**ABSTRACT**

**Introduction:** complete dentures are realized from different acrylic resins and various technologies. These materials are fragile and frequently appear cracks and fractures of these dentures. **Objectives:** To determine the durability of complete dentures made from superacryl plus. **Material and methods:** the durability of complete dentures was estimated by finite element analysis, static tensile tests and fatigue tests. Numerical simulation, as a preliminary stage, can offer the solution regarding the effective performance of the dentures. For this, it is necessary to know the mechanical and elastic properties of the acrylic resins. The reverse engineering technology was used (after a 3d laser scanning of prosthetic pieces), and the model calculation was finally validated by a fatigue experimental test. **Results:** At the static tensile tests for superacryl plus there were obtained the following results: the ultimate tensile strength, rm=66.32 Mpa; young's modulus, e=5333 mpa; total elongation at fracture, at=11.96%. The fatigue strength, determined for the material, was s0 =11.904 Mpa. **Conclusions:** The results showed a good fatigue resistance of material superacryl. According to our tests, the fatigue resistance for superacryl plus is 12 mpa. **Key Words:** complete dentures; acrylic resins; fatigue; finite element analysis

**INTRODUCTION**

Diversification of application, especially in dental medicine, made from numerical analysis with finite elements a possibility for testing new materials and for improving the already existing technologies. Noninvasive experiments permitted testing of static, dynamic and fatigue mechanical properties, with aim of lifetime evaluation, which could be seen as usage warranty.

In the literature, the domains of interest concerning complete dentures were centered especially
on materials studies and achieving technologies. Complete dentures are realized from different acrylic resins, among the most used being the heat curing ones; but the material they are made of is usually fragile. Thus, frequently cracks and fractures of these dentures appear. Noninvasive experimental studies do not reveal the complex causes of complete dentures deterioration. Computerized systems could offer some explanations regarding reasons of dentures deterioration, and could mark the minimum resistance zones, depending on variants of forces application and material type. Numerical simulation, as a preliminary stage, can offer the solution regarding the effective performance of the dentures and allow validation of some hypotheses regarding the occurrence of denture fractures.

**Study objectives**

Studies were centered on finite element analysis by static tensile tests (stress and deformation) of complete dentures realized from Superacryl Plus (heat curing acrylic resin), through which we can make some predictions regarding place and time for apparition of tension and deformation, which determine fracture risk.

**MATERIALS AND METHODS**

For testing and evaluating, we used Superacryl Plus (Spofa-Dental, Markova, Czech Republic), a heat curing dental resin. Samples and complete dentures were realized with help of classical technology. The mechanical properties of Superacryl Plus were determined on samples, through tensile tests, such as: the longitudinal elasticity modulus, the tensile strength and the deformability properties at static tensile tests. Dentures were 3D scanned (using laser scanner 3D LPX 1200 Roland) and submitted to some noninvasive tests through FEM proceedings. The geometrical model was 3D scanned with help of Dr. PICZA program. Processing of scanned images was realized through reverse engineering method. The real model, scanned, is meshed in networks of surfaces and then processed using CAD-ANSYS program, where one creates the pattern's tridimensional model. Experimental tests are made on virtual model, in order to analyze complete dentures by static tensile tests and fatigue degradation.

Further, the work hypotheses on computer were confirmed or infirmed by the real fatigue tests, with pulse loading cycles for which maximum force was considered 700N, 500N, 400N, 300N and 200N. The equipment used for this study consisted of: 3D scanner - 1200 LP Roland Picza, computer systems with programs: Pixform Pro, Solid Works 2007, Ansys.
RESULTS

At the static tensile tests there were obtained the following results: the ultimate tensile strength, Rm=66.32 MPa; Young’s modulus E=5333 MPa; total elongation at fracture, At= 11.96%.

Tensions and deformation analysis of the denture submitted to different loadings, is marked by chromatic specters which are visible on dentures components, where stress is always marked in warm colors: red, orange, yellow, while quiet zones are marked in blue. The method became necessary, because it represents the base of some more advanced analyses (at various applications), for explaining more complex phenomena, which lead to dentures degradation. (Fig. 2) This way, we can underline the minimum resistance zones, where the denture fractures itself. A very important signification has the denture loading. That is because, if denture’s support is insufficient or unequal distributed, the forces that push the denture towards the prosthetic field determine different effects. It results that an insufficient support leads to a more rapid denture breaking.

For the denture clamping to the fatigue testing machine with loading cycles, in which the maximum force was from 80 N to 200 N, there was used a rigid support (made of Melot) with a lower plane surface. Between the rigid cast support and the denture, there was used the elastic/flexible material Oranwash-Zhermack, with a thickness of 1-1.5 mm (for simulation of patient’s fibromucous behavior). The durability calculus performed for ideal situations confirms the denture reliability for a guarantee period of minimum 5 years. According to our tests, the fatigue resistance for Superacryl Plus is 12 MPa, which shows a high durability. (Fig. 3)
DISCUSSION

Fatigue degradation process depends on material structure and is characterized by the fact that, plastic deformations are situated around defects or cracks. In this case the breaking has a progressive-hidden character; the prosthetic piece conducts itself normally, until the crack extended on a certain length and then the final breaking is started, by overstressing the material from the remained section.

We consider that complete denture durability can be tested with nondestructive methods (FEM analyses), and after that we need to certify this through static and dynamic mechanical tests. The results showed a good fatigue resistance of material Superacryl. According to our tests, the fatigue resistance for Superacryl Plus is 12 MPa.

Darbar studied the interface between denture base and artificial teeth by FEM analyses and found out the reason of teeth detachment from the denture base. The maximum tensile stresses are localized at the palatal aspect of the teeth-base interface. He suggested that boxing the artificial tooth in the resin will help to redistribute the stress concentration.

Many authors analyzed mechanical properties of some denture base resins and concluded that values like: transverse strength, shear bond strength, fracture toughness, fracture force, deflection are very important for the long life of prostheses. Evaluation of material resistance is important in estimation of complete dentures durability.

Other authors studied the bond strength between plastic teeth and denture base resins and pointed out that: there are a few significant differences between the various tooth brand and resin brand; surface treatment did not modify bond strength values.

CONCLUSIONS

1. Knowing the fatigue properties for this material, the safety degree in using the denture by patients can be guaranteed on a period of 5 years.
2. The fatigue tests may conduct to determining the breaking moment of complete denture.
3. The calculus model used in the finite element analysis for the complete denture was validated by fatigue tests performed on real prosthetic pieces.
4. New materials can also be tested and thereof can be successfully used in prosthetic dentistry.

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REFERENCES