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# Real-time patient-specific finite element analysis of residual limb stresses in transtibial amputees during treadmill walking

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Fitting of a prosthetic socket is a critical stage in rehabilitation of transtibial amputees. An injured stump can lead to immobility, further surgery and death. To date, prosthetic fitting depends on the subjective skills of the prosthetist. No technology is presently available to provide real-time information on the internal stresses in the residual limb. In this study, a simplified patient-specific finite element (FE) model of the residual limb was developed for ``real-time'' stress analysis. We employed a custom-made FE code that continuously calculates internal stresses in the residual limb, based on boundary conditions acquired from force sensors, located at the limb-prosthesis interface. Validation of the modeling system was accomplished by means of a synthetic phantom of the residual limb. Human studies were conducted subsequently in 5 patients. Force sensors were placed at the stump-liner interface, and subjects walked on a treadmill during analysis. Generally, stresses under the shinbones were ~3-fold higher than stresses at the soft tissues behind the bones. Usage of a thigh corset decreased the stresses in the residual limb. Also, the stresses calculated during the trial of a subject who complained about pain were the highest, suggesting a problematic stump or prosthesis. We conclude that real-time patient-specific FE analysis of internal stresses in deep soft tissues of the residual limb is feasible, and promising for improving the fit of prostheses in the clinical setting, and for protecting the residual limb from muscle flap necrosis and pressure ulcers.

*Reference:* *G. Yarnitzky, Z. Yizhar and A. Gefen. (2005). Real-time subject-specific monitoring of internal deformations and stresses in the soft tissues of the foot: A new approach in gait analysis. J. Biomech., in press, DOI 10.1016/j.biomech.2005.08.021.*