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Correlation between the Angle of Lateral Tibial Rotation and the Ratio of Medial and Lateral Hamstring Muscle Activities during Standing Knee Flexion

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Abstract. [Purpose] This study investigated the correlation between the angle of lateral tibial rotation and the ratio of the medial and lateral hamstring muscle activities during standing knee flexion. [Subjects] Eighteen healthy subjects (6 females, 12 males) participated in this study. [Methods] Surface electromyography was used to record medial and lateral hamstring muscle activities, and the muscle activities were expressed as a percentage of the reference voluntary contraction. The angle of tibial rotation was measured with a three-dimensional motion analysis system. Subjects were instructed to perform knee flexion on one side in the standing position. Pearson's correlation coefficient was used to test the relationship between the angle of the lateral tibial rotation and the ratio of the activity of the medial and lateral hamstring muscles during standing knee flexion. [Results] The angle of the lateral tibial rotation and the ratio of the medial and lateral hamstring muscle activities showed good to excellent correlation ($r = -0.767$). [Conclusion] These results suggest that asymmetry of the medial and lateral hamstring muscle activities may cause tibial lateral rotation during standing knee flexion.
Key words: Hamstrings, Lateral tibial rotation

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INTRODUCTION

The degree of tibial rotation relative to the femur about the longitudinal axis is important during daily living activities, and excessive tibial rotation may cause movement dysfunction at the knee joint[1–4]. Specifically, excessive tibial lateral rotation relative to the femoral bone induces abnormal lower limb movement and musculoskeletal conditions such as toeing, patellar maltracking, and osteoarthritis[3]. Altered tibial rotation may also contribute to a change in the contact pressure in the patellofemoral joint and influence the rotation force across the knee joint[5, 6]. As tibial lateral rotation is associated with injuries incurred during sports and daily activities, the examination of tibial rotation during functional activities is essential for the provision of a treatment strategy for tibiofemoral rotation syndrome.

The degree of tibial rotation differs between active and passive movements. Tibial rotation in a standing and weight-bearing position is used in clinical knee examinations[7–9]. A previous study recommended that knee motion during dynamic movements such as gait should be measured, owing to the lack of correlation of knee motion measurements between static and dynamic conditions[10]. Excessive tibial rotation during gait and the single leg stance knee flexion test have been described in an individual with tibiofemoral rotation syndrome[3]. However, no study has determined the mechanism of tibial lateral rotation during knee flexion in the standing position.

The hamstring muscles play important roles in knee stability and movement in the sagittal and transverse planes[11–13]. Victor et al.[14] reported that the tibia was rotated more laterally with a 50-N lateral hamstring load than with a 50-N medial hamstring load in knee flexion experiments using cadavers. The medial hamstrings (semitendinosus and semimembranosus muscles) are inserted at the pes anserine tendon at the proximal anteromedial tibia (semitendinosus) and posterior surface of the medial condyle of the tibia (semimembranosus)[15]. Increased activity of the medial hamstring muscles was induced by tibial medial rotation[12]. The biceps femoris muscle is inserted at the head of the fibula. When muscle activity of the biceps femoris increases, the tibia rotates laterally[12, 15]. Patil et al.[16] reported that the lateral hamstring was activated earlier in an anterior knee pain group than in an asymptomatic control group, and they postulated that a difference in medial and the lateral hamstring activation would cause abnormal knee

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