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Finite element analysis of strength characteristics of various resin based restorative materials in Class V cavities

S. D. YAMAN*, M. ŞAHIN† & C. AYDIN* **Department of Restorative Dentistry and Endodontics, Faculty of Dentistry, Gazi University, Ankara, Turkey and †Department of Aeronautical Engineering, Middle East Technical University, Ankara, Turkey*

SUMMARY This study investigated the strength characteristics of various composites (Tetric Ceram, Tetric Flow, Prisma AP.H, Synergy Duo Shade, Synergy Compact, and Z 100) and compomers (Compoglass, Compoglass F, Dyract AP, F 2000) that were applied in a Class V cavity of a maxillary central incisor. The study was conducted by using a 3-dimensional finite element approach and in the study ANSYS package program was used. The tooth model had 294 elements and 420 nodes. The teeth considered were assumed to be subjected to an incisal load of 200 N acting at an angle of 26° with the longitudinal axis of the tooth but the effects of different loading angles and different loads were also analysed. Hence, the loads of 100 and 400 N and the loading angles of 0° representing bruxism and 90° representing a traumatic load were also taken into consideration. The effects of the cavity preparation size were also studied. It was determined that any increase in the loading angle and/or the amount of the load resulted in a proportional increase in the stresses developed in the tooth. Furthermore it was also verified that, as a cavity weakens the tooth structure by creating a discontinuity in an intact tooth, the larger sized cavity preparations inevitably cause larger stresses to be developed in the tooth. Strictly from the mechanical point of view, the stresses developed in the restored teeth were determined to be inversely proportional with the modulus of elasticity of the restorative materials. Therefore within the scope of the study Z 100 was found to be superior to the other materials concerned.

KEYWORDS: finite element analysis, Class V, composite, compomer

Introduction

As a result of biting forces, the restored teeth is subjected to different levels of mechanical stresses. The durability of the restored teeth largely depends on those stresses; hence extensive research is conducted to understand the mechanisms behind those stresses. The research varies in nature and includes the experimental techniques such as mechanical tests and experimental stress analyses (Jörgensen, Matona & Shimokobe, 1976; Lee & Eakle, 1984; Stewart, Balda & Norman, 1986; Sturdevant *et al*., 1986; Feilzer, De Gee & Davidson, 1987; Heymann *et al*., 1991; Hood, 1991; McCoy *et al*., 1998), as well as the theoretical techniques like the 3-dimensional finite element method (FEM) (Katona & Winkler, 1994; Rees & Jacobsen, 1995; Winkler, Katona & Paydar, 1996; Rees & Jacobsen, 1998; Rees, O'dougherty & Pullin, 1999; Rees & Jacobsen, 2000).

Improved computers and modelling techniques render the finite element method as a very reliable and accurate estimation approach in biomechanical applications. Dental sciences are also making increased use of the finite element method especially in cases where the experimental methods fail to answer properly. An experimental method may indicate the ultimate load of failure of a tooth but cannot provide satisfactory answer about the development mechanism of the failure. The intermediate levels of a process can easily be understood by using the FEM which provides the ultimate accuracy of mathematics and is very suitable to the modelling of unsymmetrical tooth structure.

This study analyses the strength characteristics of various resin based restorative materials when they are

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