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Short dental implants: finite element analysis of stress characteristics in posterior maxilla

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Objectives: Reduced bone height, higher masticatory force and increased crown-implant length ratio are all associated with short dental implants placed in the posterior mandible or maxilla. Consequently, dental practitioners generally aim to increase the bone to implant surface area contact by choosing larger

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diameters for short implants. However, there is a lack in the understanding of the response of bone to implants of short design, as offered by different manufacturers. This research employs the finite element technique to evaluate the von Mises stress characteristics within the maxilla for four typical short implant designs. The maximum compressive stresses in the cancellous and cortical bone are compared to the published stress-strain data to determine the risks of bone fracture.

Material and Methods: Parameters considered include the masticatory loading level, crownimplant length ratio and Young's moduli of both cancellous and cortical bone. The four implant designs exhibit different implant taperages and thread designs. Assumptions made in the analysis are: the complex material and geometric properties of the bone and implant are modelled using two-dimensional triangular and quadrilateral plane strain elements; and 50% osseointegration between bone and implant.

Results and Conclusion: Compared to Young's modulus variation of bone, increasing the crownimplant length ratio leads to higher stresses in bone surrounding the implant. Increased stresses are generally located in the vicinity of the implant neck in cortical bone and regions close to the implant top and bottom in cancellous bone. Implant designs with increased taperage and reduced thread profile discontinuities have reduced stress magnitudes in the bone. The fundamental data from this research will expand the application of a 'treatment planning database' which is currently being developed. Using this database, practitioners can recognise short implants that will result in improved bone response for the unique characteristics of the patient's bone at the recipient site.

Keywords: short dental implant, finite element technique, stress characteristics
