QUANTIFYING AXIAL ROTATION OF UPPER EXTREMITY SEGMENTS

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INTRODUCTION: The calibrated anatomical systems technique (CAST) (Cappozzo et al, 1995) is an established method in gait and lower limb analyses. Its application to 6-degrees-of-freedom kinematic analyses and reduction of soft tissue artefact could make it particularly useful in quantifying axial rotation of the upper extremity. Such rotations have been established as being important in generating racket-head velocity in a variety of racket skills (Marshall and Elliott, 2000). The present study assesses the accuracy of CAST in quantifying the rotation of the forearm.

METHOD: The accuracy of CAST in quantifying axial rotation was compared with a goniometer. One subject (age 22; mass 80 kg; height 1.8 m) performed 5 isolated forearm rotations of 90°. The subject sat at a table with their forearm resting on it in a fully internally rotated position. This was set as 'zero'. The elbow remained flexed at an approximate orientation of 90° to isolate the rotation of the forearm from that of the humerus. One arm of a goniometer was attached to a table whilst the other arm was attached to the heads of the second and third metacarpals. These landmarks have limited movement relative to the forearm about the longitudinal axis. The subject externally rotated the forearm whilst maintaining a stationary elbow position throughout. The rotation was simultaneously captured with a seven camera motion capture system (Qualisys, Sweden) operating at 240 Hz. The rotation of the forearm was determined relative to the humerus using rigid clusters of four non-collinear markers. The forearm cluster was placed at the most distal point possible. The forearm was defined proximally by the medial and lateral epicondyles of the humerus and distally by the styloids of the radius and ulna whilst the humerus was defined proximally by the acromion process of the scapula with a radius of 0.04 m and distally by the medial and lateral epicondyles of the humerus. Axial rotation was determined by the third rotation in the XYZ Cardan sequence using movement analysis software (Visual 3D; C-motion, USA).

RESULTS: A mean rotation of 73.23° (± 7.58) was recorded.

DISCUSSION: The underestimation of forearm rotation measured using CAST highlights the difficulties of quantifying axial rotations about the upper extremity. Measurement of the forearm is particularly difficult as it is the interaction of the radius and ulna that provide the rotation and the rotation is therefore greater at the distal end of the segment. The forearm cluster was placed at the most distal point practically possible but rotation of this segment may be better estimated by considering the relative rotations of the humerus, forearm and hand. Soft tissue artefact has been highlighted as being reduced by CAST (Cappozzo et al., 1995) but this effect was still observed and quantification of this effect could provide further accuracy to this method.

CONCLUSION: The axial rotation of the forearm was underestimated by the CAST method but could still prove to be an effective method if the limitations highlighted here are addressed.

REFERENCES:

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