TEST-RETEST RELIABILITY OF UNPLANNED CHANGE OF DIRECTION MARKERLESS KINEMATICS IN SOCCER PLAYERS

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1 INTRODUCTION

The present study aimed to test the reliability of unplanned change of direction (UCOD) kinematics, using a markerless motion analysis system, in soccer players. The UCOD was chosen because it is the movement most frequently associated with anterior cruciate ligament (ACL) injuries.

2 METHODS

A total of 14 male under-23 league soccer players, without a history of ACL injury, were evaluated performing 45º UCOD in two sessions, with one to two weeks interval. The side-step maneuver was chosen as the sport-specific movement for the test, as it places the greatest stress on the ACL [1]. Running speed was controlled at 4 to 5 m/s using infrared sensors, and the reaction time was 500 ms. The athletes wore the same clothes they usually wear in practice, and 8 Miqus cameras (Qualisys AB, Sweden) were used for video recording with a sampling frequency of 85 Hz. The data was processed using Theia3D software (Theia Markerless, Inc, Kingston - Ontario, Canada) with a cut-off frequency set at 10 Hz. The final model consisted of 17 rigid segments with 3 degrees of freedom for the ankle, knee, and hip joints and 6 degrees of motion for the trunk. Event determination, lower limb joint angles (XYZ Cardan sequence) and trunk absolute angles were computed using Visual 3D software (C-Motion, Inc, Rockville, USA). The integrated and pointwise intraclass correlation coefficient (ICC) and standard error of measurement (SEM) were calculated [2], as well as the minimum detectable change (MDC). The reference values used for the ICC were <0.5 (poor), 0.5–0.75 (moderate), >0.75 (good), and >0.9 (excellent). Results will be presented for the most important indicators for ACL injury risk (knee abduction, flexion, and internal rotation angles, as well as trunk angle in the frontal plane).

3 RESULTS

With moderate to good reliability for both lower limbs, the markerless system seems to be reliable in assessing important indicators for evaluating ACL injury risk, such as trunk lateral flexion and knee abduction angle (integrated ICC between 0.63 and 0.83) during UCOD. However, the results were not reliable for knee flexion and internal rotation angles (Table 1). The pointwise ICC shows some variation along the curve, particularly in the sagittal and transverse planes (Figure 1), indicating that certain phases of the movement are more reliable than others.

Table 1 - Test-retest reliability of lower limb and trunk kinematics.

		Right lower limb				Left lower limb			
		Integrated				*Integrated*			
		ICC	SEM (°)	SEM%	MDC (°)	ICC	SEM (°)	SEM%	MDC (°)
Trunk	**Frontal**	0.83	3	6%	8.3	0.73	4	8%	11.1
	Sagittal	0.66	4.8	8%	13.4	0.39	5.8	11%	16.1
Knee	**Frontal**	0.63	3.4	15%	9.3	0.73	3.2	16%	8.9
	Transverse	0.51	5.7	16%	15.7	-0.04	6	18%	16.6

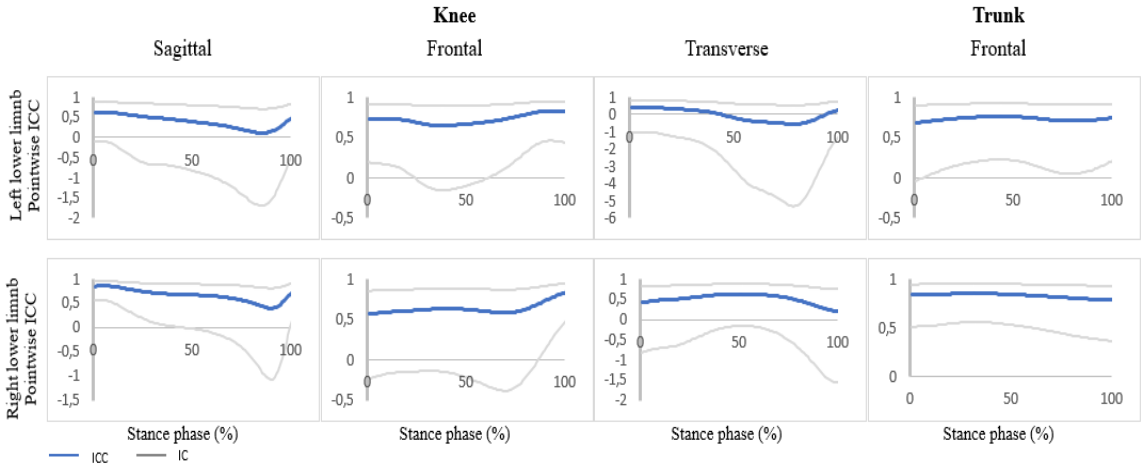

Figure 1 - Pointwise ICC during the stance phase (0-100%).

4 DISCUSSION AND CONCLUSION

The findings of the present study (with the exception of the transverse plane of the left knee joint) are similar to those obtained by De Bleecker et al. [3], although they evaluated different sport-specific movements and used a marker-based system. De Bleecker et al. [3] used the laboratory reference method for motion analysis, while Carvalho et al. [4], used the same markerless system, and obtained better results for the gait cycle. These results suggest that the lower ICC values in our study can be attributed to the greater variability of the sport-specific action (UCOD) rather than the lack of reliability of the markerless system (Theia 3D). The results of the present study are not conclusive, as the minimum required sample size (18) was not reached. However, it may serve as a foundation for future studies aiming to validate the markerless system in more complex sporting actions.

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REFERENCES

[1] T. Dos'Santos, A. McBurnie, C. Thomas, P. Comfort, and P. A. Jones, "Biomechanical Comparison of Cutting Techniques: A Review and Practical Applications," Aug. 01, 2019, *Lippincott Williams and Wilkins*. doi: 10.1519/SSC.0000000000000461.

[2] A. Pini, J. L. Markström, and L. Schelin, "Test–retest reliability measures for curve data: an overview with recommendations and supplementary code," *Sports Biomech*, vol. 21, no. 2, pp. 179–200, 2022, doi: 10.1080/14763141.2019.1655089.

[3] C. De Bleecker *et al.*, "How reliable are lower limb biomechanical evaluations during volleyball-specific jump-landing tasks?," *Gait Posture*, vol. 113, pp. 287–294, Sep. 2024, doi: 10.1016/j.gaitpost.2024.07.001.

[4] A. Carvalho *et al.*, "Markerless three-dimensional gait analysis in healthy older adults: test–retest reliability and measurement error," *J Biomech*, p. 112280, Aug. 2024, doi: 10.1016/j.jbiomech.2024.112280.