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THE EFFECT OF A MANDIBULAR IMPLANT-RETAINED OVERDENTURE ON RESIDUAL RIDGE RESORPTION OF THE ANTERIOR MAXILLA

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ABSTRACT

Two implants in the anterior mandibular region to retain complete denture resembles that of natural anterior teeth and have been reported to cause Combination Syndrome, particularly severe resorption of the anterior maxilla. Such bone resorption was compared between two clinical situations; conventional dentures (CDs) and conventional maxillary denture opposing mandibular implant-retained overdenture (IRO). The results conflicted because of the two-dimensional methods used to quantify bone resorption. Hence, this study investigated the possibility of using a three dimensional (3D) radiography technique to objectively quantify bone resorption to ascertain the effects of mandibular implants on the anterior maxilla. As it was hypothesized that the increased bite force associated with IRO disrupts blood flow more than does the CD, blood flow was measured beneath the denture. A Finite Element Analysis (FEA) to simulate the two modalities of treatment was also carried out and the results correlated with the clinical outcomes. CBCT images of before and after one year of treatment of 18 IRO and 4 CD patients were obtained from a previous study and were reconstructed into 3D models using Mimics program v17. Superimposition of the maxillae models was achieved using a Standard Tessellation Language registration method. Bone resorption was measured as changes in bone volume pre- and post-treatment. A laser Doppler flowmeter (LDF) with a non-invasive probe was used to measure blood flow beneath the denture in 9 IRO and 4 CD patients. Measurements were taken for 2 minutes each at time 0, 30, 60 and 90 minutes after denture removal on the right, mid, and left sides. For the FEA, 3D models of maxilla, mucosa, and denture were created and duplicated in ANSYS 16.0 to perform two simulations, the IRO and CD models. Maximum stress and strain and total deformation were obtained and compared to the outcomes of anterior maxilla resorption from the clinical study. The mean reduction of bone volume in the anterior maxilla of CD patients was found to be 2.60% (SD = 1.71%, range = - 4.89 % to − 0.92%, median = - 2.30%). The mean reduction of bone volume of the IRO patients was almost three times higher at 7.25% (SD = 3.16%, range = -13.25 to − 1.50, median = - 7.15 %). The ANOVA one-way test showed a significant difference in volume reduction between the two groups: $F_{2,19}$ = 4.095, $p < 0.05$. The blood flow return was 3.5 times the baseline value in the IRO and about double in the CD group indicating greater blood flow disruption in the IRO patients. The results of Mixed repeated ANOVA showed that there was a statistically significant interaction between the time and groups variables: $F_{1.6, 17.1}$ = 4.948, $p = 0.03$. Also there was significant effect of group: $F_{1, 11}$ = 8.181, $p = 0.016$, and strong significant effect of time: $F_{1.3, 17.1}$ = 146.807, $p < 0.001$. FEA revealed that the maximum principal stress (MPa) in the anterior maxilla in the IRO model ranged from 0.019 to 0.336, while it ranged from 0.011 to 0.193 in the CD model. The maximum principal strain in the IRO model was 1.75 greater than that in the CD model. Total deformation was 1.8 higher in the IRO model. Greater bone resorption was observed in regions of higher stress which were on the occlusal and buccal sides of the anterior maxilla residual ridge. Bone resorption in anterior maxilla in the IRO group was almost three times higher than the CD group which could be attributed to the presence of two implants in the mandible. This result is in tandem with the greater blood flow disruption observed in the anterior maxilla underneath denture opposing IRO which encouraged more bone resorption.

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TABLE OF CONTENTS

CHAPTER ONE

INTRODUCTION

1.1   BACKGROUND OF STUDY

It has been established well that the natural remaining mandibular anterior teeth may cause severe residual ridge resorption in the opposing anterior maxilla underneath complete denture (Carlsson et al. 1967; Kelly, 1972). This resorption may be attributable to excessive occlusal force exerted on the anterior maxillary bone as patients prefer to chew anteriorly with the natural remaining teeth (Fontijn-Tekamp et al. 1998; Tolstunov, 2007). The placement of two implants in the interforamina region to retain the mandibular denture resembles that of natural anterior teeth and have been reported to cause phenomena similar to those above; this is referred to clinically as Combination Syndrome (Maxson et al., 1990; Thiel et al., 1996; Kreisler et al., 2003; Lopez-Roldan et al., 2009).

In a typical complete edentulous situation, implants are not placed in the anterior maxilla, as there is inadequate bone quantity and quality (Carlsson & Omar, 2010) and because the maxillary denture often is quite retentive without implants (Santos et al., 2015).   Hence, the anterior maxilla may be overloaded by the opposing mandibular implants, as it has been shown that the maximum bite force in implant overdenture (IRO) patients is at least twice that in mandibular conventional complete denture (Rismanchian et al., 2009; Ahmad et al., 2015). This increase in bite force also is manifested clinically, in that maxillary CD break frequently in the midline region (Rutkunas et al., 2008).

Several researchers have compared the amount of residual ridge resorption of the anterior maxilla area in two clinical situations; conventional maxillary denture opposing mandibular conventional mandibular denture and conventional maxillary denture opposing mandibular implant-retained overdenture, to ascertain whether implant-retained or supported overdentures indeed contribute to Combination Syndrome (Jacobs et al., 1993; Narhi et al., 2000; Rutkunas et al., 2008). However, the results reported, were contradictory, possibly because of the method used to quantify bone resorption. The methods of quantification used commonly are either