Finite Element Analysis of ACL Reconstruction Surgery Knee

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Abstract: The Anterior Cruciate Ligament (ACL) tear is one of the most common injuries, with roughly 200,000 reconstruction surgeries occurring annually in the U.S.A. alone. Unfortunately, 13% of these reconstruction surgeries fail, often with the weakest point of the surgery to blame: the point of attachment. Too much stress on the bone plug - screw - host bone interface throughout rehabilitation can cause the graft to fail, rendering the surgery useless. By using properties of material homogeneity and symmetry, a finite element analysis model of this interface was created in Abaqus. A Holzapfel-Gasser-Ogden constitutive model was used to represent the Patellar tendon in the reconstructed knee, the bone and the metallic screw were governed with linear elastic, isotropic homogenous material as previous studies have done, and the geometry and the loading profile of forces were derived from physiological journals. Rehabilitation exercises were tested on the model by changing the peak loading profile on the tendon. The coefficient of friction was also increased on the model to explore the effects of healing on the bone plug. Also, the screw material parameters were manipulated to represent different materials commonly used to make interference screws to test for stress shielding. The variable of interest was the von mises stress in the bone plug, which predicts the likelihood of failure due to each change in the parameters. Disseminated in the discussion, the project provided insights into rehabilitation exercises that were of clinical relevance. The study drew not only general conclusions, but also numerical comparisons of stress from loading patterns on the reconstructed tendon. It also provided significant results when other parameters were changed, demonstrating this model's sensitivity and value for future studies. Although these results were consistent with ideas previously put forth in literature, the model provided unique direct analyses that were of higher clinical relevance. Finally, this model provides other opportunities to easily and readily test various other parameters of the reconstructed knee for future studies.