

Bone Remodeling Response During Mastication on Free-End Removable Prosthesis – a 3D Finite Element Analysis

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Abstract: An understanding of functional responses in oral bone is a crucial component of dental biomechanics. The purpose of this study was to investigate the use of an osseointegrated implant as support for a free-end removable partial denture (RPD) on the potential biological remodelling response during mastication. A three-dimensional (3D) finite element analysis (FEA) was performed to determine the biomechanical responses to masticatory loading in the posterior mandible. Stresses and strains were analysed at lingual/buccal and mesial/distal areas of the premolar to molar region to anticipate bone remodeling response. Mandibular bone incorporating an implant-supported RPD experienced substantially greater stress/ strain magnitudes than that prior to placement of implant, which is suggestive of engagements of bone remodelling. The results suggest similar outcomes to those reported clinically. Developing a simulation reflecting the outcomes of restorative treatment can provide meaningful insight into restorative treatment planning, clinical outcomes, and removable prosthodontics designs.

Keywords: Bone Biomechanics, Osseointegrated Implants, Removable Partial Denture.

1. Introduction

Although there is a tendency to offer fixed prostheses to our patients, this might change again with the demographic changes and with an ageing population, an increase in their reduced dentition and low socioeconomic wealth in large parts of the world (Mericske-Stern, 2009). Rehabilitation of partially edentulous mandibles with Kennedy class I removable partial dentures (RPDs) requires anatomic reconstruction of the lost alveolar bone, replacement of posterior teeth and stable occlusal contacts to allow for functional mastication.

Treatment planning for free-end RPDs became highly complex over time, and a set of reliable criteria is necessary for decision-making and problem managing. The functional needs of the distal part of mandible, combined with the physiologic differences among the support system of the prosthesis, continue to present major problems to dental surgeons. The physiological movement capacity of a tooth, due to its periodontal ligament, is limited to 0,1mm, whereas the compressibility of the mucosa varies from 0,4mm to 4mm (Biagi & Elbrech, 1955).

Implant supported free-end RPDs are suggested as a solution for the biomechanical problems, providing long-term occlusal stability (Keltjens *et al.*, 1993; Cho *et al.*, 2002). However, the presence of a RPD, supported or not by an implant, changes the local biomechanical status, whereby bone may model and remodel to accommodate a new loading environment.