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CLINICAL COMPARISON OF DIFFERENT METHODS OF POSTERIOR TEETH RESTORATION

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Increasing the effectiveness of dental restorations is an important problem in modern dentistry because of the significant prevalence of dental caries. The present research is comparative clinical evaluation of the results of restorative treatment of decayed posterior teeth with direct composite restorations, metal-ceramic and zirconium dioxide onlays. It has been conducted among 90 young aged patients in comparison with a control group, which included 10 healthy persons with intact dentitions. It has been established that the use of zirconium onlays provides the greatest effectiveness of dental restorations according the indicators of their quality, dental status, plaque control, periodontal health, data of computer occlusion diagnostics in the 12-month follow-up period. Further research has to study oral microflora after dental restorations with various materials.

Key words: posterior teeth, onlay, resin composite, metal-ceramics, zirconium, periodontal health, dental occlusion.

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КЛІНІЧНЕ ПОРІВНЯННЯ РІЗНИХ МЕТОДІВ РЕСТАВРАЦІЇ БОКОВИХ ЗУБІВ

Збільшення ефективності відновлення цілісності коронок зубів залишається важливою проблемою сучасної стоматології з огляду на значну поширеність карієсу. Представлене дослідження – порівняльна клінічна оцінка результатів відновлювального лікування часткових дефектів молярів прямими композитними реставраціями, металокерамічними вкладками та вкладками, виготовленими з діоксиду цирконію, серед 90 дослідних пацієнтів молодого віку в порівнянні з контрольною групою, до якої увійшло 10 здорових осіб з інтактними зубними рядами. Встановлено, що застосування цирконієвих вкладок забезпечує найбільшу результативність відновлювального лікування через 12 місяців за показниками якості реставрацій, клінічного стану зубів, наявності зубних відкладень, пародонтального статусу, даних комп'ютерної оклюзіографії. Необхідні подальші дослідження мікрофлори ротової порожнини при відновленні часткових дефектів зубів різними матеріалами.

Ключові слова: моляри, вкладки, композити, металокераміка, цирконій, пародонтальний статус, оклюзія.

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According to the WHO, approximately 2.3 billion people suffer from caries of permanent teeth. At the same time, before the COVID-19 pandemic, the prevalence of dental caries was 91.8 %, with an average DMFT (decayed, missing, and filled teeth) index of 12.13. Whereas after the pandemic, its prevalence decreased to 84.5 % with a DMFT index of 10.99. Such changes in index values are associated with an increase in missing teeth and a decrease in decayed and filled teeth [8]. These dynamics indicate the need to improve measures of secondary prevention of dental caries to increase the number of saved teeth.

In turn, the use of modern technologies and the latest materials allows effective anatomical and functional restoration of decayed teeth. Thus, optimization of resin composite materials due to an increase in the proportion of inorganic filler and improvement of bonding techniques makes it possible to widely use the method of direct restoration of decayed posterior teeth [4].

At the same time, the results of our previous research proved that in practice, direct composite restorations are carried out mainly without considering gnathological approaches, by means of grinding according patient's subjective feelings. Afterwards, it contributes to the development of occlusal disorders [2]. On the contrary, indirect restorations are made from materials which are resistant to masticatory load in laboratory conditions in articulators. They allow greater effectiveness of restorative treatment from the position of functional dynamic occlusion.

The choice of restorative material affects other treatment outcomes, in particular, it is important for marginal adaptation. Restorations based on zirconium dioxide, manufactured using CAD/CAM technique, provide the best results in marginal fit, periodontal response, and oral hygiene [7, 13]. This was confirmed by a comparative study among 95 patients after the use of prosthetic rehabilitation for 12 months. According to the results, the greatest increase in the modified dental plaque index (88 %) was found for cobalt-chrome ceramic prosthesis fabricated by the conventional method, 81 % was for cobalt-chrome ceramic prosthesis fabricated by a computer aided design and computer aided manufacturing (CAD/CAM) technique, and 63 % was for zirconia-based prosthesis ($p<0.01$). According to the values of the periodontal

index, the number of people with healthy periodontal tissues for conventional method of metal-ceramics was 17 %, for CAD/CAM metal-ceramics was 24 %, and for zirconia was 37 % [3].

Moreover, according to the results of a study of 129 patients with generalized periodontitis, the use of zirconium dioxide designs decreases inflammatory processes in periodontal tissues in 12 months, what is explained by the biocompatibility of this material and a decrease in the risk of microbial biofilm formation [10].

Nevertheless, studies of the effectiveness of the use of various construction materials for oral hygiene and periodontal health were carried out mainly for crowns, which are not an alternative to resin composite restorations and onlays in the restoration of partial dental decays. Therefore, in the presented study, we conducted a comparative study of restorations made of different materials and using different techniques for restoring caries decay in proximal surfaces of molars which take part in occlusal vertical dimension fixation.

The purpose of the study was to perform a clinical evaluation of restorations of partially decayed molars by the mean of direct resin composite restorations, metal-ceramic and zirconium onlays according to the criteria of restoration quality, plaque index, periodontal health, occlusal relationships in the 12-month follow-up period.

Materials and methods. The clinical study was conducted at the Department of Prosthetic Dentistry of the Dnipro State Medical University. During the work, the principles of the Helsinki Declaration of the World Medical Association “Ethical Principles of Biomedical Research on Human Subjects” were strictly observed. Informed consents were obtained from all patients-participants after explaining the character of this study and possible risk and discomfort.

To achieve this purpose, we treated 90 patients with caries decay in the proximal (mesial or distal) surfaces of the maxillary and mandibular first and second molars (Class II by Black). In the study, there were people of young aged according to the WHO (their average age was 28.0±3.1 years), equally women and men who did not have periodontal diseases and dentition defects.

Exclusion criteria were somatic diseases in the stage of decompensation, severe endocrine disorders, oncological pathology, immunosuppression of various genesis, pregnancy and smoking.

The patients were divided into 4 experimental groups of 30 persons, equivalent in age, sex and clinical situation, in particular, according DMFT index and index of dental occlusal surface decay (up to 0.6). In the first group, decayed molars were restored by means of direct restorations with resin composite materials recommended for posterior teeth. Dynamic occlusion control was carried out using articulating paper of different thickness. Such a way, 144 direct resin composite restorations were made.

In the second research group, the restorative treatment consisted of metal-ceramic onlays fabricated by the conventional method, which includes taking impressions, casting models, plastering them in the universal articulator of Non-Arcon type. For individual adjustment of this articulator, the silicone bite registrants were received in centric and eccentric occlusions. Casting models in the articulator was carried out using the facial arch. It was made 137 metal-ceramic onlays. In the third research group, dental prosthetics was performed using CAD/CAM technology of zirconium on the special equipment. This method was used to make 122 onlay designs. Comparison of the obtained results of the experimental groups was carried out with the data of the control group, which included 10 young aged people with intact dentitions and healthy periodontal tissues.

Clinical studies were conducted after prosthetic treatment at once and in the 12-month follow-up period. Restorations were evaluated using modified United States Public Health Service (USPHS) criteria. They were considered successful when they were classified as "A" and "B" according to all criteria (anatomical form, marginal adaptation, surface texture, marginal discoloration, retention, and secondary caries). In turn, if the restoration met “C” from at least one or more criteria, they were considered unsatisfactory [5].

It was used Modified Approximal Plaque Index, Gingiva Index by Silness & Löe, and probing pocket depth to describe the periodontal health of teeth. Using William’s periodontal probing, it was examined six surfaces of tooth. They were mesial-buccal, buccal, distal-buccal, distal-lingual (palatinal), lingual (palatinal), and mesial-lingual (palatinal) [1]. As a comparison, the results of the control group were used.

Occlusion analysis was performed both by studying occlusal contacts on diagnostic models in the articulator, and using the CAD/CAM software.

Obtained data were processed with variation statistic methods using Microsoft Office Excel 2016 Software. Student’s test was used. The difference was considered statistically significant at $p<0.05$.

Results of the study and their discussion. At once after the treatment, all the performed restorations met the requirements, that is, level "A" according to all criteria. Whereas, after 12 months, 95.8 % of 144 direct composite restorations, 97.0 % of 137 metal-ceramic onlays, and 100 % of 122 zirconia restorations were successful. In all cases, the cause of unsuccessful resin composite restorations was excessive wear of their occlusal surface. For metal-ceramic onlays, the problem of ineffective restorative treatment were marginal fit disorders (Table 1).

Table 1

Clinical Evaluation of the Restorations According to the Modified United States of Public Health Service Criteria (12-month follow-up, No. of teeth)

Category	Score	Characteristic	Restorations		
			Direct composites (n=144)	Metal-ceramics (n=137)	Zirconium (n=122)
Anatomic form (Wear)	A	Original	91	137	122
	B	Changes in contour, clinically acceptable	47	0	0
	C	Excessive wear	6	0	0
Marginal adaptation	A	Closely adapted	111	120	119
	B	Slight discontinuity, clinically acceptable	32	13	3
	C	Margin ledge	0	4	0
Surface texture	A	Enamel-like	104	137	122
	B	Rougher than enamel	37	0	0
	C	Unacceptable rough	0	0	0
Marginal dis-coloration	A	No mismatch	136	137	122
	B	Slight mismatch	8	0	0
	C	Unacceptable mismatch	0	0	0
Retention	A	Present	132	137	122
	B	Partial lost, but clinically acceptable	0	0	0
	C	Clinically unacceptable partial lost or absent	0	0	0
Secondary caries	A	Absent	144	137	122
	C	Present	0	0	0

Among 138 acceptable composite restorations, 5.8 % had a grade of "B" in four criteria, 20.3 % in three ones, 34.1 % in two ones, and 5.8 % in one criterion. According to the results presented in the table, the most problematic for composite restorations were wear, marginal adaptation, and surface texture. Accordingly, among 133 satisfactory metal-ceramic onlays, 9.8 % met criterion "B" in terms of marginal adaptation. Zirconium-based onlays showed the best long-term result. In only 2.5 % of cases out of 122 observations, the compliance level "B" according to the marginal fit criterion was established.

It should be noted the absence of disorders according to such criteria as retention and secondary caries for all restorations. Onlays have proven to be more effective in preserving color and surface smoothness compared to resin composite materials.

Therefore, according to the results of our study, the use of composite materials to restore decays of the proximal surfaces of molars causes wear of the occlusal surface due to masticatory load. While the reason for unsuccessful prosthetics with metal-ceramic onlays is mainly marginal adaptation. The most likely reason for this was cement layer decay. As can be seen from our study, this drawback can be eliminated by using improved bonding systems and composite cements, as in cases of fixation of zirconia prosthetics.

The results of the evaluation of periodontal status in the distant term after restorative treatment are presented in Fig. 1.

Restoration of the proximal surfaces of the posterior teeth with resin composite materials caused worsening of oral hygiene, which was manifested by an increase in the plaque index compared to the control ($p<0.05$). In turn, this led to the development of inflammatory process in the marginal periodontal tissues and the destruction of the periodontal ligament, which was manifested by the deepening of the dental-gingival sulcus in comparison with the control group ($p<0.05$). In our opinion, the development of marginal gingivitis was caused with difficulty to restore point interdental contacts directly in the oral cavity.

Accordingly, prosthetics of dental decays with onlays did not contribute to the development of inflammatory-destructive phenomena in the periodontal tissues and ensured a satisfactory state of hygiene. The best periodontal health results were obtained in the cases of zirconia restorations. The location of the restoration edge at the level of the gingival margin was decisive in preserving the periodontal health.

No patient was diagnosed with a critical state of the periodontal tissues after restorative treatment that required special treatment.

In turn, computer occlusion analysis proved that immediately after the restoration treatment, it was possible to achieve optimal intercuspidation in all occlusions, which was evidenced by the uniform blue coloring of the occlusal surface of dentitions in all patients.

The positive outcomes of occlusion renewal in the near term proves that a high-quality result can be ensured by the use of different methods such as clinical occlusion checking, modeling of the occlusal surfaces of restorations in the articulator, and by means of CAD/CAM method.

Nevertheless, in 12 months after the treatment, preservation of occlusal balance was registered only in patients with indirect restorations, while resin composite materials did not allow maintaining optimal occlusal relations in all patients (Fig. 2).

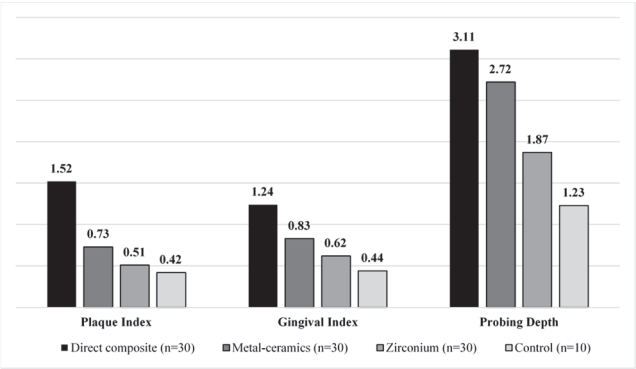

Fig. 1. Mean values of the Modified Approximal Plaque and Gingiva Index by Silness & Löe and the probing pocket depth (12-month follow-up, points)

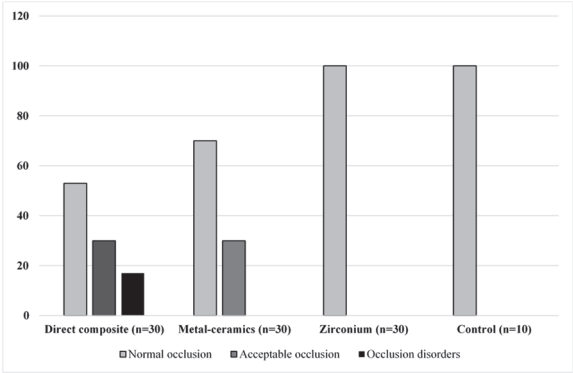

Fig. 2. Results of 12-month follow-up computer occlusion diagnostics (%)

Occlusal disorders in the cases of direct composite restoration of molar decay were established in 47 % of cases out of 30 patients. At the same time, according occlusion diagnostics, 30 % of 30 patients had only green staining of the supracontacts, while 17 % of 30 patients had red staining. Centric supracontacts were registered in 30 % of 30 patients in the group of composite restorations, and eccentric ones were in 40 % of 30 cases. Hyperbalancing interdental contacts were registered in 7 % of 30 patients. It's important that red staining was observed in cases of the greatest wear of resin composite restorations.

In the group of patients with metal-ceramic onlays, acceptable disorders of occlusal balance, described by green staining, were found in 10 % of 30 cases. During the function, it is possible to assume a slight displacement of the metal-ceramic onlays because of the insufficient durability of the cement layer, taking into account the most unfavorable localization of decay that are being restored on the proximal surfaces. During prosthetics with zirconia designs, no violations of occlusion were observed. In our view, the obtained result is related to the currently known advantages of CAD/CAM technology.

Such a way, zirconia onlays allowed to preserve functional dynamic occlusion in 100 % of 30 patients; metal-ceramic onlays were successful in 90 % of 30 cases; resin composite restorations were effective only for 53 % of 30 patients.

Thus, the results of our study confirmed the sufficient effectiveness of direct composite restorations for the restoration of posterior teeth, which was described in the article [4]. At the same time, established successfulness of their application corresponds to the value of the annual failure rates of only 2.4 % [6]. In cases of restoring posterior teeth by the direct method, an acceptable occlusion can be renewal clinically, as effectively as with the indirect method, which corresponds to the conclusions of the meta-analysis [11]. According the results of our research, the problem of resin composite restorations in posterior teeth is, firstly, in their wear because of functional load, which leads to the occlusion disorders, and, secondly, in decrease in oral hygiene and the progression of the inflammatory process in the marginal periodontium.

We have confirmed that zirconium restorations are the best for dental plaque prevention in comparison with metal-ceramic prosthesis, which is consistent with the data [3, 9] and it can be explained by the biocompatibility of this material [10]. Based on the results of computer occlusion diagnostics, long-terming presentation of occlusion balance is only expected for indirect restorations with the best results for zirconium prothesis. Indeed, CAD/CAM technology has the greatest effectiveness to restore and to preserve occlusal vertical dimension [12].

Conclusions

To achieve effective restoration of proximal surfaces of posterior teeth is possible using both direct resin composite restorations, and indirect metal-ceramic and zirconium restorations. However, zirconium dioxide-based onlays fabricated by a CAD/CAM technique, demonstrate the greatest effectiveness. At long-term follow-up, they demonstrate 100 % satisfaction, compared to 95.8 % of resin composite restorations and 97.0 % of metal-ceramic onlays. Zirconium prosthesis ensures the best condition of abutment teeth and their periodontal tissues according the indicators of their quality, dental status, plaque control, periodontal health, data of computer occlusion diagnostics. Zirconia onlays in molars contribute to the preservation of functional dynamic occlusion in 100 % of cases compared to 53 % for resin composite restorations and 90 % for metal-ceramic onlays. Further research is warranted to study oral microflora during dental restoration with various materials.

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