ISSN: 0975-8585

Research Journal of Pharmaceutical, Biological and Chemical Sciences

Analysis of Polishability of the Modern Thermo-Injection Plymers Used In Dentistry.

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ABSTRACT

This paper is dedicated to the analysis of quality of the finishing treatment and products used in dentistry from the thermo-injection plastic nylon polymers. Non-monomeric nature of these materials is a significant positive factor affecting the biological inertness of artificial dentures. The findings of the research are aimed at development of the optimum conditions of the finishing treatment of polymers in order to improve the quality of treatment and increase the specialists' performance.

Keywords: structural materials, thermoplastic polymers, scanning (raster) electron microscopy, denture treatment.

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ISSN: 0975-8585

INTRODUCTION

Today at the Russian dental market the new structural polymers for the thermo-injection technology are offered [1-4]. The experience in working with the thermoplastic samples has shown that there is one substantial defect related to the difficulty of the finishing treatment of materials from this group [5, 6]. The traditional treatment applied to the acrylic polymers hardly allows achieving the qualitative surface of thermoplastics due to their high viscosity and elasticity. By accumulating microflora on their surface the dental prostheses may be destroyed by bacteria and the by-products [7, 8]. The quality of the processing technology determines the healthy performance of the subjacent oral cavity tissues; bacterial colonization resistance, esthetics and optimum durability of the denture structure itself [9-11]. The things mentioned above incite to carry out further research investigations concerning analysis of the new materials.

Objective of the study

To develop the optimal mode of the finishing treatment of the modern domestically made thermoplastic non-acrylic polymers allowing increasing the specialists' performance and quality of treatment.

PROCEDURE

According to the goals set in order to evaluate the efficiency of finishing treatment of the dental polymers the following structural materials used have been compared: the new home thermoplastic non-monomeric nylon-based polymer, "Belflex" ("Vladmiva", Russia), the well-known polymer "Evidsan' ("Evident plus", Russia) and the polymer that is well-known at the world dental market "Valplast", ("Advanced Technologies", USA). In order to accomplish the objective set the samples of the same size have been made (n=30); ten samples per each polymer. For the treatment process the rotating tools like different kinds of milling (cutting) tools, heads, burrs and polishing paste "Poliset" ("Vladmiva", Russia) have been used. The material was treated with metal, corundum and diamond tools of different grit size. The analysis of the sample surface was performed at the macro-and micro-levels. For the visual and objective evaluation the GOST 24105-80 criteria have been used. The analysis of samples of the thermoplastic non-monomeric polymers at the micro-level was performed with the use of the raster electron microscopy. The microscopic examination of samples was carried out in the CUC "Nanostructured materials and nanotechnologies" by BelGU with the use of the scanning ionic-electron microscope "Quanta 200 3-D", Japan. The exploration of the surface was performed at the three random points of each sample with increase by x300, x1000. On the basis of the pictures obtained there was carried out the comparison of the sample surfaces with the use of the traditional and designed algorithm of the finishing treatment for the optimum period of time.

MAIN PART

Mechanical (machining) tooling by the production of the curative polymeric dentures is used to attain the accuracy of the surface, esthetic appearance and performance of the denture. Sometimes the processing time in terms of such operations occupies up to 80% of the total labor content by the denture production.

The finishing mechanical treatment of dentures is performed manually and consists of the stages of grinding and polishing of plastics with the use of a grinding motor, dental ball-bearing hand piece, polishing media and rotating tools. The modern range of the rotating tools is represented by metal, corundum, diamond cutters, heads, and burrs of different grit size. The peculiar feature of the traditional plastic by grinding and polishing consists in the relative low melting temperature, low heat conductivity and viscosity. The difficulty by the thermoplastic polymers treatment is related to the possible fast deformation of the product under pressure and heating. Treatment of the newly fire-polished piece of a polymer means loss in quality and time and quite often the irretrievably spoiled sample. The attainment of the final shine requires significant labor content.

In the global dental practice the denture polishing is performed to the condition of "visible shine" which is defined by eye. In a dentist's practice this very condition of the denture structure is the criterion that it is ready to be fixed in the oral cavity. It is essential that time expenditures on the sample treatment may vary a lot. The common approaches to the finishing treatment of polymers in dentistry consist of the successive steps of grinding and polishing. The in-and-out movements by the shape grinding heads of the medium and

small grit size are used. The optimum rate is 20-40 thousand rpm. The specific pressure on surface processed makes 0,2-0,1 kg/cm$^{2.}$ After that the entire surface is treated with a fine-grain abrasive cloth of (00) type. This step is followed by the finishing stage of polishing with the use of discs or down brushes with application of polishing agents.

As the results of the studies performed it has been found out that the nylon-based thermoplastic polymers are poorly treated with the corundum cutters. During processing the tools gets stuck quickly and breaks down whereas the sample surface becomes uneven. The diamond galvanized tool is also not efficient. The time spent on achievement of the required criteria by treatment of polymers of different kind varies from 4 to 20 minutes. The sintered diamond was determined as the most efficient tool.

The objective exploration of the sample surface with the use of the scanning ionic microscopy allowed detecting defects on the micro-level of the surface. During the investigation performed we have evaluated the structure homogeneity, presence of irregularities, cracks, pinholes, their size and number. Thus, on the surface of the “Belflex” sample by increasing by 300 times we have detected hollows, caverns, and roughness. On the surface of the “Evidsan” sample by increasing by 300 times we have detected the defects in the form of pinholes and burrs. On the surface of the “Valplast» sample by increasing by 300 times we have detected mostly grooves, grains and caverns, Fig. 1.

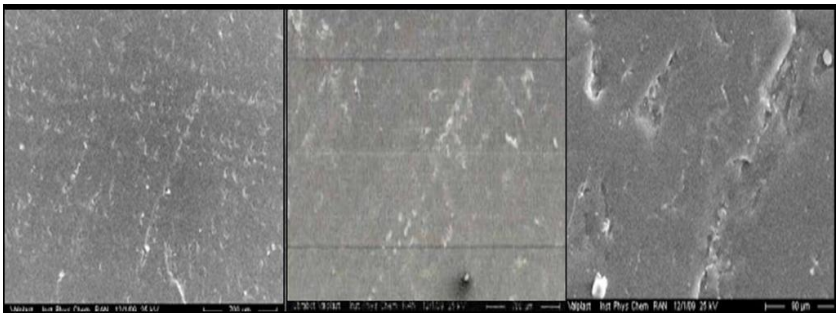

Figure 1: Surfaces of the samples from “Belflex”, “Evidsan” and “Valplast” increased by 300

With increase by 1000 the various defects in the form of hollows, caverns, irregularities and grains on the surfaces of all the samples under investigation can be seen clearly. In the pictures by increase by 1000 it is possible to carry out the exact measurement of the various defects as well as to calculate the quantity thereof, Fig. 2.

Figure 2: Surfaces of the samples from “Belflex”, “Evidsan” and “Valplast» increased by 1000

The experimental analysis of the macro- and micro-surface for the purpose of selection of the optimal processing conditions contributes to the development of the algorithm for finishing treatment of the thermoplastic polymers.

SUMMARY

On the basis of the findings of the experimental research the peculiar features of conditions of the mechanical (machining) tooling of the nylon-based thermoplastic polymers have been specified: for the rough

treatment of the surface it is most efficiently to use the sintered vacuum-coated diamond tooling; the maximal cutting properties of burrs while cutting viscous nylon show themselves by a slight contact with the material without any pressure. By increase in the pressure the cutting properties of burrs are reduced rapidly and the sample surface gets out of its shape, is distorted; the treatment shall be performed with intensive water cooling; intermittent operation is required; the cutting tools require periodical ultrasonic or sand blasting cleaning. The weakening of the tool cutting properties takes place also due to the overheating of the cutting edges since nylons feature low thermal conductivity and cannot discharge the heat released by cutting in time; the entire surface of the polymeric sample is treated by in-and-out movements of the shape grinding heads of the medium and small grit size. The optimum rate makes 5-10 thousand rpm; the treatment of the entire surface with a fine-grain abrasive cloth of type (00); the polishing stage consists in the use of the ultra-low revolution rates, 2-4 thousand rpm with the polishing agents designed for polymers.+

CONCLUSION

Thus, the new Russian non-monomeric thermo-injection polymers “Belflex”, “Evidsan” without any doubts feature their own positive properties and the application thereof is an integral part of the quality orthopedic treatment under partial or complete absence of teeth in the domestic dentistry.

On the basis of the findings of the research performed it is possible to the state the relative difficulty of the finishing treatment of the non-acrylic elastic basic polymers as compared with the monomeric dental polymers. In order to achieve the optimal result the treatment of the non-monomeric thermo-injection polymers will require additional efforts, costs and specialists. In order to improve the quality of the orthopedic treatment of patients with the use of the non-fixed dentures from the modern home non-monomeric thermo-injection polymers it makes sense to apply the developed mode of the finishing surface treatment. These recommendations will allow improving the denture quality and optimizing the specialists’ performance.

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