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## Analysis of Oral Mucosa Cytogram (Including Markers of Local Inflammatory and Toxic-Allergic Processes).

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### ABSTRACT

The article covers the data on the analysis of oral mucosa cytogram, when applying modified polymer with silver nanoparticles as structural material for designing complex removable dentures and apparatus.

**Keywords:** complex dental prosthetics, removable dentures, silver nanoparticles, analysis of cytogram, eosinophils, foreign body resorbing cells, neutrophils.

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## INTRODUCTION

The article reports about modified polymer with silver nanoparticles that was developed in the Department of Orthopedic Dentistry, Voronezh N.N.Burdenko Medical University, together with the Voronezh State University [2]. Silver is located on the surface of polymer and is not included in the structure of a polymeric unit. With that, analysis of physico-mechanical, toxico-hygienic characteristics of modified polymer demonstrated significant improvement of values and complete blockage of residual monomer discharge from the prepared denture or apparatus into oral tissue [1,3]. Having obtained the results of preliminary trials the authors performed analysis of cytological characteristics of oral mucosa when applying complex removable dentures and apparatus produced from modified polymer with silver nanoparticles [4, 5].

## MATERIALS AND METHODS

60 patients divided into two groups were examined to meet the objectives; Group I were the patients with standard dental prostheses, in patients of group II prostheses with modified polymer were applied.

The authors applied complex removable dentures from non-modified (group I) and modified (group II) polymers and performed comparative analysis of dynamic changes of oral mucosa cytological key characteristics in both groups. The following results were obtained.

In both groups the findings "Foreign body resorption cells" were identical at the stage "prior prosthesis" and amounted to 0 units in all cases. This fact supports total homogeneity (comparability) of these findings in both groups.

Statistical analysis revealed lack of differences between groups in the findings "Foreign body resorption cells" at the stage "prior to prosthesis" (Me of group 1 = 0 units in the field of vision, LQ = 0, UQ = 0; Me of group 2 = 0 units in the field of vision, LQ = 0, UQ = 0; Mann-Whitney U test, statistical significance p-level = 1,111111).

In group 1(non-modified polymer) the finding "Foreign body resorption cells" amounts to 1 to 3 units in the field of vision ( $2.7 \pm 0.15$  units in the field of vision) at the stage "in 7 days". In group 2 (modified polymer) this finding is 0 units in the field of vision in all cases. The difference between groups amounts to 100% with the advantage of group 2 (application of modified polymer).

Statistical analysis revealed significant differences between groups in the finding "Foreign body resorption cells" at the stage "in 7 days" (Me of group 1 = 2.0 units in the field of vision, LQ = 1, UQ = 3; Me of group 2 = 0 units in the field of vision, LQ = 0, UQ = 0; Mann-Whitney U test, statistical significance p-level = 0.000000).

In group 1(non-modified polymer) the finding "Foreign body resorption cells" amounts to 1 to 3 units in the field of vision ( $2.6 \pm 0.14$  units in the field of vision) at the stage "in one month". In group 2 (modified polymer) this finding is 0 units in the field of vision in all cases. The difference between groups amounts to 100% with the advantage of group 2 (application of modified polymer).

Statistical analysis revealed significant differences between groups in the finding "Foreign body resorption cells" at the stage "in one month" (Me of group 1 = 2.0 units in the field of vision, LQ = 1, UQ = 3; Me of group 2 = 0 units in the field of vision, LQ = 0, UQ = 0; Mann-Whitney U test, statistical significance p-level = 0.000000).

In group 1(non-modified polymer) the finding "Foreign body resorption cells" amounts to 4 to 6 units in the field of vision ( $5.9 \pm 0.25$  units in the field of vision) at the stage "in 6 months". In group 2 (modified polymer) this finding is 0 units in the field of vision in all cases. The difference between groups amounts to 100% with the advantage of group 2 (application of modified polymer).

Statistical analysis revealed significant differences between groups in the finding "Foreign body resorption cells" at the stage "in 6 months" (Me of group 1 = 5.2 units in the field of vision, LQ = 4, UQ = 6; Me of group 2 = 0 units in the field of vision, LQ = 0, UQ = 0; Mann-Whitney U test, statistical significance p-level = 0.000000).

Therefore, in case of non-modified polymer application foreign body resorption cells normally absent appear in the oral mucosa cytogram of the prosthetic bed. At that the excess rate of statutory values in one week and in one month is twofold, in six months – fivefold.

In case of modified polymer application foreign body resorption cells lack in the oral mucosa cytogram of the prosthetic bed during the total period of clinical research.

Advantages of modified polymer application comparing to non-modified polymer application in regards to this finding is considered to be 100% during the total period of observation.

This fact gives evidence of tissue response development to contact with the basis of non-modified acrylic polymer construction actively “recognized” by oral mucosa as a foreign body. Modified polymer application prevents such a tissue response that can only be explained by high level of its biological compatibility.

This clinically defined advantage of application of modified acrylic polymer with silver nanoparticles has high statistical significance.

In both groups the findings “Eosinophils” were identical at the stage “prior prosthesis” and amounted to 0-1 units in the field of vision ( $0.53 \pm 0.03$  units in the field of vision). This fact supports total homogeneity (comparability) of these findings in both groups prior to prosthesis.

Statistical analysis revealed absence of differences between groups in the finding “Eosinophils” at the stage “prior to prosthesis” (Me of group 1 = 0.5 units in the field of vision, LQ = 0, UQ = 1; Me of group 2 = 0.5 units in the field of vision, LQ = 0, UQ = 1; Mann-Whitney U test, statistical significance p-level = 0.111111).

In group 1(non-modified polymer) the finding “Eosinophils” amounts to 8 to 10 units in the field of vision ( $8.77 \pm 1.36$  units in the field of vision) at the stage “in 7 days”. In group 2 (modified polymer) this finding is 0 to 1 unit in the field of vision ( $0.56 \pm 0.04$  units in the field of vision). The difference between groups amounts to 93.9% with the advantage of group 2 (application of modified polymer).

Statistical analysis revealed significant differences between groups in the finding “Eosinophils” at the stage “in 7 days” (Me of group 1 = 8.2 units in the field of vision, LQ = 7.4, UQ = 8.8; Me of group 2 = 0.5 units in the field of vision, LQ = 0, UQ = 1; Mann-Whitney U test, statistical significance p-level = 0.000000).

In group 1(non-modified polymer) the finding “Eosinophils” amounts to 7 to 9 units in the field of vision ( $7.9 \pm 1.46$  units in the field of vision) at the stage “in one month”. In group 2 (modified polymer) this finding is 0 to 1 unit in the field of vision ( $0.57 \pm 0.03$  units in the field of vision). The difference between groups amounts to 92.9% with the advantage of group 2 (application of modified polymer).

Statistical analysis revealed significant differences between groups in the finding “Eosinophils” at the stage “in one month” (Me of group 1 = 7.0 units in the field of vision, LQ = 6, UQ = 8; Me of group 2 = 0.5 units in the field of vision, LQ = 0, UQ = 1; Mann-Whitney U test, statistical significance p-level = 0.000001).

In group 1(non-modified polymer) the finding “Eosinophils” amounts to 4 to 5 units in the field of vision ( $4.8 \pm 1.09$  units in the field of vision) at the stage “in 6 months”. In group 2 (modified polymer) this finding is 0 to 1 unit in the field of vision ( $0.7 \pm 0.09$  units in the field of vision). The difference between groups amounts to 89.4% with the advantage of group 2 (application of modified polymer).

Statistical analysis revealed significant differences between groups in the finding “Eosinophils” at the stage “in 6 months” (Me of group 1 = 4.7 units in the field of vision, LQ = 4, UQ = 5; Me of group 2 = 0.5 units in the field of vision, LQ = 0, UQ = 1; Mann-Whitney U test, statistical significance p-level = 0.000063).

Therefore, in case of non-modified polymer application sixteen fold increase in the absolute count of eosinophils is observed in the oral mucosa cytogram as early as during the first seven days after prosthesis. During the following months their concentration decreases to some extent, but even in 6 months it exceeds norms up to nine times.

In case of modified polymer application increase in the absolute count of eosinophils is not observed during the total period of observation.

Advantages of modified polymer application comparing to non-modified polymer application in regards to this finding amounts to 93.8% and does not decrease lower than 89.8% during the total period of observation.

This fact supports development of expressed local sensibilization of prosthetic bed mucosa as a component of complex local inflammatory reactions to long-lasting contact with non-modified acrylic polymer. Application of modified acrylic polymer allows avoiding local sensibilization of prosthetic bed mucosa and, thereby, prevents progressive local inflammatory reactions and decreases their general level.

This clinically defined advantage of application of modified acrylic polymer with silver nanoparticles has high statistical significance.

In both groups the findings "Eosinophils with segmented nuclei" were identical at the stage "prior prosthesis" and amounted to 0 units in the field of vision in all cases. This fact supports total homogeneity (comparability) of these findings in both groups prior to prosthesis.

Statistical analysis revealed absence of differences between groups in the finding "Eosinophils with segmented nuclei" at the stage "prior to prosthesis" (Me of group 1 = 0 units in the field of vision, LQ = 0, UQ = 0; Me of group 2 = 0 units in the field of vision, LQ = 0, UQ = 0; Mann-Whitney U test, statistical significance p-level = 1.111111).

In group 1(non-modified polymer) the finding "Eosinophils with segmented nuclei" amounts to 1 to 3 units in the field of vision ( $2.5 \pm 0.03$  units in the field of vision) at the stage "in 7 days". In group 2 (modified polymer) this finding is 0 units in the field of vision in all cases. The difference between groups amounts to 100% with the advantage of group 2 (application of modified polymer).

Statistical analysis revealed significant differences between groups in the finding "Eosinophils with segmented nuclei" at the stage "in 7 days" (Me of group 1 = 2.0 units in the field of vision, LQ = 1, UQ = 3; Me of group 2 = 0.0 units in the field of vision, LQ = 0, UQ = 0; Mann-Whitney U test, statistical significance p-level = 0.000307).

In group 1(non-modified polymer) the finding "Eosinophils with segmented nuclei" amounts to from 1 to 3 units in the field of vision ( $2.7 \pm 0.05$  units in the field of vision) at the stage "in one month". In group 2 (modified polymer) this finding is 0 units in the field of vision in all cases. The difference between groups amounts to 100% with the advantage of group 2 (application of modified polymer).

Statistical analysis revealed significant differences between groups in the finding "Eosinophils with segmented nuclei" at the stage "in one month" (Me of group 1 = 2.0 units in the field of vision, LQ = 1, UQ = 2.9; Me of group 2 = 0.0 units in the field of vision, LQ = 0, UQ = 0; Mann-Whitney U test, statistical significance p-level = 0.000353).

In group 1(non-modified polymer) the finding "Eosinophils with segmented nuclei" amounts to from 4 to 5 units in the field of vision ( $4.7 \pm 0.10$  units in the field of vision) at the stage "in 6 months". In group 2 (modified polymer) this finding is 0 units in the field of vision in all cases. The difference between groups amounts to 100% with the advantage of group 2 (application of modified polymer).

Statistical analysis revealed significant differences between groups in the finding "Eosinophils with segmented nuclei" at the stage "in 6 months" (Me of group 1 = 4.6 units in the field of vision, LQ = 4, UQ = 5; Me of group 2 = 0.0 units in the field of vision, LQ = 0, UQ = 0; Mann-Whitney U test, statistical significance p-level = 0.000004).

Therefore, in case of non-modified polymer application eosinophils with segmented nuclei normally absent appear in the oral mucosa cytogram of the prosthetic bed. At that the excess rate of statutory values in one week and in one month is twofold, in six months – more than fourfold.

In case of modified polymer application eosinophils with segmented nuclei lack in the oral mucosa cytogram of the prosthetic bed during the total period of clinical research.

Advantages of modified polymer application comparing to non-modified polymer application in regards to this finding is considered to be 100% during the total period of observation.

This fact gives evidence of tissue response development to contact with the basis of non-modified acrylic polymer construction actively “recognized” by oral mucosa as a toxico-sensitized factor. Modified polymer application prevents development of such correlations between the basis of materials and oral mucosa that can only be explained by high level of its biological compatibility.

This clinically defined advantage of application of modified acrylic polymer with silver nanoparticles has high statistical significance.

In both groups the findings “Neutrophils” were identical at the stage “prior to prosthesis” and amounted to 0-1 units in the field of vision ( $1.6 \pm 0.01$  units in the field of vision). This fact supports total homogeneity (comparability) of these findings in both groups prior to prosthesis.

Statistical analysis revealed absence of differences between groups in the finding “Neutrophils” at the stage “prior to prosthesis” (Me of group 1 = 1.5 units in the field of vision, LQ = 1, UQ = 2; Me of group 2 = 1.5 units in the field of vision, LQ = 1, UQ = 2; Mann-Whitney U test, statistical significance p-level = 1.111111).

In group 1(non-modified polymer) the finding “Neutrophils” amounts to 9 to 18 units in the field of vision ( $10.0 \pm 1.39$  units in the field of vision) at the stage “in 7 days”. In group 2 (modified polymer) this finding is from 1 to 2 units in the field of vision ( $1.9 \pm 0.41$  units in the field of vision). The difference between groups amounts to 87.5% with the advantage of group 2 (application of modified polymer).

Statistical analysis revealed significant differences between groups in the finding “Neutrophils” at the stage “in 7 days” (Me of group 1 = 10.4 units in the field of vision, LQ = 11, UQ = 13; Me of group 2 = 1.3 units in the field of vision, LQ = 1, UQ = 2; Mann-Whitney U test, statistical significance p-level = 0.000014).

In group 1(non-modified polymer) the finding “Neutrophils” amounts to 7 to 9 units in the field of vision ( $7.8 \pm 2.22$  units in the field of vision) at the stage “in one month”. In group 2 (modified polymer) this finding is from 2 to 4 units in the field of vision ( $3.5 \pm 0.36$  units in the field of vision). The difference between groups amounts to 57.1% with the advantage of group 2 (application of modified polymer).

Statistical analysis revealed significant differences between groups in the finding “Neutrophils” at the stage “in one month” (Me of group 1 = 7.0 units in the field of vision, LQ = 6, UQ = 8; Me of group 2 = 3.0 units in the field of vision, LQ = 2, UQ = 4; Mann-Whitney U test, statistical significance p-level = 0.000221).

In group 1(non-modified polymer) the finding “Neutrophils” amounts to 6 to 8 units in the field of vision ( $7.9 \pm 1.11$  units in the field of vision) at the stage “in 6 months”. In group 2 (modified polymer) this finding is from 1 to 2 units in the field of vision ( $1.8 \pm 0.11$  units in the field of vision). The difference between groups amounts to 78.6% with the advantage of group 2 (application of modified polymer).

Statistical analysis revealed significant differences between groups in the finding “Neutrophils” at the stage “in 6 months” (Me of group 1 = 7.0 units in the field of vision, LQ = 6, UQ = 8; Me of group 2 = 1.5 units in the field of vision, LQ = 1, UQ = 2; Mann-Whitney U test, statistical significance p-level = 0.001480).

Therefore, in case of non-modified polymer application seven fold increase in the absolute count of neutrophils is observed in the oral mucosa cytogram of the prosthetic bed. In one months and six months after prosthesis their concentration stably exceeds norm up to 4.7 times.

In case of modified polymer application increase in the absolute count of neutrophils does not exceed physiological values and falls within the range 1.5 – 3 units in the field of vision during the total period of observation.

Advantages of modified polymer application comparing to non-modified polymer application in regards to this finding amounts to 87.5% and does not decrease lower than 57.1% during the total period of observation.

This fact supports development of moderate non-specific inflammation of prosthetic bed mucosa as a response to contact with foreign surface of non-modified acrylic polymer. Application of modified acrylic polymer allows almost completely neutralizing non-specific inflammatory reaction of the oral mucosa.

This clinically defined advantage of application of modified acrylic polymer with silver nanoparticles has high statistical significance.

In both groups the findings “Fibroblastic infiltration rate” were identical at the stage “prior to prosthesis” and amounted to 1 grade in all cases. This fact supports total homogeneity (comparability) of these findings in both groups prior to prosthesis.

Statistical analysis revealed absence of differences between groups in the finding “Fibroblastic infiltration rate” at the stage “prior to prosthesis” (Me of group 1 = 1 grade, LQ = 1, UQ = 1; Me of group 2 = 1 grade, LQ = 1, UQ = 1; Mann-Whitney U test, statistical significance p-level = 1.111111).

In group 1 (non-modified polymer) the finding “Fibroblastic infiltration rate” amounts to 1 - 2 grades ( $1.9 \pm 0.04$  grades) at the stage “in 7 days”. In group 2 (modified polymer) this finding is equal 1 during the total period of observation. The difference between groups amounts to 41.2% with the advantage of group 2 (application of modified polymer).

Statistical analysis revealed significant differences between groups in the finding “Fibroblastic infiltration rate” at the stage “in 7 days” (Me of group 1 = 1.7 grades, LQ = 1, UQ = 2; Me of group 2 = 1.0 grades, LQ = 1, UQ = 1; Mann-Whitney U test, statistical significance p-level = 0.000195).

In group 1 (non-modified polymer) the finding “Fibroblastic infiltration rate” amounts to 2 - 3 grades ( $2.9 \pm 0.05$  grades) at the stage “in one month”. In group 2 (modified polymer) this finding is equal 1 during the total period of observation. The difference between groups amounts to 63% with the advantage of group 2 (application of modified polymer).

Statistical analysis revealed significant differences between groups in the finding “Fibroblastic infiltration rate” at the stage “in one month” (Me of group 1 = 2.7 grades, LQ = 2, UQ = 3; Me of group 2 = 1.0 grades, LQ = 1, UQ = 1; Mann-Whitney U test, statistical significance p-level = 0.000783).

In group 1 (non-modified polymer) the finding “Fibroblastic infiltration rate” is reported to be maximal and amounts to the identical value of 3 grades in all patients at the stage “in 6 months”. In group 2 (modified polymer) this finding amounts to 1 - 2 grades ( $1.3 \pm 0.2$  grades). The difference between groups amounts to 53.3% with the advantage of group 2 (application of modified polymer).

Statistical analysis revealed significant differences between groups in the finding “Fibroblastic infiltration rate” at the stage “in 6 months” (Me of group 1 = 3 grades, LQ = 3, UQ = 3; Me of group 2 = 1.4 grades, LQ = 1, UQ = 2; Mann-Whitney U test, statistical significance p-level = 0.000387).

Therefore, in case of non-modified polymer application progressive fibroblastic infiltration of the prosthetic bed area takes place starting with the seventh day of prosthesis during the follow up six months; it reaches its maximum possible rate till the end of the observation period.

In case of modified polymer application moderate fibroblastic infiltration develops only in the period from the first to the sixth months after prosthesis. Infiltration rate remains moderate and does not reach its maximum even at the end of the observation period.

Advantages of modified polymer application comparing to non-modified polymer application in regards to this finding obtains 63% and does not fall lower than 41.2% during the total period of observation.

These apparent fibrous changes of the soft tissue of the prosthetic bed are proved to be morphological after-effects of the complex reaction of chronic inflammation as a response to a long-lasting contact of mucosa and non-modified acrylic polymer surface. Modified polymer application to a great extent allows decreasing the process of fibrous changes; it appears to develop due to direct restraint of chronic inflammation processes in the mucosa of the prosthetic bed.

This clinically defined advantage of application of modified acrylic polymer with silver nanoparticles has high statistical significance.

### CONCLUSION

To sum up, application of modified acrylic polymer with silver nanoparticles for designing removable laminar dentures is proved to be biologically safe.

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