blood cells were studied.

Results. The course of acute and early periods of traumatic disease has accompanied variability morphological forms of red blood cells, as evidenced by a decrease in MCV and RDW increased levels of the 3rd to 5th day. The optimized therapy used in the treatment of patients, has a positive effect on the parameters of red blood cells, contributes to a better recovery of red blood cells after hypoxia resulting multiple trauma.

Conclusion. The study has demonstrated variations in the morphologic properties of red blood cells in the acute and early period of traumatic disease, as confirmed by pathological changes of the erythrocyte indices. The administration of the proposed