Aspects of Acrylic Teeth Methyl Methacrylate Chemical Treatment

Noninvasive scanning electron microscopy investigations

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The surface relief map changes induced by methyl methacrylate (MMA) chemical treatment to the flat ridge lap area of the acrylic teeth in order to improve the bond strength to the denture base resin acrylic tooth interface, was investigated with a scanning electron microscopy (SEM), a classical non-invasive investigation method. The ridge lap area of 20 artificial acrylic molars was milled to flat. The samples were randomly assigned in two experimental groups, ten samples pertaining to each one of the groups. The flat surfaces of the acrylic molars were submitted to a different treatment. Group 1: (control group), no chemical treatment; Group 2: Chemical treatment with methyl methacrylate. Each specimen was submitted to SEM investigation with SEM: HITACHI TM3000 Scanning Electron Microscope. The SEM imaging captured data depicted obvious changes of the surface relief aspect of the samples treated with methyl methacrylate compared to control group. Acrylic teeth chemical treatment with methyl metahcrylate generates surface topography changes, visible in SEM imaging, topography aspects responsible for the improved adhesion of acrylic teeth to denture base resin.

Keywords: acrylic teeth, methyl methacrylate, non-invasive investigation, scanning electron microscopy

The common reason for the group of senior patients determined to demand dental treatment is represented, most frequently, by the replacement of the missing teeth from the complete denture structure. The replacement of complete dentures teeth knows a major importance in order to achieve a masticator and often an esthetic function. The detachment of artificial teeth from the denture base resin is a real social and also a psychological problem among elderly patients, and according to authors as [1, 2] from 20% to 30% of all denture repair situations being associated with the artificial teeth detachment from denture base resin (figs. 1, .2). There is reason to believe that the registered failure rates are almost the same worldwide, and this problem must be considered, due to the increased frequency, a major concern in complete denture manufacturing and repair technologies.

The purpose of this study is not focused on the technological steps followed by the dental technician_dentist team, in order to realize the repair of the detached teeth from the denture base resin, but knowing the fact that the methyl methacrylate is the most used organic solvent in the complete denture technology repair techniques, the present paper aims to realize a study with SEM noninvasive investigations of the topography of the acrylic teeth sample surfaces submitted to chemical treatment with methyl methacrylate, the study being born as a consequence of the desire to research the structure of the surface of the involved interfaces and to seek a microscopically proof of the denture base acrylic tooth adhesion.

Another reason that had lead us to the election of methyl methacrylate (MMA) was the fact that other authors also indicate the improvement of the adhesion of acrylic teeth to denture base resin after chemical treatment of ridge lap area with methyl methacrylate, methylmetacrylate being used in those situations also as a cleaning agent of the contaminated acrylic teeth ridge lap areas [3, 4]. The technical laboratory factor that decreases the bond strength of the denture tooth to the denture base resin is ridge lap surface contamination with wax or tinfoil substitute residues [5 - 7].

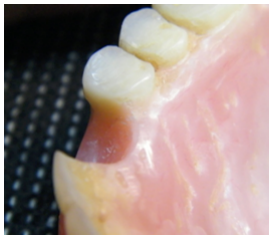

Fig.1. Acrylic tooth detached from the denture base resin

Fig.2. Aspect of one of the technological repair steps procedure of the detached tooth from the denture base resin

According to other authors which have showed serious preoccupations in the last years in the field of polymeric substrates adhesion and polymeric interfaces noninvasive investigations, methyl methacrylate treatment of artificial acrylic teeth the ridge lap areas is associated with higher values of adhesion [8 - 11]. The explanation could be the one found in the article of Valittu [12].

According to this author, the MMA (methylmethacrylate) treatment dissolves the PMMA (polymethyl methacrylate) structure and increases the acrylic teeth self cured acrylic denture base resin adhesion.

The main parts of a complete denture are represented by the artificial teeth and the denture base. The artificial acrylic teeth are largely used in technical dental laboratories to realize complete dentures. The most used material for denture fabrication is poly (methyl methacrylate) (PMMA)

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resin polymer because it has a significant resistance to environmental degradation, also because it is one of the hardest thermoplastics and has good optical properties. PMMA swells and dissolves in many organic solvents and it has poor resistance to many other chemicals on account of its easily hydrolyzed ester groups. The conventional composition of acrylic teeth is mostly cross-linked PMMA. The gingival ridge lap area, practically the bonding surface of the artificial teeth, may not be as highly cross-linked as the rest areas of the tooth.

If the two complete denture components, the teeth and the denture base, have the same chemical composition and if the micromechanical or chemical links, generated trough mechanical or chemical treatment of the tooth denture base resin interfaces are stronger, the adhesion at the interface reaches higher values when the tooth denture base interface is subjected to mechanical tests, in other words the bond strength of the interface artificial teeth denture base reaches higher values [10, 11].

The scanning electron microscope (SEM) is a type of electron microscope that may be used to visualize a sample by scanning it with a high-energy beam of electrons in a raster scan pattern. At the moment of interaction of the electrons with the atoms of the surface of the samples, different signals are produced. The numerous different signals generated by a SEM are represented by two types of electrons: secondary electrons and back-scattered electrons (BSE). SEM can reveal details between 1 and 5 nm in size.

The signal of the electron beam is emitted from an electron gun fitted with a tungsten or lanthanum filament cathode. Focused by condenser lenses to a spot the beam passes through pairs of scanning coils in the electron column, in the final lens. These deflect the beam in the OX and OY axes so that it scans over a rectangular area of the sample surface.

The interaction of the primary electron beam with the sample is followed by a loose of energy from the electrons; the interaction volume being directly dependent to the electron's landing to energy.

For SEM investigations, the samples must have a size in order to fit in the specimen chamber and must be mounted rigidly on a specimen holder. The specimens, for conventional SEM imaging, must be electrically conductive, at the surface at least. It is required also that the sample must be completely dry. The ability to image a comparatively large area of the specimens; the ability to image bulk materials not just thin films or foils are some of the advantages of SEM.

Experimental part

Materials and methods

The null hypothesis is based on the idea that the effects of the chemical treatment with methyl methacrylate to the superficial layer of the acrylic teeth *ridge lap area* does not generates morphological differences at the surface of the superficial layer of the acrylic teeth.

20 first upper artificial acrylic molars (Spofa Dental complete denture kit) (fig. 3) were used in order to mille the mucosal surface, the so called ridge lap area, to a flat surface (fig.4).

Fig.3. Spofa Dental complete denture kit.

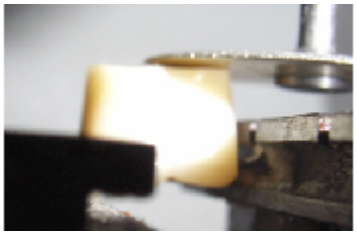

Fig.4.The milled ridge lap area

After the milling of the ridge lap area the 20 samples were randomly assigned in 2 groups, 10 samples for each of the two groups.

The flat area of each of the 10 samples from the first group, the control group, was left chemically untreated, and the flat area of the 10 samples of the second group was submitted to the chemical treatment with methyl methacrylate. The 20 samples, from the control group (without chemical treatment) and from the group 2 (methyl methacrylate chemically treated) were submitted to the noninvasive SEM investigation. To realize this type of noninvasive investigation, it was used SEM: HITACHI TM3000. Among the imaging modes of SEM Hitachi TM3000 it has been chosen Topo Mode in order to investigate the aspects of the surface of the samples before and after methyl methacrylate treatment. SEM Hitachi TM3000 it provides a real alternative to optical microscopes, stereo microscopes and confocal laser scanning microscopes and has applications for sectors such as, cosmetics, healthcare, pharmaceutical, materials science. The samples submitted to SEM TM3000 investigation can have between 70 mm and 50 mm thickness.

It was chosen to work at the same accelerating voltage for both sample groups, 1.) control and 2.) methyl methacrylate, at 1000X and 2000X magnification.

Results and discussions

Comparing the samples between them, at the same working parameters, the following aspects were found.

At 5000 V acceleration voltage, and 1000X and 2000X magnification, it can be observed the roughness of the chemically untreated surface sample characterized by granular aspect areas alternating with smooth areas.

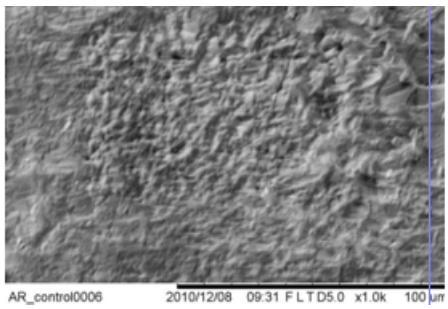

Fig.5. Surface aspect of acrylic teeth of the control group at 1000X magnification observation condition: surface

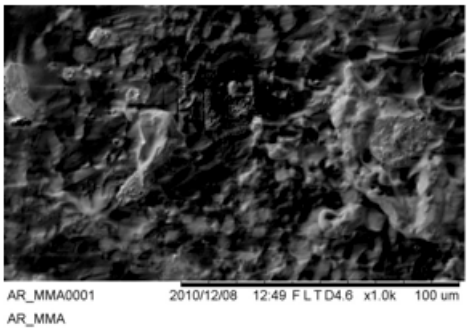

Fig. 6. Surface aspect of acrylic teeth of the group 2, at 1000X magnification magnification observation condition: surface

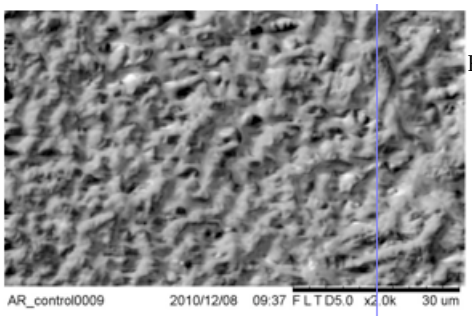

Fig. 7. Surface aspect of acrylic teeth of the group 2 at 2000X magnification observation condition :surface

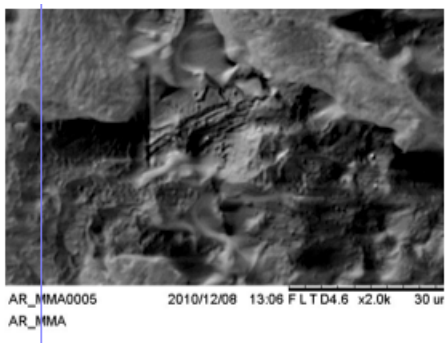

Fig.8. Surface aspect of acrylic teeth of the group 2 at 2000X magnification observation condition: surface

The chemically methyl methacrylate treated surface samples was characterized by irregular, steep relief with retentive negative dark shaded areas alternating with smooth areas visualized as positive, superficial regions indicated by light grey shaded colors.

The SEM imaging data captured after the chemical treatment of acrylic teeth with methylmethacrylate, both at 1000X and 2000X magnifications, at the same working voltage parameters, are showing a surface texture characterized also by rough landscape of the entire captured area, as it was described in the captured imaging data of the untreated acrylic teeth samples. But this rough texture aspect of the so called ridge lap area milled to flat surface field is randomly modified from place to place, by irregular areas characterized by different intensity of the gray shades of the capture. These areas are visualized as light gray. The back scattered electron detection is responsible for the shadows at the sample surface, being possible, to visualize higher or lower areas of the surface sample, as intense shades, and as light shades. These light shaded areas could represent regions at which methylmethacrylate plasticizes, softens and swollen the areas of the acrylic teeth surface sample. According to Vallitu PK et all [12] the methyl methacrylate dissolves the poly (methylmethacrylate) texture improving in this way the adhesion between the acrylic teeth and the denture base resin.

In another paper were studied the aspects of the acrylic teeth denture base resin bond strength [13].

Conclusions

Methylmethacrylate plasticizes and softens the areas of the acrylic teeth surface samples. The softening of the acrylic teeth surface areas facilitates the improvement of the adhesion values among above mentioned substrates.

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