Reliability of 2D Motion Analysis System for Sagittal Plane Lower Limb Kinematics during Running

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Abstract : Introduction: Running is one of the most popular sports activity among people. Improper sagittal plane ankle, knee and hip kinematics are considered to be associated with the increase of injury risk in runners. Motion assessing smart-phone applications are increasingly used to measure kinematics both in the field and laboratory setting, as they are cheaper, more portable, accessible, and easier to use relative to 3D motion analysis system. The aims of this study are 1) to compare the results of 3D gait analysis system and CE; 2) to evaluate the test-retest and intra-rater reliability of coach's eye (CE) app for the sagittal plane hip, knee, and ankle angles in the touchdown and toe-off while running. Method: Twenty subjects participated in this study. Sixteen reflective markers and cluster markers were attached to the subject's body. Subjects were asked to run at a self-selected speed on a treadmill. Twenty-five seconds of running were collected for analyzing kinematics of interest. To measure sagittal plane hip, knee and ankle joint angles at touchdown (TD) and toe off (TO), the mean of first ten acceptable consecutive strides was calculated for each angle. A smartphone (Samsung Note5, android) was placed on the right side of the subject so that whole body was simultaneously filmed with 3D gait system during running. All subjects repeated the task with the same running speed after a short interval of 5 minutes in between. The CE app, installed on the smartphone, was used to measure the sagittal plane hip, knee and ankle joint angles at touchdown and toe off the stance phase. Results: Intraclass correlation coefficient (ICC) was used to assess test-retest and intra-rater reliability. To analyze the agreement between 3D and 2D outcomes, the Bland and Altman plot was used. The values of ICC were for Ankle at TD (TRR=0.8,IRR=0.94), ankle at TO (TRR=0.9,IRR=0.97), knee at TD (TRR=0.78,IRR=0.98), knee at TO (TRR=0.9,IRR=0.96), hip at TD (TRR=0.75,IRR=0.97), hip at TO (TRR=0.87,IRR=0.98). The Bland and Altman plots displaying a mean difference (MD) and ±2 standard deviation of MD (2SDMD) of 3D and 2D outcomes were for Ankle at TD (MD=3.71,+2SDMD=8.19, -2SDMD=-0.77), ankle at TO (MD=-1.27, +2SDMD=6.22, -2SDMD=-8.76), knee at TD (MD=1.48, +2SDMD=8.21, -2SDMD=-5.25), knee at TO (MD=-6.63, +2SDMD=3.94, -2SDMD=-17.19), hip at TD (MD=1.51, +2SDMD=9.05, -2SDMD=-6.03), hip at TO (MD=-0.18, +2SDMD=12.22, -2SDMD=-12.59). Discussion: The ability that the measurements are accurately reproduced is valuable in the performance and clinical assessment of outcomes of joint angles. The results of this study showed that the intra-rater and test-retest reliability of CE app for all kinematics measured are excellent (ICC ≥ 0.75). The Bland and Altman plots display that there are high differences of values for ankle at TD and knee at TO. Measuring ankle at TD by 2D gait analysis depends on the plane of movement. Since ankle at TD mostly occurs in the none-sagittal plane, the measurements can be different as foot progression angle at TD increases during running. The difference in values of the knee at TD can depend on how 3D and the rater detect the TO during the stance phase of running.

Keywords : reliability, running, sagittal plane, two dimensional

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