Nonphysiological knee motion is associated with the increased strain on the proximal tibial epiphysis: A finite element study

Hiroshi Watanabe1, Kohei Murase2, Tokifumi Majima1
1Nippon Medical School, Tokyo, 2Osaka University, Suita,
Email: watanabehiroshi@nms.ac.jp

Disclosures: Hiroshi Watanabe (N), Kohei Murase (N), Tokifumi Majima (N) (Information for disclosures can be taken from the online abstract system after entering ALL authors)

INTRODUCTION: Previously, we reported that the increased proximal tibial slope angle over 12 degrees could be the risk for suffering from proximal tibial epiphyseal injuries during epiphyseal closure (Ref.). Meanwhile, the effects of nonphysiological knee motion such as knee abduction with external tibial rotation on the proximal tibial epiphysis remain unknown. To elucidate those effects, we investigated the strain distribution in proximal tibial epiphysis with different posterior tibial slope angle using finite element analysis.

METHODS: The finite element models of the proximal tibia were reconstructed from CT images and consisted of cancellous/cortical bone and epiphyseal plate. The variations in proximal tibial slope angle (5, 10, and 16 degrees) and two variations including abduction with external tibial rotation (valgus) and normal knee were prepared, and the equivalent strain in the proximal tibial epiphysis were calculated. The loading force on the medial and lateral joint surface, and the tensile force by the patellar tendon were applied to the models, and the force setting was modified in accordance with the knee motion (valgus/normal).

RESULTS SECTION: The equivalent strain on the proximal tibial epiphysis models indicated significant differences between valgus and normal knee model in 10 and 16 degrees of proximal tibial slope angle models. Meanwhile, the equivalent strain on the proximal tibial epiphysis models indicated no significant differences between valgus and normal knee model in 5 degrees of proximal tibial slope angle model.

DISCUSSION: The increased equivalent strain might be due to the stress intensity factor of mode III, considering the rotation force in the proximal tibial epiphysis. The adolescent athletes should avoid nonphysiological knee motion in sports activities, considering the association between increased strain on proximal tibial epiphysis and the nonphysiological knee motions.

SIGNIFICANCE/CLINICAL RELEVANCE: Our results indicate that the adolescent athletes should carefully avoid nonphysiological knee motion in sports activities.


Figures: The images show the equivalent strain in the proximal tibial epiphysis in valgus knee (Left, knee abduction with external tibial rotation) and normal knee (Right) at three patterns of posterior tibial slope angle (PTSA; 5, 10, and 16 degrees).