INFLUENCE ON BONE STRESS DISTRIBUTION OF NUMBER OF IMPLANTS, CROWN HEIGHT AND IMPLANT LENGTH FOR 3-UNIT BRIDGES IN THE POSTERIOR MANDIBLE: A 3D FINITE ELEMENT ANALYSIS

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Bone volume reduction caused by bone resorption could be a critical limitation for placing dental implants, particularly in the posterior section of the mandible. Short dental implants' placement was introduced alternatively to surgical bone augmentation procedures. Recent studies indicated that in short and medium term short implants could present survival and success rates similar to conventional implants. However their biomechanical efficiency is controversial also because higher crowns may be necessary to compensate the bone resorption, leading to a less suitable crown-to-implant ratio.

The aim of this study was to evaluate the stress transmitted to surrounding bone by different configurations of number of implants, implant length and crown height in a three-unit bridge positioned in the posterior mandible by means of finite element analysis.

The 3D geometry of the edentulous mandible was reconstructed from computerized tomography (CT) scans. Bone material elastic properties were assigned to each tetrahedral element based on the Grey Value. The implants’ meshes were placed in second premolar and second molar position for the two implants configurations and also in first molar position for the three implants configurations. A superstructure representing a porcelain three unit bridge was built using beam elements for each configuration. Six different implant configurations were compared: LS2) two 4mm wide x 11mm long implants with 8mm high crowns; LS3) three 4 mm wide x 11mm long implants with 8mm high crowns; SS2) two 4mm wide x 6mm long implants with 8mm high crowns; SS3) three 4mm wide x 6mm long implants with 8mm high crowns; SL2) two 4 mm wide x 6 mm long implants with 13 mm high crowns; SL3) three 4 mm wide x 6 mm long implants with 13 mm high crowns. A 200 N axial and 45° oblique loads were applied to each crown. For each configuration the effect of both loading scenarios was evaluated in terms of state of stress in the bone-implant interface. (Von Mises stress, maximum and minimum principal stresses)

In all configurations the stress was more concentrated in the cervical area of the peri-implant bone but especially under oblique load. Under oblique load it was several times higher than under axial load, particularly the maximum principal stress was from 15 to 35 times higher. Under oblique load the maximum peri-implant stress was found in the SL2 configuration while the minimum peri-implant stress was found in the LS3 configuration. The increase of stress parameters values in SS configurations respect to respective LS configurations was on average of the 15%. The average increase of stress values in SL configurations respect to SS configuration was about the 42% under tilted load. Configurations with 2 implants were recorded to undergo the 31% more stress on average than the respective 3 implants configurations.

Crown height, implant number and implant length seem to be all influencing factors on implant bone stress, however the augmentation of crown height seems to have a greater effect than the reduction of implant length. Even if the stress observed in all configurations was within a physiological range, a three-unit bridge with 13 mm long crowns supported by two short implants may be biomechanically hazardous in the presence of horizontal forces, and the addition of another short implant or increase of bone volume may be suggested to dissipate the stress at bone-implant interface. The use of short dental implants to support a three unit bridge in the posterior mandible can be considered a potential alternative to standard length implants, but crown height and lateral forces have to be carefully analyzed in every patient.