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Review

A methodology for fracture strength evaluation of complete denture

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ABSTRACT

Objective: This paper presents a methodology for evaluating the mechanical strength and structural integrity of complete denture based on a thorough study on the mechanical properties of dental material and numerical FEM analysis.
Methods: A light curing composite resin, Eclipse (Dentsply International Inc.,– DeguDent GmbH, Hanau, Germany) was tested to evaluate the mechanical properties. According to standards recommendations were performed tensile and bending tests, fracture mechanics and fatigue crack growth rate tests. Using ABAQUS software, was performed a complex FEM analysis on a denture model obtained by 3D scanning and reverse engineering techniques, which may reveal if the applied load can initiate a crack or not. For if a crack is initiated, based on the methodology presented in this study, is analyzed the effect it has on complete denture.
Results: For a pressure load of 1.5 MPa, applied on palatal cusps of the upper teeth, we identified the stress concentrations areas, the values of maximum principal stress and strain, and were observed that a crack is initiated. Based on XFEM analysis were evaluated the stress intensity factors at the crack tip and was determined an equivalent stress intensity factor, $K_I^{eq} = 7.42$ MPa $\sqrt{}$mm. The value of K_I^{eq} is lower than the threshold stress intensity factor range, ΔKth (resulted from experimental tests), which means that the crack initiated is a stationary crack. Based on results, was calculated a risk factor, which give the fracture probability of the complete denture.

1. Introduction

The loss of teeth impairs patients' appearance, masticatory ability and speech, thus upsetting the quality of their social and personal life [1]. To restore these functions, removable and complete dentures are often used. The selection of materials for the construction of dentures is crucial because this directly relates to the performance and life span of the appliance during service in the oral cavity. Generally, the complete dentures are made of acrylic composite resins, as basis, and artificial teeth. Acrylic composite resins consist of three primary ingredients: an organic resin matrix, inorganic filler particles and a coupling agent [2,5]. Due, to the brittle fracture behavior and sometimes the processing technology of these materials, there can be obtained complete dentures with small defects which can initiate cracks and resulting in failure of total denture before the expected life time. Among the prevalent fracture types, 29% was a mid-line fracture, in which 68% were observed in maxillary complete dentures and 28% in mandibular complete dentures [4]. The longevity of the maxillary complete dentures for patients with occlusion against mandibular natural dentitions is about 21 months, whereas the average denture life time for those with occlusion against artificial mandibular teeth is of about 10 years [6]. Dorner and all pointed out that the

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