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JOINT MOMENTS OF THE LOWER EXTREMITIES OF CHIRUNNING TECHNIQUE IN CHIRUNNERS: A PILOT STUDY

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The purpose of this pilot study was to compare the joint moments of the lower extremities in the sagittal plane between the ChiRunning and the common heel-toe running techniques. Two male experienced ChiRunners participated in the study. The joint moments of the lower extremities were analyzed from the kinetic data collected during their ChiRunning and common heel-toe running. When compared to the heel-toe strike technique, ChiRunning technique showed that peak hip flexion moment and ankle dorsiflexion moment appeared earlier in the gait cycle. Ankle dorsiflexion moment was greater in magnitude while knee flexion moment was lower in magnitude.

KEY WORDS: ChiRunning, Heel-toe strike, joint moment.

INTRODUCTION: The majority of the runners today are using the heel-toe strike method with approximately 80% of the runners landing with their heels as they strike the ground (Helle et al., 2006). Landing with the heel can provide a great amount of stress and cause a great amount of torque within the joints of the lower extremities which have implications for injuries (Helle et al., 2006). With mere technical adjustments, these injuries might be prevented through modifying running technique. Danny Dreyer, an utlramarathon runner, developed a midfoot running technique called ChiRunning based on the theory of Tai Chi. ChiRunning combines the inner focus and flow of Tai Chi with the power and energy of running (Dreyer & Dreyer, 2004). This style of running uses a midfoot strike technique and is said to be better than the more common heel-toe strike technique. To the knowledge of the authors, no biomechanical information in ChiRunning technique is available. Therefore the purpose of this study was to compare the joint moment variables of the lower extremities between ChiRunning technique and the common Heel-toe strike running technique. The results from the study will lay the foundation for future research on the ChiRunning technique.

METHODS: Two male participants with more than two years ChiRunning experiences participated in the study (age 27.5 ±4.5, height 192.5 cm ± 0.5cm, BMI 29.15 ± 0.15). A total of 35 reflective markers were placed on anatomical landmarks of the body according to the Plug-in-Gait marker set provided by VICON motion system©**.** The anatomical landmark for the markers include: the heel, the lateral and medial malleolus, the tibia, the lateral and medial side of the knee, the thigh, the anterior iliac spine, the posterior iliac spine, C7 and T10 vertebras, the wrist, the second metacarpal of the hand, the radius, the elbow, upper arm, acromio process, the posterior side of the head, and the anterior side of the head. Two Kistler force plates (Model 9286AA, Kistler Instruments Corp, Winterhur, Swtz) were used to record the ground reaction forces generated during the heel-toe and ChiRunning. Using a metronome to control the speed, the participants were asked to approach the force plates at a pace of 160steps/min. The participants completed a total of 5 successive trials for each condition of ChiRunning and Heel-toe running. Nine infra-red, high-speed, optical camera and Vicon motion system© was used to capture 3-dimensional motion. The moments of force at the joint of the hip, knee, and ankle in the sagittal plane were calculated through the inverse dynamics approach by using Vicon Nexus software (v1.3). Moments of force were normalized to body mass to allow between subjects comparisons. Each trial was time-normalized to a 100% gait cycle and then averaged for five trials. No significant difference in the measurements was found between left and right leg. Therefore the joint moments presented are the data of the left leg.

RESULTS: The average joint moment of force of the lower extremities of the hip, knee and ankle are presented in Figure 1. Comparing with Heel-toe running, ChiRunning showed 1) significantly bigger and earlier appeared flexion moment in hip; 2) significantly smaller flexion moment and larger extension moment in knee joint; and 3) significantly higher ankle dorsiflexion moment.

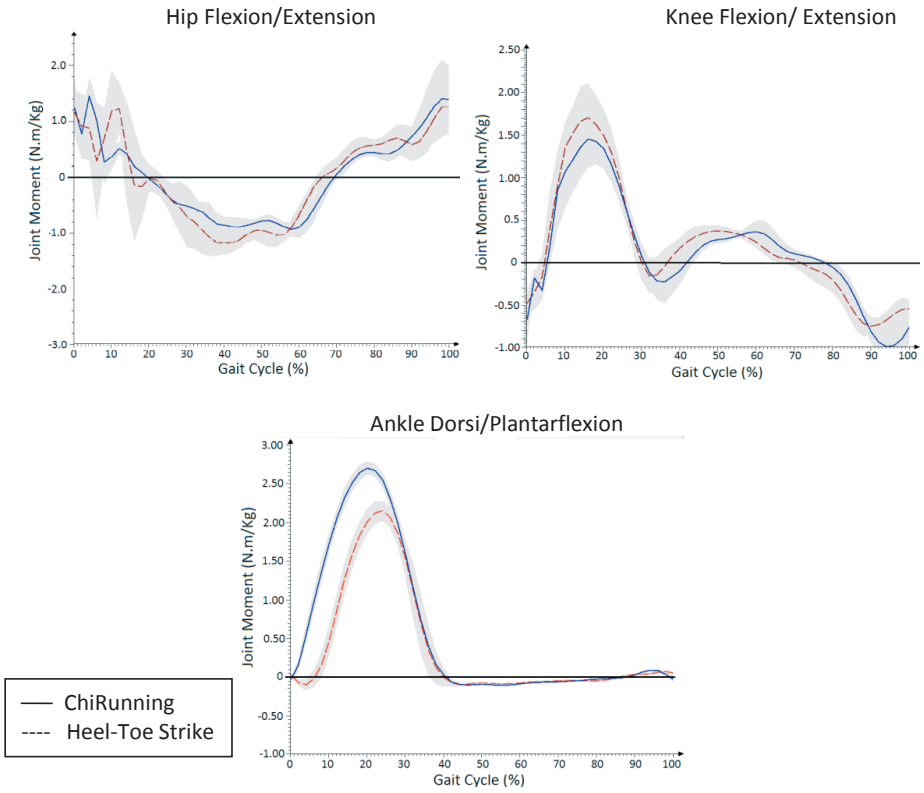

Figure 1: Average joint moments of the lower extremities in the sagittal plane for the hip, knee and ankle (n=2).

The extension moment of the hip, knee and ankle are indicated by the negative values in the figures. The gray areas represent the standard deviation at each time point of the gait cycle. To generate the curves, a mean curve was computed from the 5 trails for both technique and from each participant. The 2 curves were then computed to generate the mean curves as shown in the figure for each running style.

DISCUSSION: According to ChiRunning, the ChiRunning technique requires runners to have a specific posture which is defined as a slight forward lean of the body about the axis of the forward lean being the ankle joint and with relaxed legs and the foot picked up from the ground (Dreyer & Dreyer 2004). The postural alignment is defined as a leveled pelvis using the lower abdominal muscle. Shoulders are placed over the hips, with the hips over the ankles and with a neutral head position as claimed by ChiRunning. ChiRunning emphasizes the mid-foot strike method of running. It is thought that the midfoot landing under the posture line will reduce tension in the lower extremities and may reduce running injuries. ChiRunning requires for the body to have a forward lean from relaxed ankles, which may engage the pull

of gravity, while the heel lifts via knee bend with the knee staying relatively low as it bends. According to ChiRunning theory, gravity is the runner's main source of propulsion and the shin muscles are not engaged. They are only engaged and needed for momentary support between strides (Dreyer & Dreyer, 2004).

In Chirunning the hip flexors are required to lift the upper leg upward and forward. By increasing the stride length, runners begin to lift their knees and thus cause them to heel-strike (Dreyer & Dreyer, 2004). ChiRunning suggests that runners should allow the natural recoiling action of the hip flexor tendons to return the leg to its resting position (Dreyer & Dreyer 2004). By allowing the natural recoiling action to occur, the hip flexors don't need to work. This can be accomplished by rotating the pelvis more. From Figure 1, peak hip flexion moment appears to be present earlier within the gait cycle for the ChiRunning technique. The reason for this could be due to the forward lean and the shorter stride length. In heel strike technique, it is said that ankle dorsiflexion, along with hip and knee flexion are required to help disperse the force of impact generated at heel strike (Dugan & Bhat, 2005).

From Figure 1 showed that knee flexion moment was lower in ChiRunning when compared to Heel-toe running. One of the distinguishing attributes to ChiRunning is that runners are required not to lift their knees as they run. When the knees lift, the legs will swing forward, causing the heels to strike which will create a braking motion and thus creating a greater impact at the heel and knee. Also, ChiRunners are instructed to rotate their legs medially toward their center line until their feet are parallel to each other and pointing forward. Results of this study indicate that knee flexion moment was lower in magnitude when compared to the heel-toe strike technique. As ChiRuning technique requires runners not to lift theirs knee, there is less knee flexion, this might be the reason leading to smaller knee flexion moment during running.

From Figure 1, ankle dorsiflexion moment was greater in magnitude and appeared earlier in the gait cycle for ChiRunning when compared to heel-toe strike technique. Excessive pronation has been linked to many injuries that occur at the ankles. In heel strike, when the foot makes intial contact with the ground, ankle dorsiflexion causes the tibia to internally rotate and thus cause pronation of the foot (Novacheck, 1997). The authors of ChiRunning agree that with dorsiflexion, the heel acts as a fulcrum, and with repeated contraction of the tibialis anterior, the fascia of the shin muscle can become inflamed, leading to shin splints (Dreyer & Dreyer, 2004). To avoid this, ChiRunnig suggests that you eliminate the use of the shin muscles. Since gravity is the main source of forward propulsion, the shin muscles should not be engaged (Dreyer & Dreyer, 2004).

CONCLUSION: Based on the results of the study, ChiRunning creates lower flexion moment and higher extension moment in the knee, and results in earlier appearance of the hip flexion and ankle dorsiflexion moment in the stance phase. Moreover higher ankle flexion moment was observed. However, as the study only included a few participants, to generate a conclusion further study with a large sample size is needed.

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