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Effects of Foot Placement on the Kinematics and Articular Contact Patterns of the Knee During Cycling Using 3D Fluoroscopy Method

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INTRODUCTION: Cycling exercises have been used in the rehabilitation of the lower extremities with musculoskeletal diseases or injuries. The need for injury-specific cycling exercises has been raised in clinical settings and in the literature, considering the differences in posture and pedaling mechanics in different injury populations. It appears that proper adjustment of the pedaling patterns such as through the foot positions on the pedal may help modulate the kinematics of the knee to reduce the risk of overuse injuries and/or improve recovery. The aim of the current study was to study the effects of the feet placement on the pedals on the kinematics of the knee during cycling.

MATERIAL AND METHODS: Eleven healthy young adults wearing 14 markers on the right lower limb performed cycling exercises on an ergometer with the feet placed on the pedals at neutral position, 10 degrees of inversion, and 10 degrees of internal rotation while the skeletal motions of the knee were imaged by a bi-plane fluoroscopy system (ALLURA XPER FD, Philips). The knees of the subjects were also CT scanned and used to construct CT-based bone models, which were then registered to the fluoroscopy images using a fluoroscopy-to-CT registration method, giving the rotations, translations and articular contact kinematics of the knee. A one-way analysis of variance was used to analyze the effects of pedaling patterns on each of the variables (α=0.05).

RESULTS AND DISCUSSIONS: Accurate 3D skeletal kinematics of the knee during cycling was measured. Significantly increased knee flexion was found in cycling exercises with the foot internal rotated. Significantly decreased contact areas of the knee in both medial and lateral compartments were found in the conditions of

inverted or internal rotated foot placement. Decreased contact areas associated with inadequate foot placement may lead to abnormal pressure distributions in the articular surfaces during cycling, which may be a risk factor of failure of the knee articular cartilage.