COMPARATIVE ANALYSIS OF MARKER-BASED AND MARKERLESS MOTION CAPTURE SYSTEMS IN BACKPACK CARRIAGE

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Summary

Marker-based motion capture systems are widely regarded as the gold standard for movement analysis. However, their applicability is limited when assessing locomotion with external loads due to marker occlusion. Markerless systems have emerged as a promising alternative. This study aims to compare trunk-pelvis kinematics between marker-based and markerless motion capture systems during backpack carriage

Introduction

Three-dimensional motion capture systems provide essential insights into human locomotion. Traditional marker-based systems deliver highly accurate data but pose challenges when analyzing movements involving backpacks or exoskeletons due to marker occlusion, particularly in the trunk and pelvis regions [1,2]. To address this issue, markerless motion capture has been proposed as an alternative. The objective of this study was to assess the differences in trunk and pelvis kinematics between marker-based and markerless systems during loaded and unloaded walking conditions [3].

Methods

A total of 16 healthy adults (9 males) participated in this study (mean age: 35.4 ± 10 years; height: 1.71 ± 0.09 m; weight: 67.2 ± 12.3 kg). Participants walked at a self-selected pace under two randomized conditions: normal walking (no load) and walking with a 10 kg backpack. Motion data were collected using a marker-based system (Qualisys AB, Sweden) and a markerless system (Theia, Canada). The trunk-pelvis kinematic model employed in the marker-based analysis was previously validated for backpack carriage studies [3]. Statistical analysis was performed using one-dimensional statistical parametric mapping (SPM1D) to compare kinematic waveforms between the two systems and conditions [4].

Results and Discussion

The analysis revealed a systematic offset between the marker-based and markerless models in the sagittal plane, with partial significant differences in the frontal and transverse planes [1]. Specifically, the markerless system overestimated thoracic inclination while underestimating hip flexion when compared to the marker-based model. These discrepancies were more pronounced under the loaded condition, suggesting that the choice of motion capture system should be carefully considered when evaluating posture and movement under external load conditions.

Previous studies have also reported similar offsets between marker-based and markerless motion capture techniques [2,3]. Sinclair et al. [1] highlighted that while markerless systems offer a more accessible and non-intrusive alternative, they tend to introduce systematic biases in joint kinematics, particularly under dynamic conditions. Wu et al. [2] further emphasized that improvements in algorithmic processing could help mitigate these discrepancies. The present findings align with these prior observations, reinforcing the necessity of methodological considerations when interpreting markerless motion capture data.

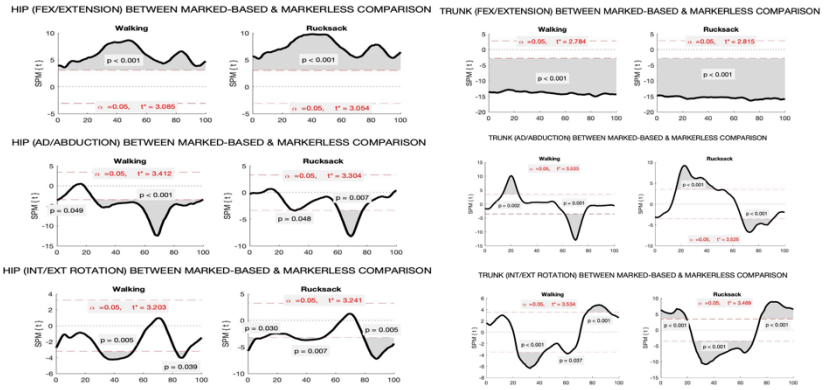

Figure 1. Trunk and hip kinematics with marker-based and markerless systems compared during loadless and backpack conditions.

Conclusions

The findings indicate that while markerless motion capture presents a viable alternative to marker-based systems, inherent differences in kinematic estimations must be acknowledged. Researchers should account for these discrepancies when interpreting data, particularly in load carriage scenarios. Future research should focus on refining markerless algorithms to improve their accuracy and reliability.

References

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