Mandibular reconstruction-biomechanical strength analysis (FEM) based on a retrospective clinical analysis of selected patients

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Abstract: Restoration of mandible discontinuity defects continues as a challenge for maxillofacial surgeons. Despite the development of algorithms for reconstruction plates fixation and autogenous grafting techniques, complications are still encountered including screw loosening, bone resorption or delayed / incomplete union.

Aim of the study was to analyze the possibility of obtaining bone union in the aspect of biomechanical conditions two mandible reconstructions using an autogenous iliac crest bone graft stabilized with a reconstruction plate, and to attempt to predict patient outcomes based on strength parameters obtained by the finite-element analysis.

The authors of the present paper were trying to determine to what extent the reconstruction model and changes occurring in hard tissues of the bone and autogenous graft (simulated by changes in material properties) might help predict individual patient courses. The effort of reconstruction plates was defined using the values of the von Mises stress ($\sigma_{\text{HMH}}$) while the effort of bones was determined based on the values of strain intensity $\varepsilon_{\text{int}}$. The results of the above mentioned simulations are presented in the form of bar graphs and strain / stress distribution maps. Our strength analyses indicate that uncomplicated healing of grafts fixed with reconstruction plates requires that the initial loading of the stomatognatic system should not result in strain intensity exceeding 20-40 [$\times10^{-4}$]. This range of strain intensity evokes an increase in the mineral phase. The state of nonunion between the mandibular bone and the graft might result from prolonged periods of insufficient loading of the mandible during treatment.

key words: bone grafts, mandibular reconstruction, finite element method - FEM, reconstruction plates, bone healing