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The effect of lateral banking on the kinematics and kinetics of the lower extremity during lateral cutting movements

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ABSTRACT

There are many aspects of cutting movements that can limit performance, however, the implementation of lateral banking may reduce some of these limitations. Banking could provide a protective mechanism, placing the foot and ankle in orientations that keep them out of dangerous positions. This study sought to determine the effect of two banking angles on the kinematics and kinetics of the lower extremity during two athletic maneuvers.

Kinematic and kinetic data were collected on 10 recreational athletes performing v-cuts and side shuffle movements on different banked surfaces (0°, 10°, 20°). Each sample surface was rigidly attached to the force platform. Joint moments were calculated and compared between conditions using a repeated measures ANOVA.

Banking had a pronounced effect on the ankle joint. As banking increased, the amount of joint loading in the transverse and frontal planes decreased likely leading to a reduction in injury risk. Also an increase in knee joint loading in the frontal plane was seen during the 20° bank during the v-cut. Conversely loading in the sagittal plane at the ankle joint increased with banking and coupled with a reorientation of the ground reaction vector may facilitate a performance increase. The current study indicates that the 10° bank may be the optimal bank, in that it decreases ankle joint loading, as well as increases specific performance variables while not increasing frontal plane

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knee joint loading. If banking could be incorporated in footwear it may be able to provide a protective mechanism for athletes.
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1. Introduction

1.1. Injury

Some of the most common injuries in sports such as basketball occur in the lower extremity (35.9–92%), with the ankle and foot accounting for majority of these injuries (16.6–44%), followed by the knee (5–20%) (Harmer, 2005; Hikey, Fricker, & McDonaled, 1997; Messina, Farney, & DeLee, 1999; Taylor & Attia, 2000; Zvijac & Thompson, 1996). A large percentage of ankle injuries are inversion ankle sprains (22–65%) (Harmer, 2005), with the primary cause thought to be an excessive inversion moment, which exceeds the internal eversion moment provided by the peroneal muscles when the ankle is in a plantarflexed and inverted position (Stacoff, Steger, Stussi, & Reinschmidt, 1996). Recently, footwear companies have considered incorporating lateral banking elements into their footwear, which raises the lateral aspect of the foot relative to the medial aspect. In theory incorporating lateral banking elements has the potential to reduce inversion ankle sprains by reducing the amount of ankle inversion during plantarflexion, keeping the ankle joint further away from the limit of its range of motion where ankle ligaments may be prone to injury. Banking could also allow additional time for the peroneal muscles to react and provide lateral support to prevent ankle sprain at the crucial time immediately after foot strike (Simpson, Shewokis, Alduwaisan, & Reeves, 1992).

Banking also has the potential of reducing the loading that the ankle joint experiences, specifically the inversion moment during athletic movements. During a side cut, loading is oriented on the medial aspect of the foot and forefoot (Queen, Haynes, Hardaker, & Garrett, 2007). Banking could invoke a lateral shift in the centre of pressure, reducing the ankle joint moment arm in the frontal plane, thereby reducing the inversion moment that potentially leads to ankle injury (Shelburne, Torry, Steadman, & Pandy, 2008). As well theoretical calculations by Greene (1987) clearly showed that banking can decrease the peroneal tendon force required to stabilize the ankle joint, and Alexander (1991) stated that aligning the resultant force vector with the leg generally leads to favorable minimization in joint moments and musculoskeletal stresses.

The knee joint is also frequently injured in sport and while benefits to the ankle joint are plentiful, benefits to the knee joint may also result from banking. Patellofemoral pain is thought to occur when frontal plane moments are large (Stefanyshyn, Stergiou, Lun, Meeuwisse, & Worobets, 2006), and lateral wedging (banking) has been shown to reduce these frontal plane moments (Fisher, Dyrby, Mundermann, Morag, & Andriacchi, 2007; Kakihuna et al., 2005; Kerrigan et al., 2002; Mundermann, Nigg, Humble, & Stefanyshyn, 2003). However the direct influence of banking on knee injuries is not as clear as for the ankle joint.

1.2. Performance

It has been shown that flat curved running is slower than straight running with a tighter turn leading to a greater decrease in performance. Cutting maneuvers can also be considered running with a very small radius of curvature (Chang & Kram, 2007; Jain, 1980).

In sport, greater running speeds are achieved with a greater ground reaction force (Weyand, Sternlight, Bellizzi, & Wright, 2000). Recent studies examining curvilinear running have concluded that the same peak resultant force is present compared to straight running; however the direction of the resultant force changes due to the required centripetal acceleration providing a smaller vertical component and a greater horizontal component (Chang & Kram, 2007). A smaller vertical force vector requires an increase in ground contact time to generate vertical impulse to support body weight over

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