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Is markerless motion tracking a feasible approach for in field kinematic analysis of weightlifting?

Holzer, D., Hummel, C., Paternoster, F.K., Stöcker, F., Thiele, F.

Technical University Munich

INTRODUCTION:
In weightlifting, a quantitative kinematic analysis of an athlete can be useful to assess the performance during the snatch. A marker-based approach (MB) is widely used to obtain kinematic data in weightlifting [1]. Yet, it is not suitable for in field activities such as competitions. Recently developed markerless video-based systems (VB) working with deep learning-based pose estimation algorithms might be an alternative approach [2]. However, the applicability and accuracy of VB systems in assessing highly dynamic full body activities remain mostly unexplored. Hence, the aim of this study was to compare the kinematics of a snatch using a VB along with a MB approach.
METHODS:
24 experienced weightlifters (17 Male, 7 Female) each performed 6-9 snatches with a load between 65-85% of their individual one repetition maximum. MB (200Hz using Vicon Nexus) and VB (100Hz using Contemplas with Theia3D for pose estimation) 3D motion capture were used to analyze snatch kinematics of 140 trials. The results of the VB tracking system were compared to the MB system to validate the technology regarding the accuracy during the snatch. Statistical parametric mapping (SPM) and paired t-tests were used to demonstrate differences between the two systems.
RESULTS:
Preliminary results of 4 subjects (29 trials) showed that on average joint center estimation between the systems differed by 30±9mm for the knees, 27±9mm for the ankles, 49±10mm for the hip and 48±9mm for the shoulder joints. This resulted in significant differences ($p < 0.05$) regarding joint angle estimations (e.g. maximal flexion, maximal angular velocity, and average velocity). Average differences were 5±2° for the knee, 18±5° for the hip and 8±4° for the ankle joint. SPM analysis revealed significant differences throughout the majority of all phases of the snatch. For example, the transition phase between first and second pull was far less pronounced or barely detectable by the VB system.
CONCLUSION:
In preliminary results, we found significant differences in all variables analyzed. Joint center location was similar to previous studies [3].The major difference found was the far less pronounced transition phase in the VB tracking results, which is a key phase to analyze during the snatch. Besides that, overall shape of lower limb kinematics was similar. However, shoulder kinematics were barely comparable with maximal shoulder abduction angles highly underestimated by the VB system (25%). Further, big differences regarding maximum angular velocities indicate difficulties in the comparability between the two systems. As a result, our preliminary results suggest that accuracy of VB motion capture is not yet sufficient for high quality kinematic analysis of weightlifting. However, given the practicality, it should be a promising alternative to analyze weightlifting performance in the future.

REFERECES
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