P01-12 ID193

KINEMATICS ANALYSIS OF ANKLE EVERSION SPRAIN IN SPORTS ONE CASE DURINGTHE 2010 FIFA WORLD CUP

Xi Li[1, 2], Ling Qin[1, 2, 3], Kai-Ming Chan[1, 2, 3] and Daniel Tik-Pui Fong[3]

Centre for Space Medicine and Engineering Technology, Shenzhen Research Institute, The Chinese University of Hong Kong, Shenzhen, China[1]
Centre for Sports Medicine and Rehabilitation Technology, Shenzhen Research Institute, The Chinese University of Hong Kong, Shenzhen, China[2]
Department of Orthopaedics and Traumatology, Prince of Wales Hospital, Faculty of Medicine, The Chinese University of Hong Kong, Hong Kong, China[3]

The purpose of this study was to present the 3-dimensional ankle joint kinematics of an eversion ankle sprain case with MBIM motion analysis technique. The results showed that the maximum eversion angle occurred 0.20 seconds after trampled. At that time, the ankle joint was 25° everted, 42° externally rotated, and 15° plantarflexed. The Maximum eversion velocity was 210deg/s. The results from the MBIM technique could contribute to the understanding of the injury mechanism of ankle sprain injury.

KEY WORDS: video analysis, injury mechanism, ankle eversion sprain.

INTRODUCTION: The ankle is one of the most commonly injured joints with sprains accounting for 77% of all ankle injuries (Kemler, can de Port, Backx & van Dijk, 2011) and for 10~30% of all injuries in sport. In the all ankle sprains, nearly 85% are lateral sprains, while, medial sprains, which also known as the eversion ankle sprain, are less common than lateral ankle sprains, comprising 10~18% of all (Fong, Hong, Chan, Yung & Chan, 2007; Lin, 2006; Watermanet al., 2011; Shaw, Gribble & Frye, 2008). However, medial sprains are typically associated with subsequent syndesmosis injury or medial malleolus fracture, and represent a more disabling problem (Wolfe, Uhl, Mattacola & McCluskey, 2001), requiring longer recovery and different treatment (Boytim, Fischer & Neumann,1991; Hopkinson, St Pierre, Ryan & Wheeler, 1990). Besides, specific populations and sports display an increased incidence of medial ankle sprains (Waterman et al., 2011).
A precise description of the injury situation is a key component to understanding the injury mechanism and preventing injuries (Bahr & Krosshaug, 2005). However, quantitative analyses on injury cases with calibrated video recording are available only under rare circumstances, and no quantitative study on eversion ankle sprain cases was reported. Instead, injuries in sports are occasionally shown on television with multiple camera views, and those video recordings could be further analyzed to explain the cause of injury. To develop a novel biomechanical analysis to produce continuous measurement of joint kinematics from video recordings, Krosshaug and Bahr (2005) introduced a model-based imagematching (MBIM) motion analysis technique for investigating human motion from uncalibrated video sequences and employed the technique to determine the injury mechanism of anterior cruciate ligament (ACL) ruptures (Krosshaug, Slauterbeck, Engebretsen & Bahr, 2007).
During the 2010 FIFA World Cup games, an eversion ankle sprain injury was shown on television. The player was unable to continue the match after the ankle eversion sprain motion and the injury motion was clearly shown by 2 camera views. Using the MBIM motion analysis technique, the ankle joint kinematics of ankle sprain injury case could be reconstructed. The purpose of this article was to present the 3-dimensional ankle joint kinematics of the ankle sprain case.

METHODS: Video recording of the injury case was obtained from the FIFA Broadcasting System, which was recorded from the game Portugal versus Brazil: the Brazilian player was

trampled by a Portuguese player on the lateral of his lower leg and suffered an eversion ankle sprain when striving for the ball.
The video recordings (50Hz) were 1024×576 pixels in resolution, captured by 2 video cameras, the relative angle between cameras 1 and 2 was about 80°. The video recordings were transformed into uncompressed AVI image sequences using Adobe Premiere Pro (version CS4, Adobe Systems Inc, San Jose, California). Then, the image sequences were synchronized and rendered into 1-Hz video sequences by Adobe After-Effects (version CS4, Adobe Systems Inc). The matchings were performed using 3-D animation software Poser 4 and Poser Pro Pack (Curious Labs Inc, Santa Cruz, California). The skeleton model from Zygote Media Group Inc (Provo, Utah) was used for the skeleton matching. The skeleton matching started with the shank segment and then distally matched the foot and toe segments frame by frame. The joint angle time histories were read into Matlab (MathWorks Inc, Natick, Massachusetts) with a customized script for data processing. Joint kinematics was deduced by the joint coordinate system (JCS) method. The ankle joint measurement standard was according to the recommendation of the International Society of Biomechanics (Wu et al., 2002). The ankle joint kinematics results from the MBIM technique were filtered and interpolated by Woltring's generalized cross-validation spline package with 15-Hz cut-off frequency.

RESULTS: The injury occurred when the two players were striving for the ball. The Brazilian player was trampled by a Portuguese player on the lateral of his left lower leg and suffered a severe eversion ankle sprain. At the point of trampled, the ankle joint everted 3°, externally rotated 8°, and dorsiflexed 30° (Figure 1). At 0.20 seconds after trampled, the eversion angle reached the maximum (Figure 3). At that time, the ankle joint was 25°everted, 42° externally rotated, and 15°plantarflexed.The maximum eversion velocity was 210deg/s (Table 1).

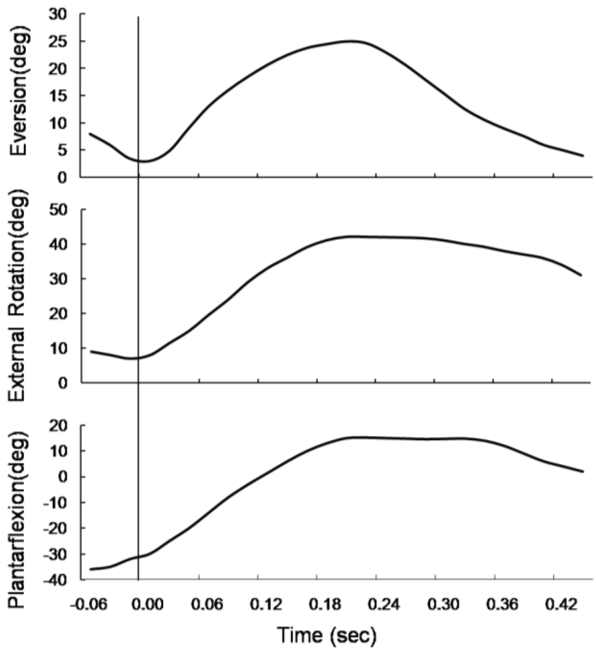


Figure 1: Ankle joint kinematics of the player during the ankle sprain injury. Time zero represented the point of trampled.

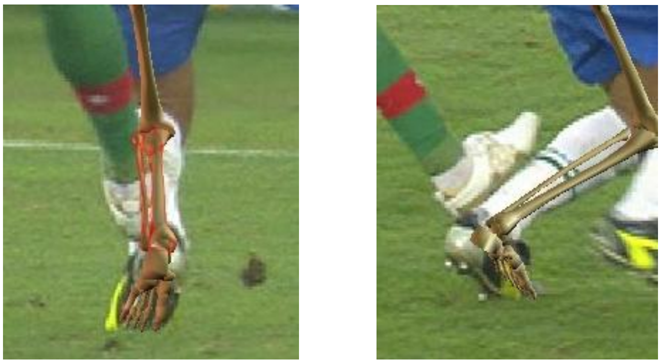
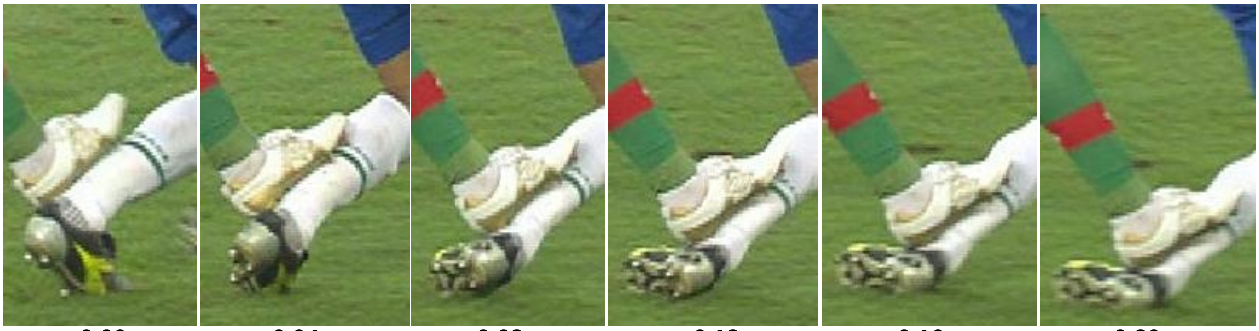


Figure 2: Skeleton matching on images of camera 1 (left) and camera 2 (right) at the point of trampled.



0.00s	0.04s	0.08s	0.12s	0.16s	0.20s

Figure 3: Frame sequence. Time zero represented the point of trampled.

Table 1
Kinematic Data Comparison of Inversion and Eversion Ankle Sprains

	Inversion case 1	Inversion case 2	Inversion case 3	Eversion
Maximum inversion/eversion angle (°)	142	78	48	25
Maximum inversion/eversion velocity(°/s)	1752	1397	632	210

DISCUSSION: Previously, the 3-dimensional ankle joint kinematics of 2 inversion ankle sprain cases (Table 1, case 1 & case 2) were reported, also with MBIM motion analysis technique (Mok et al., 2011), and Fong et al. (2009) reported the first ever kinematics analysis of ankle inversion ligamentous sprain injury, which accidentally happened in their laboratory (Table 1, case3). Compared with the inversion cases, both the maximum angle and maximum velocity of eversion are obviously lower. It is due to the biomechanics of the ankle joint, which allow for less eversion than inversion. Also the deltoid ligaments are strong and often an avulsion fracture at the medial malleolus occurs before a deltoid ligament sprain. This type of sprain can occur when the ankle is forced into eversion to stress the deltoid ligaments and commonly occur comorbidly with syndesmotic and medial malleolus fractures (Hintermann, Knupp & Pagenstert, 2006). The results of this study also suggested that the method and equipment designing to prevent eversion ankle sprain should be different from that to prevent inversion ankle sprain.

This study was limited to 1 case screened out for MBIM motion analysis. Before generalizing the results to the injury mechanism of ankle eversion sprain, more injury cases are needed to be analyzed and reported. Previous study (Mok et al., 2011b) showed good validity when compared to bone-pin marker-based motion analysis on a cadaveric specimen and good reliability between different trials on the same cadaveric specimen, different researchers for matching, and different shod conditions (shod and barefoot). However, in this study, videos were zoomed-in too much, only a little part of the sports ground could be seen, it was hard to identify the perpendicular lines on the ground, which are essential in setting up the virtual environment for estimating the position of the athlete during the model matching procedure. So, the accuracy of the data was influenced. At this point, the results of this study can merely point out the research gap and spark further discussion on the injury mechanism.

CONCLUSION: This study reported the ankle joint kinematics of ankle eversion ligamentous sprain. The maximum eversion angle occurred 0.20 seconds after stamped. At that time, the ankle joint was 25° everted, 42° externally rotated，and 15° plantarflexed. The Maximum eversion velocity was 210deg/s.The results from the MBIM technique could contribute to the understanding of the injury mechanism of ankle sprain injury.

REFERENCES:

Bahr, R., &Krosshaug, T. (2005).Understanding injury mechanisms: a key component of preventing injuries in sports. *British Journal of Sports Medicine*,39(6), 324-329.

Boytim, M.J., Fischer, D.A.,& Neumann, L. (1991).Syndesmotic ankle sprains. *American Journal of Sports Medicine,*19(3), 294-298.

Fong, D.T.P., Hong, Y., Chan, L.K., Yung, P.S.H., &Chan, K.M. (2007).A systematic review on ankle injury and ankle sprain in sports. *Sports Medicine*, 37(1), 73-94.

Fong, D.T.P., Hong, Y., Shima, Y., Krosshaug, T., Yung, P.S.H., &Chan, K.M. (2009).Biomechanics of supination ankle sprain: a case report of an accidental injury event in the laboratory. *American Journal of Sports Medicine,* 7(4), 822-827.

Hintermann, B., Knupp, M., &Pagenstert, G.I.(2006).Deltoid Ligament Injuries: diagnosis and management. *Foot and Ankle Clinics,* 11(3), 625-637.

Hopkinson, W.J., St Pierre, P., Ryan, J.B., & Wheeler, J.H. (1990). Syndesmosis sprains of the ankle. *Foot and Ankle,* 10(6), 325-330.

Kemler, E., van de Port, I.,Backx, F., & van Dijk, C.N. (2011). A systematic review on the treatment of acute ankle sprain: brace versus other functional treatment types. *Sports Medicine,* 41(3), 185-197.

Krosshaug, T. & Bahr, R. (2005).A model-based image-matching technique for three-dimensional reconstruction of human motion from uncalibrated video sequences. *Journal of Biomechanics,* 38(4), 919-929.

Krosshaug, T., Slauterbeck, J.R., Engebretsen, L., & Bahr, R. (2007).Biomechanical analysis of anterior cruciate ligament injury mechanisms: three-dimensional motion reconstruction from video sequences. *Scandinavian Journal of Medicine and Science in Sports,*17(5), 508-519.

Lin, C.F. (2006). Ankle Syndesmosis Injuries: Anatomy, Biomechanics, Mechanism of Injury, and Clinical Guidelines for Diagnosis and Intervention. *Journal of Orthopaedic and Sports Physical Therapy*, 36(6), 372-384.

Mok, K.M., Fong, D.T.P., Krosshaug, T., Hung, A.S.L., Yung, P.S.H., & Chan, K.M. (2011a).An ankle joint model-based image-matching motion analysis technique. *Gait and Posture* 34(1), 71-75.

Mok, K.M., Fong, D.T.P., Krosshaug, T., Engebretsen, L., Hung, A.S.L., Yung, P.S.H., Chan, K.M. (2011b). Kinematics analysis of ankle inversion ligamentous sprain injuries in sports: 2 cases during the 2008 Beijing Olympics. *American Journal of Sports Medicine* 39(7), 1548-1552.

Shaw, M.Y., Gribble, P.A., & Frye, J.L. (2008).Ankle bracing, fatigue, and time to stabilization in collegiate volleyball athletes.*Journal of Athletic Training,* 43(2), 164-171.

Waterman, B.R., Belmont, P.J., Cameron, K.L., Svoboda, S.J., Alitz, C.J., & Owens, B.D. (2011).Risk factors for syndesmotic and medial ankle sprain: role of sex, sport, and level of competition. *American Journal of Sports Medicine,* 39(5), 992-998.

Wolfe, M.W., Uhl, T.L., Mattacola, C.G., & McCluskey, L.C.(2001). Management of ankle sprains. *American Family Physician,*63(1), 93-104.

Wu, G., Siegler, S., Allard, P., Kirtley, C., Leardini, A., Rosenbaum, D., Stokes, I. (2002). ISB recommendation on definitions of joint coordinate system of various joints for the reporting of human joint motion – part 1: ankle, hip, and spine. *Journal of Biomechanics* 35, 543-548.