INFLUENCE OF SKIN MOVEMENT ARTEFACTS ON THE CALCULATED KINEMATIC GEOMETRY AND JOINT KINETICS OF THE LOCOMOTOR SYSTEM DURING ACTIVITY

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INTRODUCTION: Motion analysis has played an important role in sports and orthopaedic biomechanics. A major source of error in modern skin-marker-based motion analysis systems is skin movement artefacts (Cappozzo et al., 1996). Traditional methods have either failed to reduce effectively skin movement artefacts or simply ignored them in reconstructing movement, resulting in artefactual joint dislocation or inaccurate limb positions, with important consequences on the calculated geometry and joint kinetics of the locomotor musculoskeletal system. The present study addresses these issues.

METHODS: A 3D computer graphics-based model of the human locomotor system was developed, with the knee as a parallel spatial mechanism, the hip as a ball-and-socket joint and the ankle as a two-revolute mechanism. 34 muscles were included and represented as straight lines, wrapping around bones when necessary. Computer experiments were performed based on experimental data from a normal subject. A set of marker trajectories that were skin-movement-free, was generated by applying measured joint kinematics to the model. With the true data, 20 computer-simulated gait trials were performed, by introducing artificial noise into each three-dimensional marker coordinate with a noise model by Chèze et al. (1995). Musculoskeletal geometry of the locomotor system and its joint kinematics and kinetics were then calculated by the model WITHOUT joint constraints using traditional methods and WITH joint constraints using Global Optimisation Method (GOM; Lu & O'Connor, 1999).

RESULTS: Without joint constraints, traditional methods created apparent artifact dislocations at joints. With GOM, joint dislocation was not present and the errors in the calculated joint positions, joint moments, muscle lines of action and muscle lengths were significantly less than those calculated using traditional methods.

CONCLUSION: The results suggest that geometrical and mechanical variables of the locomotor system during gait are sensitive to skin movement artifacts and that GOM is effective in reducing these effects. The GOM not only provides a way of imposing joint constraints into skin-marker-based models but also takes full advantage of these joint models in controlling relative motion of body segments. The present study indicates that the GOM will contribute to improving the reliability of motion analysis results, thus strengthening their application in sports.

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