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EFFECTS OF TENSION BAND IMPLANTS ON THE MECHANICAL LOADING OF THE FEMORAL GROWTH PLATE DURING GUIDED GROWTH IN ADOLESCENTS

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Summary: Malalignment of the lower limb leads to permanent increased loading of one compartment in the knee joint, one of the most common causes of knee osteoarthritis. A preventive therapy is available for adolescents in the form of correcting the deformity through growth control by temporary hemiepiphysiodesis. Here one side of the growth plate is 'occluded' by a tension band implant. With this guided growth procedure, the malalignment can be corrected. In up to 50%, the leg deformity returns [1]: the so-called rebound effect. Both, the influence of mechanical loading on length growth of bones and the way how the loading of the growth plate is changed by inserting a tension band implant are poorly understood. The objective of the current study was to examine how the insertion of the implant changes the local stress and strain distributions in the growth plate. For the investigation of the mechanical situation, a non-individual 3D finite element (FE) model was created based on the data of 5 patients with valgus malalignment. Characteristic geometric parameters of the growth plate and femur were taken from preoperative 2D full-length standing X-ray images in the frontal plane. The knee joint contact forces at characteristic positions of the gait cycle were used as boundary conditions. The lateral and medial knee contact forces were determined through Open-Sim based on the data of instrumented gait analyses [2]. For each chosen point of time and joint angle throughout the gait cycle, three FE models were built: one representing the state before treatment without implant, one immediately after implantation and one at the end of treatment when the implant itself is under stress due to bone growth [3].Results for standing on both legs show an inhomogeneous stress distribution in the pathological growth plate. As expected with valgus malposition, increased compressive stresses were observed laterally before insertion of the implant. The insertion of the implant initially reduces compressive stresses on the implant side, i.e. medially, but at the end of the treatment, higher compressive stresses occurred on the implant side medially and tensile stresses laterally. The shear stresses were also significantly higher and were now concentrated mainly on the implant side. Findings from the literature show that growth in the growth plate is inhibited by static compressive stresses and stimulated by tensile or shear stresses. These are the effects that occur due to the insertion of the implant. The results will allow a better understanding of implant induced local changes in the mechanical loading in the growth plate and the resulting growth inhibition over the gait cycle.

References

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