Journal of Biomechanics 44 (2011) 2576–2578

Contents lists available at ScienceDirect

Journal of Biomechanics

journal homepage: www.elsevier.com/locate/jbiomech
www.JBiomech.com

Short communication

Kinematics and kinetics of an accidental lateral ankle sprain

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ARTICLE INFO

Article history:
Accepted 11 July 2011

Keywords:
Ankle
Sprain
3D motion analysis

ABSTRACT

Ankle sprains are common during sporting activities and can have serious consequences. Understanding of injury mechanisms is essential to prevent injuries, but only two previous studies have provided detailed descriptions of the kinematics of lateral ankle sprains and measures of kinetics are missing. In the present study a female handball player accidentally sprained her ankle during sidestep cutting in a motion analysis laboratory. Kinematics and kinetics were calculated from 240 Hz recordings with a full-body marker setup. The injury trial was compared with two previous (non-injury) trials. The injury trial showed a sudden increase in inversion and internal rotation that peaked between 130 and 180 ms after initial contact. We observed an attempted unloading of the foot from 80 ms after initial contact. As the inversion and internal rotation progressed, the loads were likely to exceed injury threshold between 130 and 180 ms. There was a considerable amount of dorsiflexion in the injury trial compared to neutral flexion in the control trials, similar to the previously published kinematical descriptions of lateral ankle sprains. The present study also adds valuable kinetic information that improves understanding of the injury mechanism.

1. Introduction

Ankle sprains are among the most frequent sports injuries and represent a significant contribution to time lost from sports participation (Fong et al., 2007). The injured athlete may suffer long-term sequelae such as an unstable joint and reduced proprioception (Wikstrom et al., 2010), increasing the risk of subsequent ankle injuries. Various preventive measures have been shown to be effective in reducing the incidence of ankle sprains (McKeon and Mattacola, 2008), but these may be refined with an improved understanding of the injury mechanism (Bahr and Krosshaug, 2005).

Lateral ankle ligament injury is traditionally described as an inversion trauma (Andersen et al., 2004), but a detailed description of joint kinetics is lacking. There are several ways to study sports injury biomechanics. One of the most valuable methods is analyzing the rare injuries occurring during biomechanical testing (Krosshaug et al., 2005). With a high number of test subjects, an injury may occur even when the injury risk is lower than during normal training. Two previous reports describe the kinematics of accidental ankle sprains using video analysis, but kinetic descriptions are lacking (Fong et al., 2009; Mok et al., 2011). A more precise description of moments acting on the ankle at the time of injury would improve the understanding of injury mechanisms. This case report provides a description of the kinematics and kinetics of an ankle sprain in a motion analysis laboratory.

2. Methods

The injured athlete participated in baseline testing for a cohort study initiated to study risk factors for ACL injury. The study protocol was approved by the Regional Committee for Medical and Health Research Ethics.

An elite female team handball player (173 cm, 63.7 kg, 22 years) suffered an accidental ankle lateral ligament sprain during testing. The injury was confirmed by clinical examination of an orthopedic surgeon.

The player wore running shoes, shorts, and a sports bra, and 34 reflective markers were attached to the legs, arms, and torso. Eight 240 Hz infrared cameras (ProReflex , Qualisys Inc., Gothenburg, Sweden) captured the motion, while ground reaction forces were measured by a $120 \times 60\,cm^2$ force platform (AMTI LG6-4-1, Watertown, MA, USA) collecting at 960 Hz. Prior to the sidestep cutting we performed a static calibration trial. The player was instructed to focus entirely on faking and moving around a static defender (height 178 cm) using her usual right–left sidestep cutting technique. The defender adjusted her position between trials to ensure that the player stepped onto the force platform with her right foot. For a trial to be accepted, the cut had to be performed with match-like intensity as perceived by the investigators, the stance foot had to hit the force platform, and all markers had to stay firmly attached to the player's skin. The injury occurred during the player's third accepted trial. Prior to this the player had completed 19 trials, which were discarded because markers fell off or the player did not hit the force plate.

The kinematics were obtained using custom Matlab scripts (Mathworks Inc., Natick, MA, USA), as described by Krosshaug and Bahr (2005). Kinetics were calculated with standard inverse dynamics, with joint moments projected onto the joint rotational axes. Marker trajectories and force data were processed with a smoothing spline with 15 Hz cut-off frequency (Woltring, 1986). The motion of the foot segment was calculated from the ankle joint center and markers at the heel and at the head of the fifth metatarsal. Ankle flexion was defined as rotation

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doi:10.1016/j.jbiomech.2011.07.014