Vector Analysis of Frontal Plane Video to Determine Sagittal Plane Knee Kinematics

Samuel Wordeman[1], Kevin Ford PhD[2], Timothy Hewett PhD[2], Gregory Myer PhD[1]

[1]Department of Biomedical Engineering, University of Cincinnati, [2]FACSM

ABSTRACT

Frontal (FP) and sagittal (SP) plane knee kinematics contribute to knee abduction moment, a risk factor for non-contact ACL injury1. To date no single camera method to measure bi-planar knee kinematics has been widely employed. The purpose of this study was to develop and validate a practical, FP video method to determine knee flexion angle (KFA). Twenty female basketball, soccer and volleyball players (N=20; Age: 15.9±1.3 yrs, height: 163.6±9.9 cm; body mass: 57.0±12.1 kg) performed 5 drop vertical jump trials from a 31 cm box. Motion was recorded with 3D motion analysis and a camcorder in the FP. KFA was expressed as a function of FP joint coordinates using vector analysis and known segment lengths. Continuous KFA was calculated for all 100 trials using FP joint center coordinates from 3D video analysis. Paired t-tests and root mean squared (RMS) error was used to compare calculated and actual KFA throughout the contact phase. Joint center coordinates from FP video were digitized and KFA was calculated at initial contact (IC) and peak flexion (PKF). Range of motion (ROM) was defined as the difference between KFA at IC and PKF. Figure 1a presents mean KFA ± SEM vs. normalized time for 3D data and FP calculated KFA for all 100 trials. RMS error ± standard deviation with t-test results are as indicated. The average RMS error of the calculation across 100 trials was 5.51 ± 2.56o (95% CI = 5.01-6.02). Significant differences were noted primarily at low knee flexion. Figure 1b shows the relationship between ROM calculated from FP video and actual KFA. FP video analysis provides a simple, efficacious method to quantify bi-planar knee ROM. Use of this technique may facilitate clinic-based ACL injury risk screening with a simplified, accurate single camera approach.