SQUARE TO THE TARGET? COACHING CUES AND TECHNICAL ANALYSIS OF THE AUSTRALIAN FOOTBALL HANDBALL

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Handball is an important skill in Australian Football. This study evaluated technical factors associated with handball accuracy by comparing successful and unsuccessful passes as well as evaluating current coaching cues used for the handball pass. Four elite Australian football players performed eight handballs with their preferred hand toward a bulls-eye target. Three dimensional kinematic data was collected and analysed between maximum backswing and ball contact to compare hits and misses. No significant differences were found for group results; however, medium effect sizes were found for hand velocity, hand path direction, elbow and humerus range of motion, humerus angle at ball contact and humerus angular velocity. Pelvis orientation toward the target showed a small effect. Data suggests further work in the area of handballing accuracy is warranted.

KEY WORDS: handball, Australian football, three-dimensional analysis, accuracy.

INTRODUCTION: Handballing (sequence displayed in Figure 1) is one of two methods of legally passing the ball in the game of Australian Football (AF). It involves punching the AF ball out of a stationary platform hand that holds the ball, using the area between the thumb and forefinger of the punching hand which is clenched (McLeod & Jaques, 2006). Handballing allows players to catch the opposition off guard, and promotes quick safe movement of the ball (McLeod & Jaques, 2006).

In spite of the importance of the handball within AF, there is little scientific knowledge available regarding elite performance of the handball. Biomechanics studies in AF have predominantly focussed on kicking (e.g. accuracy, Dichiera et al. 2006; distance kicking, Ball, 2008; preferred and non-preferred foot kicking, Ball, 2011) with only one case study reporting handball technique. Parrington et al. (2009) performed a pilot study to gain an initial understanding of the handball in one elite AF player. Differences were found for preferred and non preferred hands as well as across conditions.

Currently no work has been published examining technical elements contributing to handball accuracy. The evaluation of successful and unsuccessful handball passes within individuals is a reasonable approach to begin this exploration. The evaluation of coaching cues that are currently used to help with development and refinement of the handball skill is also a useful and applied approach to provide an evidence base for current practice. The cue first encourages the player to 'square up to the target' (turning the hips to face the target) to make an accurate pass and the second is to hit the ball through and down the line of the target (S. Dalrymple & B. Gotch, AFL Development Coaches, personal communication). The aim of this study was to evaluate the kinematics of the handball pass for accuracy by comparing successful and unsuccessful passes and by evaluating current coaching cues.

Figure 1: Handball sequence (reproduced from Parrington et al., 2009).

METHOD: Data Collection: Four male elite AF players (21 ±2 y, 83.8 ±8.5 kg, 188.3 ±10 m) who had been determined by coaching staff as having good handball technique performed eight handballs with both preferred and non-preferred hands aiming the Sherrin football (official ball of the Australian Football League) at a target 5m away. Each participant was instructed to pick up the ball from the ground on a sound cue and attempt to hit the centre of a bullseye target, positioned at a height of 1.5 m. The participant was asked to perform the task with game-level intensity.

Subject preparation followed the same protocol as Parrington et al. (2009). Virtual anatomical markers were identified to determine joint centres at the shoulder, elbow, wrist and the centre of the hand, hip, knee and ankle. Three towers of Optotrak position sensors [Northern Digital Inc. (NDI), Ontario, Canada] were used to capture the 3D data (sample rate=100 Hz) during handball execution from initiation of movement to the end of follow through. Target accuracy was manually recorded, and reviewed using two-dimensional video. A hit was allocated to a direct hit in the central circle (radius=0.1 m), and a miss was given to hits outside this section of the target.

Data Analysis: Three-dimensional data was recorded using First Principles software (NDI) and exported for analysis to Visual3D (C-Motion, Inc., Maryland, USA). Raw data were interpolated and smoothed using a lowpass filter (Butterworth, 7 Hz cutoff, chosen based on residual analysis and visual inspection of curves). Data were normalised from the onset of downswing (defined as the first downward motion of the hand after backswing) to ball contact (100%) (Parrington et al., 2009). Mean and standard deviation of hits and misses were calculated for each parameter (Table 1) and compared using T-tests conducted in Excel (Microsoft). Effect sizes (Cohen's *d*) were calculated to provide additional information.

Table 1: Kinematic variables (Parameters refer to punching hand at ball contact unless stated).

Parameter		Definition
Time (swing phase)		Time from maximum backswing to ball contact
Pelvis orientation (°)		Orientation of pelvis about vertical axis with respect to target
Shoulder orientation (°)		Orientation of shoulders about vertical axis with respect to target
Hand velocity	Speed (m/s)	Velocity of the punching hand
	Direction (°)	Direction of the hand in the transverse plane
Elbow angle (°)		Elbow flexion angle
Elbow ROM (°)		Elbow flexion range between maximum backswing and ball contact
Humerus angle (°)		Humerus angle (about the global X-axis)
Humerus ROM (°)		Humerus range of motion (about the global X-axis) between maximum backswing and ball contact
Humerus angular velocity (°/s)		Humerus angular velocity (about the global X-axis)

RESULTS: Results are provided in Table 2. No significant differences were found between accurate and inaccurate passes (hits and misses). Medium effects were found for punching hand velocity (speed, *d*=0.5 and direction *d*=0.7), elbow range of motion (*d*=0.5), humerus angle (*d*=0.4), humerus range of motion (*d*=0.4) and humerus angular velocity (*d*=0.5). Small effects were found for pelvis orientation (*d*=0.3).

Accurate passes were made with lower hand speed and humerus angular velocity. Humerus range of motion and elbow range of motion were larger for misses, while the humerus angle at ball contact was slightly smaller. Pelvis orientation angle was smaller when the target was hit.

Table 2

Results (Parameters refer to punching hand at ball contact unless stated).

Parameter		Hit		Miss		Effect size
		Ave	St dev	Ave	St dev	Cohen's D
Time (swing phase)		0.1	0.0	0.1	0.0	0.1
Pelvis orientation (°)		15	3	16	4	0.3
Shoulder orientation (°)		22	10	23	8	0.1
Hand velocity	Speed (m/s)	7.1	1.2	7.7	1.1	0.5
	Direction (°)	83	3	78	10	0.7
Elbow angle (°)		59	5	60	6	0.1
Elbow ROM (°)		6	5	8	4	0.5
Humerus angle (°)		40	5	38	8	0.4
Humerus ROM (°)		32	12	36	11	0.4
Humerus angular velocity (°/s)		508.6	150.5	577.7	125.5	0.5

DISCUSSION: Squaring up to the target when making a handball has been used as a coaching cue to help the effectiveness of the pass. In this study, the orientation of both the shoulder and the pelvis were analysed to assess the function of this cue. Although shoulder orientation did not appear to differ between accurate and inaccurate passes, the orientation of the pelvis showed a small effect and may contribute to handball accuracy. This variable requires further investigation with a larger sample to assess its significance.
Coaching players to handball accurately has also involved punching the ball through the line of the target. The difference for hand direction was not significant, but the effect size suggests that the path of the hand could affect the accuracy of the pass. The direction of the hand at ball contact was closer to being perpendicular to the face of the target in the accurate passes. This may imply that striking across the ball, rather than through the ball could result in inaccuracies.
Misses were characterised by a greater hand speed and humerus angular velocity. In Parrington et al. (2009), speed of the hand, and shoulder angular velocity were found to be greater in the maximal handball condition in comparison to the accuracy handball. When maximal distance is concerned, a greater hand speed is likely to result in a greater performance; however, results collected for accuracy in this study suggest a speed-accuracy tradeoff. The speed-accuracy tradeoff describes the compromise between the speed at which a skill is performed and the accuracy which it achieves, and has been shown in dominant arm throwing (e.g. Sachlikidis & Salter, 2007). Given the dynamic nature of AF, athletes should strive to elite performance of the skill that involves passing the ball with both speed and accuracy.
Future directions for study could involve looking at further technical points related to coaching cues, such as stepping toward the target to gain power, and increasing the range of motion in the shoulder to develop speed in the hand. A comparison of preferred and non-preferred hands is justified, given the common use of both hands for this skill within the game. Establishing whether the variables reported show significance through an analysis of an increased number of participants would be beneficial.

CONCLUSION: This study analysed the kinematics of Australian football handballing with regards to accuracy. Hand speed and shoulder angular velocity were smaller for accurate passes (hits). Pelvis orientation angle was smaller for accurate passes, suggesting the player was squarer to the target, and hand direction was closer to 90 degrees (perpendicular to the face of the target) in the accurate passes. Both pelvis orientation and hand direction are implicated with coaching cues and require further investigation with increased participants to establish any significant differences or trends.

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