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Submodelling approach to screw-to-bone interaction in additively manufactured subperiosteal implant structures

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Abstract-

Thanks to new digital technologies, complex cases of severe maxillary atrophy may now be treated with additively manufactured subperiosteal implant structures (AMSISs). However, there are few studies addressing this topic and most of them focus on the mechanical behaviour of the AMSIS itself without considering its interaction with the maxilla bone. The aim of this study is to provide a methodology based on finite element analysis (FEA) to evaluate the effect of interaction between the maxilla bone and the screws fixing the AMSIS. The mechanical performance of an AMSIS was examined via a FEA based on submodelling. Significant differences were encountered in displacements and reaction forces when bone–screw interaction was considered. Stress in the cortical layer was found to be close to the maximum strength while the trabecular layer seems to have no effect on the results; stresses in the AMSIS are lower than the fatigue stress limit. Finally, the comparison of stresses between models with and without osseointegration shows how stresses drop once osseointegration is complete. The proposed submodelling approach considerably reduces the computational effort and enables both a detailed model of the interaction between the thread of the screws and the bone and an accurate evaluation of displacement and stress fields on the interface. The results have shown that stresses in the cortical bone are highly affected by the initial geometry of the thread inside the bone, which demonstrates the importance of modelling the effect of the thread.

Index Terms- ad hoc prosthesis, AMSIS, dental implant, finite element method, screw-to-bone contact, submodelling, subperiosteal implant structures

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