

THE INFLUENCE OF COORDINATED JOINT ACTIONS ON THE ACCURACY AND VARIABILITY OF RUGBY LINE-OUT THROWING

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INTRODUCTION: There has been substantial coaching literature directed towards rugby union line-out throwing technique but relatively few quantitative biomechanical studies have been conducted. The aim of this study was to establish the temporal and kinematic characteristics of successful line-out throwing, with particular emphasis on the relationship between kinematic coordination/variability and throw accuracy/consistency.

METHODS: Four regular rugby union line-out throwers (age = 19.5 ± 0.6 years; mass = 100.5 ± 2.2 kg) participated in this study. Playing level ranged from University 1st XV level to senior international level. Each subject performed a minimum of six throws at a fixed target (height = 3.2 m) within an indoor environment at each of four distances (6, 10, 11.8 and 14 m) in a pseudo-random order. At the first three distances, subjects threw using two common techniques: a 'flat' throw and a 'lob' throw. Reflective markers were attached to the subject to allow the reconstruction of the whole-body 3-D kinematics using a distributed eight-camera Vicon 612 motion analysis system sampling at 120 Hz. The release characteristics (ball velocity and release angle) for each trial were obtained via 3-D video analysis (Peak Motus 8.0) of recordings from two calibrated 50 Hz digital video cameras (Sony DCR-TRY900E). A third video camera positioned behind and above the thrower allowed calculation of the resultant distance from the target centre to the ball position as a measure of accuracy. A 17-segment kinematic model was defined to allow calculation of segment and joint angles and angular velocities for each throw. Whole-body and segment centre of mass (CM) time histories were also recovered incorporating the inertia data of de Leva (1996). Temporal and kinematic variables were obtained for key phases/instances during the movement. The extent of segmental coordination was evaluated using continuous relative phase measures and movement variability was associated with throw accuracy measures via correlation. Differences in biomechanical measures between conditions were examined using dependent t-tests and repeated measures ANOVA techniques.

RESULTS: All subjects demonstrated good accuracy at shorter distances (mean distance offset from target ranged from 0.236 m to 0.339 m across subjects @ 6 m distance). Accuracy degradation became more obvious for some individuals at longer throw distances ($S2 = 0.339$ m @ 6 m, $S2 = 0.810$ m @ 14 m) but not others ($S4 = 0.298$ m @ 6 m, $S4 = 0.365$ m @ 14 m). Temporal sequencing as a relative percentage of throw duration remained consistent for successful throwers with only slight increases in absolute throw durations for longer distances ($S3$ throw duration = 0.674 s @ 6 m, 0.737 s @ 14 m; $S3$ backswing/propulsion % = 73.7/26.3 @ 6 m, 72.7/27.3 @ 14 m). Measures of joint coordination and variability and their association with throw accuracy and consistency require further investigation.

DISCUSSION: All subjects were experienced throwers but differences in accuracy and technique did become more apparent at longer distances, probably due to differences in trunk and shoulder strength between subjects. The implications for coaching and training practices will be discussed.

REFERENCES:

de Leva, P. (1996). Adjustments to Zatsiorsky-Seluyanov's segment inertia parameters. *Journal of Biomechanics*, 29, 1223-1230.