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# DENTAL AESTHETIC INLAY CORE – PRACTICAL EVALUATION

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**Abstract**

The focus of dentistry now is both on the prevention and treatment of diseases and on meeting the demands for better esthetics. The improvement of metal-free structures and various technologies for prosthetics with metal-free ceramics is one of the most important areas in dental research.

**The objective:** to assess the condition of periodontal tissues of teeth restored by different types of inlay cores and predict the development of pathological processes in the tissues surrounding the restored root.

**Materials and methods.** 108 people took part in researches and 1296 laboratory and clinical analyzes were performed. All patients underwent aesthetic prosthetics with crowns made of press ceramics. Patient Informed Consent was obtained from all the persons under treatment. The use of ceramic inlays in prosthetics with ceramic crowns does not cause inflammatory processes in periodontal tissues, and after traumatic exposure of the tooth preparation for prosthetics, are quickly restored to the level of a healthy gingival margin. The use of ceramic inlays in combination with ceramic orthopedic structures allows to reduce the hygienic index by 46.3%, gingival index - by 84.6%, and Russel's periodontal index - by 62.8%. In the group of patients with ceramic inlays made according to our technology, there was a tendency to reduce the intensity of leukocyte migration already in a month after prosthetics. In a year after prosthetics, this index is still reduced.

All human studies were conducted in compliance with the rules of the Helsinki Declaration of the World Medical Association "Ethical principles of medical research with human participation as an object of study". Informed consent was obtained from all participants.

**Keywords**: *metal-free ceramics, CAD/CAM ceramics, all-ceramic system*

## Introduction

Dental ceramics are one of the most common restorations owing to their advantages such as good esthetics, the ability to produce smooth surfaces (which minimizes plaque adherence and subsequent periodontal inflammation), and biocompatibility.

The improvement of metal-free structures and various technologies for prosthetics with metal-free ceramics is one of the most important areas in dental research.

Over the last 10 years, the use of ceramics made of zirconium dioxide as a frame material for the manufacture of microprostheses, single crowns and small bridges has increased. Their use in dental practice has become possible with the help of computer-aided design / computer-aided manufacturing (CAD / CAM) technologies. Clinical studies of ceramic restorations based on zirconium dioxide have shown promising clinical results and high survival rates. However, chipping and brittleness of ceramic masses layered on zirconium dioxide frames remains a topical problem of modern orthopedic dentistry.

Dental ceramics consist of a porcelain mass containing crystals of leucite, which forms a refractive skeleton, and the glass fills the gaps, adding special qualities necessary for dental ceramics.

The use of leucite crystals allowed to create porcelain masses with a high coefficient of thermal expansion for compatibility with various alloys used in dentistry. For example, the combination of leucite and glass creates thermally compatible and durable porcelain.

That is why in modern orthopedic dentistry there is an urgent problem of improving the quality of restoration of the frontal group of teeth by improving and testing the technology of pressed ceramics.

**The objective:** to assess the condition of periodontal tissues of teeth restored by different types of inlay cores and predict the development of pathological processes in the tissues surrounding the restored root.

## Methods

108 people took part in clinical and clinical-laboratory researches, which were divided into four groups depending on the type of restoration of the destroyed abutment tooth. All patients underwent aesthetic prosthetics with crowns made of press ceramics. Patient Informed Consent was obtained from all the patients under treatment. Distribution of the patients by age, sex, etc. is given in Table 1.

Women and patients aged 30-39 prevailed in the study.

In the first group (control) we included patients who did not have tabs under ceramic crowns, they were restored if necessary with photopolymer materials or glass ionomer cements.

The second group included patients who underwent prosthetics of single defects of the dentition with the same ceramic structures using metal cobalt-chromium alloy inlay cores.

The third group consisted of patients who underwent prosthetics of the destroyed crown parts of the teeth using ceramic inlays made in accordance with the Protocol of dental care [1].

In the fourth group we selected patients whose prosthetics were made according to our own scheme and our restoration designs of ceramic inserts.

Patients had no chronic somatic diseases and contraindications to crown prosthetics. The destruction of the tooth crown in all patients was the result of complicated caries. Teeth to be prosthetized had no changes in the periapical tissues and were stable.

1296 laboratory and clinical analyzes were performed.

Clinical and laboratory parameters were studied in patients before prosthetics, before fixation of the crown prosthesis, a month, 2, 6 months and 1 year after the start of prosthetics.

The condition of periodontal tissues (pathological changes) was assessed according to Schiller-Pisarev test. The results are given in Table 2

## Results

It is known that under the influence of chronic inflammation in the gingival tissue the amount of glycogen increases sharply. The latter is stained by iodine in brown, which indicates a positive test. The test dynamics allows us to judge the effectiveness of rational prosthetics and its effect on the tissues of the marginal area of the gums.

From the data presented in the table it is seen that the indicators of the test in the control group are at a stable level in all terms of the study (average 2.20 Ru). However, after the core fixing and when the cover structure is done, the indicator increases by 5.5% (to 2.34 ± 0.02 Ru), and after a prolonged use of the structure returns to the original figure (Fig. 1).

This test indexes in after - prosthetics patients reduce to normal, which is apparently due to the improvement of periodontal tissues after complete adaptation to the crown cover structures.

The results obtained in the second group (the use of cobalt - chromium inlays with a ceramic cover structure) first (before preparing the root for the inlay core) the indicator is (2.46 ± 0.01) Ru. In prosthetics, the indicator decreases slightly (to 2.40 ± 0.02) Ru and equalizes to the norm only a year after prosthetics (Fig. 2).

In the third group (the traditional method of manufacture) the fluctuations of the indicator were insignificant (Fig. 3), which indicates the bioinertness of the ceramic tab.

A slight increase in the moment of prosthetics, in our opinion, is due to trauma received during prosthetics.

The fourth group (tabs made by our own technology ) is characterized by almost complete absence of fluctuations in the glycogen index (Fig. 4).

If at the beginning of clinical trials the index was (2.30 ± 0.04) Ru, then after 1 month after prosthetics it decreases to (2.20 ± 0.01) Ru and remained at this level for 1 year.

Thus, a comparative study of glycogen levels in periodontal tissues of tooth roots, which are restored under aesthetic crowns with root inlays use, showed that the use of ceramic inlays in prosthetics with ceramic crowns does not cause inflammation in periodontal tissues. Besides, after trauma caused by tooth preparing and its preprocessing to prosthetics, glycogen level recovers fairly quickly to that of a healthy gingival margin.

We studied the hygienic component of the cover structure with fixed ceramic or metal inlays, i. e. we investigated how the material and designs features of the inlay cores affect the hygiene of the periodontium of the teeth to be restored.

In the patients under examination there were numerous deposits of soft plaque in the area of destroyed teeth before prosthetics, less often the presence of supragingival dental tartar. This defect is the main factor of negative impact on the periodontium of teeth with a destroyed crown.

The results of studies of the hygienic index (Table 3) showed that even a simple restoration of the tooth with removal of the subgingival defect and isolation of marginal periodontal tissues from microbial factors leads to a significant improvement in the hygienic condition of this area of the periodontium.

When prosthetics with ceramic crowns with the use of metal inlay cores, this effect is more noticeable and the hygienic index decreases after prosthetics by 27.8% (from 2.30 ± 0.11 to 1.66 ± 0.14 Ru).

In the study of the hygienic index in the third and fourth groups there is a tendency to improve the hygienic condition in the immediate term more intensively than in the second group. Thus, in the group of patients with traditional ceramic inlays, the hygiene index decreases after prosthetics by 45.6% (from 2.52 ± 0.14 to 1.36 ± 0.09) Ru, in the group of ceramic inlays made by our technology it decreased by 46.3% (from 2.31 ± 0.15 to 1.24 ± 0.06) Ru.

Thus, the use of ceramic inlays with a covering structure of all-ceramic crowns leads to an increase in the hygiene index by 46.3% and remains at a consistently low level in the separate terms of prosthetics (Fig. 5).

The results of studies of the gingival index are presented in Table 4. The evidence presented suggests that prosthetics with the use of ceramic inlay cores has a positive dynamics in the state of marginal periodontium. When the inlays made by our technology with a ceramic covering, dynamics of a gingival index is negative and more significant.

Russel's periodontal index had a similar tendency to change (Table 5). At prosthetics in the second group (CCA inlays) this index decreases by 58,9% (from 1,24 ± 0,08 to 0,51 ± 0,09) Ru. When prosthetics with ceramic crowns and core inlays of the same material was made, Russel's index decreases by 59.3% (from 1.23 ± 0.03 to 0.50 ± 0.05) Ru.

When prosthetics with ceramic inlays, made by our technology, Russel's index decreases by 62.8% (from 1.21 ± 0.08 to 0.45 ± 0.05 Ru).

Patients of the second group, in whom more than six months passed from the moment of tooth destruction to restoration, after fixation of the covering structure felt slight discomfort in the area of the restored tooth. In a month and 1 year after prosthetics, patients did not complain. During the year there were no pathological changes in the periodontal tissues of restored teeth. In the third and fourth groups, these subjective phenomena were not observed.

Thus, the use of ceramic inlays in combination with ceramic orthopedic structures allows to reduce the hygienic index by 46.3%, gingival index - by 84.6%, and Russel's periodontal index - by 62.8%.

The study of epithelial exfoliation and the rate of leukocyte migration during prosthetics with different types of inlays under aesthetic crowns showed that in the first group, the intensity of leukocyte emigration did not change after 2 months, although in a month after prosthetics it increased slightly, which is probably due to the processes of adaptation to prosthetics. In 6 months after fixation of the prosthesis, these indexes decreased by more than 15%. Exfoliation of the epithelium from the mucosa in 2 months was somewhat more intense, but the data are suspect. In 6 months there was a significant decrease in the number of epithelial cells in the patients' mouth lavage ($p < 0.05$ relative to baseline).

Similar changes occurred in the second group of studies. In the third group there was a clear decrease of leukocytes migration (up to 374.2 thousand / 1 ml), which indicated a decrease in the intensity of chronic inflammatory processes in the patients underwent prosthetics.

In prosthetic carriers of the control group, the intensity of leukocyte emigration in 2 months did not change, although in a month after prosthetics it increased slightly. This is probably due to the processes of adaptation to artificial crowns. Similar changes took place in the second group of studies (the use of cobalt-chromium alloy). In the third group there was a clear decrease in the migration of leukocytes (up to 385.5 thousand / 1 ml), which indicated a decrease in the intensity of chronic inflammatory processes occurring in the mucous membrane of periodontal tissues during prosthetics with ceramic inlays. In a year after fixation of the prosthesis, these figures decreased by more than 15%.

In the group of patients with ceramic inlays made according to our technology, there was a tendency to reduce the intensity of leukocyte migration by 18.9% from (465.5 ± 42.5) to (377.6 ± 38.2) thousand cells already in a month after prosthetics. In a year after prosthetics, the index is still reduced by 3.3%. Dynamics of epithelial exfoliation is shown in Table 6.

When investigate the intensity of epithelial exfoliation in the third group (the use of ceramic inlays and ceramic crowns) fluctuations in the exfoliation of the epithelium are minimal (Fig. 6). A similar situation is observed in patients of the fourth group.

## Conclusions

The use of ceramic inlays in prosthetics with ceramic crowns does not cause inflammatory processes in periodontal tissues, and after traumatic exposure of the tooth preparation for prosthetics, are quickly restored to the level of a healthy gingival margin.

The use of ceramic inlays in combination with ceramic orthopedic structures allows to reduce the hygienic index by 46.3%, gingival index - by 84.6%, and Russel's periodontal index - by 62.8%.

In the group of patients with ceramic inlays made according to our technology, there was a tendency to reduce the intensity of leukocyte migration already in a month after prosthetics. In a year after prosthetics, this index is still reduced by 3.3%.

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The authors declsre that there are no conflicts of interest.

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**Table 1.** Characteristics of patients who participated in clinical trials

| Representative group | N of patients | Distribution by sex, persons | | Distribution by age, persons | | | |
|---|---|---|---|---|---|---|---|
| | | M | F | 30-39 | 40-49 | 50-59 | 60 and > |
| The first | 32 | 11 | 21 | 27 | 2 | 3 | 0 |
| The second | 32 | 8 | 24 | 20 | 9 | 2 | 1 |
| The third | 22 | 7 | 15 | 13 | 4 | 1 | 2 |
| The fourth | 22 | 6 | 16 | 20 | 4 | 0 | 0 |
| Total | 108 | 33 | 76 | 80 | 19 | 6 | 3 |

**Table 2.** The results of Schiller-Pisarev test in patients with a tooth destroyed crown restored by various types of inlay cores, relative units

| Group | Terms after the beginning of prosthetics | | | | | |
|---|---|---|---|---|---|---|
| | Before prosthetics | At the day of the crown fixation | In 1 month | In 2 months | In 6 months | In 1 year |
| The 1st (control) | 2.21 ± 0.02 | 2.34 ±0.02 | 2.20±0.03 | 2.24±0.04 | 2.21±0.02 | 2.28±0.01 |
| The 2nd (CCA) | 2.46±0.01 | 2.40±0.02 | 2.36±0.01 | 2.33±0.02 | 2.35±0.04 | 2.38±0.03 |
| p | <0.01 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| The 3rd (ceramics) | 2.33±0.01 | 2.40±0.02 | 2.28±0.02 | 2.30±0.05 | 2.25±0.06 | 2.20±0.04 |
| p | <0.05 | <0.05 | <0.05 | >0.05 | >0.05 | >0.05 |
| The 4th (own | 2.30±0.04 | 2.35±0.01 | 2.20±0.01 | 2.20±0.02 | 2.18±0.02 | 2.22±0.05 |
| p | <0.05 | >0.05 | - | >0.05 | >0.05 | .0.05 |

*Note: p* is the probability compared to the control group

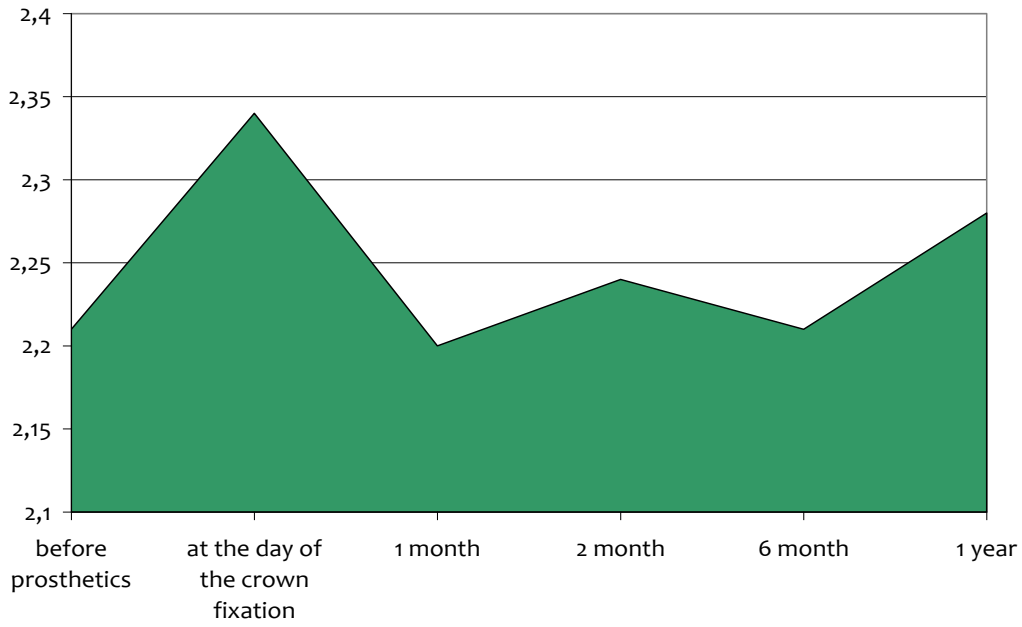


**Figure 1.** Dynamics of changes in Schiller-Pisarev test in the control group, relative units

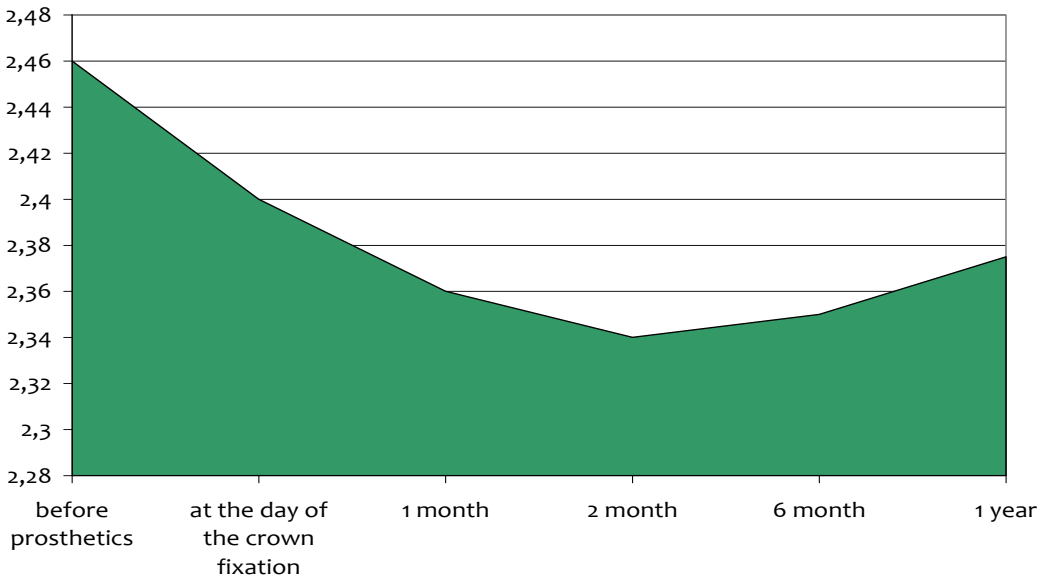


**Figure 2.** Dynamics of Schiller-Pisarev test changes in the second group, relative units

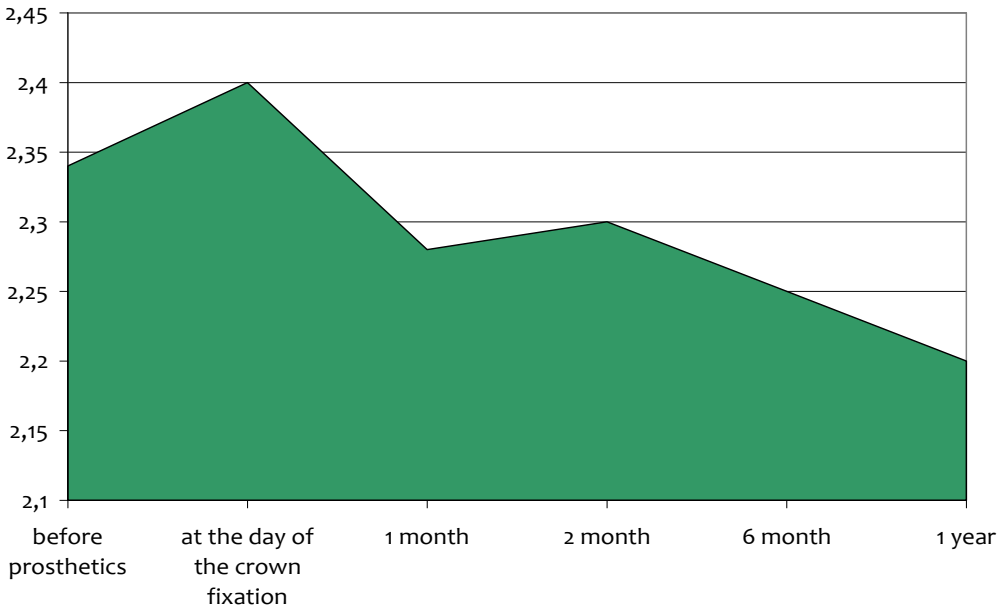


**Figure 3.** Dynamics of Schiller-Pisarev test changes in the third group, relative units


**Figure 4.** Schiller-Pisarev test changes in the fourth group, relative units

**Table 3.** Indicators of the hygienic index of patients with crown part defects, relative units

| Group | Term of observation / Research group | Before treatment | After crown's fixation | In a month | In a year |
|---|---|---|---|---|---|
| 1 | Control | 2.44 ± 0.09 | 2.34 ± 0.11 | 2.11 ± 0.12 | 1.99 ± 0.08 |
| 2 | Cobalt-chromium alloy | 2.30 ± 0.11 | 1.66 ± 0.14 | 1.32 ± 0.17 | 1.27 ± 0.21 |
| p | | >0.05 | <0.05 | <0.05 | <0.05 |
| 3 | Ceramics | 2.52 ± 0.14 | 1.37 ± 0.07 | 1.36 ± 0.09 | 1.41 ± 0.15 |
| p | | >0.05 | <0.05 | < 0.05 | < 0.05 |
| 4 | The developed inlay core | 2.31 ± 0.15 | 1.42 ± 0.02 | 1.24 ± 0.06 | 1.33 ± 0.07 |
| p | | >0.05 | <0.01 | <0.05 | <0.05 |

*Note:* p is the probability compared to the control group

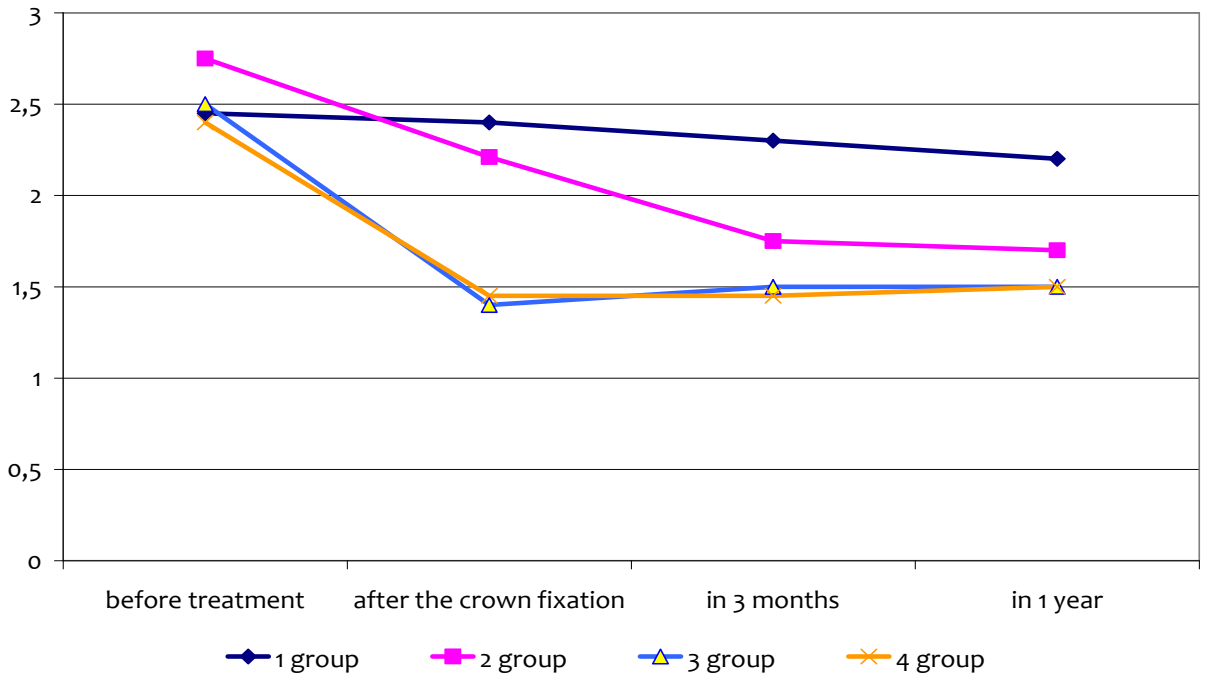


**Figure 5.** Dynamics of changes of a hygienic index at prosthetics by ceramic crowns of crown defects of dentitions and various types of inlay cores, relative units

**Table 4.** Indicators of the gingival index in the prosthesis of coronary defects using inlay cores of different materials (Loe, Silness; relative units )

| Group, N | Term of observation / Research group | Before treatment | After fixation of crown | In a month | In a year |
|---|---|---|---|---|---|
| 1 | Control | 2.10 ± 0.09 | 1.40 ± 0.20 | 0.77 ± 0.09 | 0.92 ± 0.14 |
| 2 | Cobalt-chromium alloy | 2.23 ± 0.11 | 1.43 ± 0.12 | 0.94 ± 0.13 | 0.82 ± 0.14 |
| p | | >0.05 | >0.05 | >0.05 | >0.05 |
| 3 | Ceramics | 2.01 ± 0.08 | 0.98 ± 0.02 | 0.87 ± 0.05 | 1.44 ± 0.09 |
| p | | >0.05 | <0.05 | >0.05 | <0.05 |
| 4 | The developed inlay core | 2.08 ± 0.15 | 0.72 ± 0.14 | 0.32 ± 0.04 | 0.31 ± 0.05 |
| p | | >0.05 | <0.05 | <0.05 | <0.05 |

*Note:* p is the probability compared to the control group

**Table 5.** Indicators of periodontal index in the prosthesis of coronary defects using inlay cores of different materials (Russel; relative units).

| Group N | Term of observation / Research group | Before treatment | After fixation of a crown | In a month | In a year |
|---|---|---|---|---|---|
| 1 | Control | 1.25 ± 0.08 | 0.66 ± 0.07 | 0.48 ± 0.03 | 0.66 ± 0.11 |
| 2 | Cobalt-chromium alloy | 1.24 ± 0.08 | 0.71 ± 0.05 | 0.51 ± 0.09 | 0.54 ± 0.09 |
| p | | >0.05 | >0.05 | >0.05 | >0.05 |
| 3 | Ceramics | 1.23 ± 0.03 | 0.73 ± 0.06 | 0.50 ± 0.05 | 1.48 ± 0.05 |
| p | | >0.05 | >0.05 | >0.05 | >0.05 |
| 4 | The developed inlay core | 1.21 ± 0.08 | 0.66 ± 0.02 | 0.45 ± 0.05 | 0.41 ± 0.08 |
| p | | >0.05 | >0.05 | >0.05 | >0.05 |

*Note*: p is the probability compared to the control group

**Table 6.** Dynamics of changes in the intensity of epithelial exfoliation in the prosthesis of coronary defects using inlay cores of different materials, thousand of cells / 1 ml of mouth lavage

| Group N | Term of observation / Research group | Before treatment | After fixation of the crown | In a month | In a year |
|---|---|---|---|---|---|
| 1 | Control | 33.5 ± 3.0 | 34.2 ± 2.4 | 33.9 ± 1.5 | 31.2 ± 2.0 |
| 2 | Cobalt-chromium alloy | 33.3 ± 2.4 | 49.4 ± 0.6 | 40.4 ± 1.4 | 38.2 ± 2.8 |
| p | | >0.05 | <0.05 | <0.05 | <0.05 |
| 3 | Ceramics | 32.2 ± 1.9 | 34.4 ± 4.2 | 30.9 ± 2.4 | 33.7 ± 3.1 |
| p | | >0.05 | >0.05 | >0.05 | >0.05 |
| 4 | The developed inlay core | 33.8 ± 4.2 | 32.1 ± 1.4 | 30.4 ± 5.8 | 28.8 ± 4.5 |
| p | | >0.05 | >0.05 | >0.05 | >0.05 |

*Note:* p is the probability compared to the control group

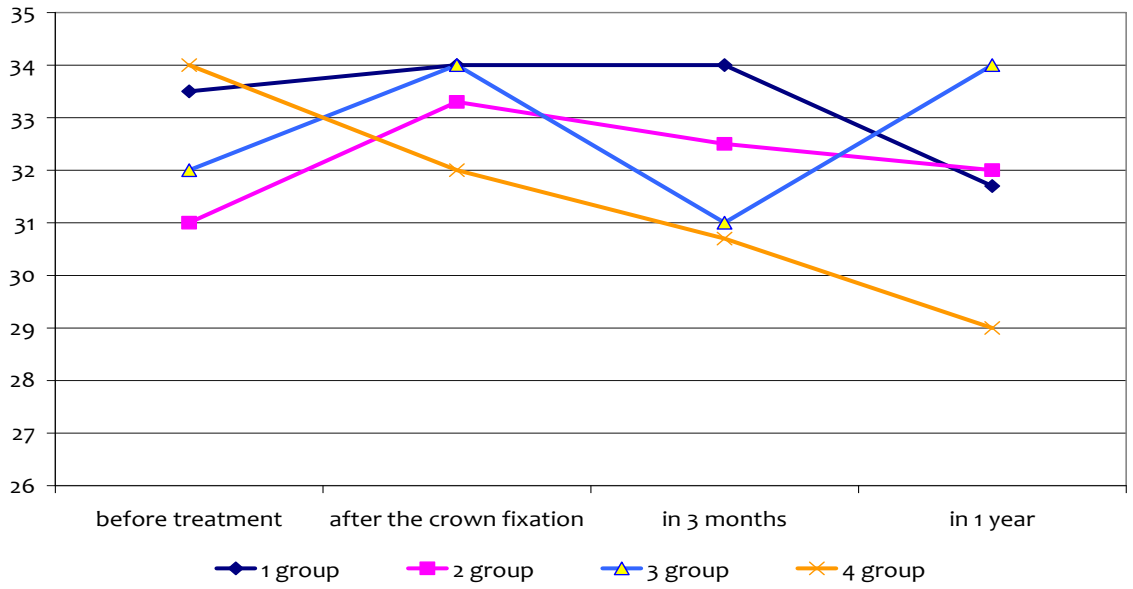


**Figure 6.** Dynamics of the intensity of epithelial exfoliation in patients with different types of inlay cores, thousand cells / 1 ml of mouth lavage