THE EFFECT OF INDIVIDUALISED COACHING INTERVENTIONS ON ELITE YOUNG FAST BOWLERS‘ TECHNIQUE

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Fast bowling in cricket is an activity well recognised as having a high injury prevalence. Previous research has associated lower back injury with aspects of fast bowling technique. Coaching interventions that may decrease the likelihood of injury, whilst maintaining or increasing ball speed, remain a priority within the sport. Selected kinematics of the bowling action of 14 elite young fast bowlers were measured using an 18 camera Vicon Motion Analysis System. Subjects were tested before and after a two year coaching intervention period, during which subject-specific coaching interventions were provided. Mann-Whitney tests were used to identify significant differences in the change in the selected kinematics between those bowlers who were coached or un-coached on each specific aspect. Coached athletes demonstrated a significant change in shoulder alignment at back foot contact (more side-on, P = 0.002) and shoulder counter-rotation (decreased, P = 0.001) relative to un-coached athletes. There was no difference in the amount of change in flexion angles of the front or back knee or lower trunk side-flexion between those who received coaching intervention and those that did not. This study shows that specific aspects of fast bowling technique in elite players can change over a two year period and may be attributed to coaching intervention.

KEY WORDS: fast bowling, cricket, injury, coaching intervention.

INTRODUCTION: Fast bowlers in cricket have injury rates comparable to contact sports such as Australian Rules football and Rugby football. Lower back stress fracture has consistently accounted for the most lost playing time in elite cricket (Newman, 2003; Orchard, James & Portus, 2006). Previous research has associated lower back injury and the appearance of abnormal radiological features with: a large shoulder counter-rotation (SCR) angle between back foot contact (BFC) and front foot contact (FFC) in the delivery stride (Foster, *et al.*, 1989; Portus*, et al.*, 2004); large amounts of trunk side-flexion during FFC in female bowlers (Stuelcken, *et al.*, 2008); non-significantly larger lower trunk extension during FFC (Ranson, *et al.*, 2008b); and the use of a straight knee during FFC (Portus, *et al.*, 2004). However, maintaining a straight knee during FFC has also been linked to increased ball speeds (Foster, *et al.*, 1989; Portus, *et al.*, 2004).

Although interventions targeted at reducing injury risk and increasing ball speed are undertaken by fast bowling coaches, only one study (Elliott & Khangure, 2002) (aimed to reduce SCR during the delivery stride) has investigated the efficacy of attempted technique modification. Knowledge of the changeability of fast bowling technique in elite bowlers, a highly complex motor skill, may give some insight into the ability of coaching to alter technique characteristics.

The purpose of this study was to determine whether a two-year coaching intervention resulted in significant changes to certain key aspects of fast bowling technique. This study was conducted on a group of elite young fast bowlers and aimed to improve the kinematics of the bowling action, focussing on risk factors related to low back injury and increased ball speed.

METHODS: Data Collection: Subjects consisted of 14 elite young fast bowlers, with age, height and mass of 18.5 (± 2.3) years, 1.90 (± 0.06) m and 82 (± 5) kg, respectively, at the time of initial testing. Baseline testing was conducted late in the summer season and follow up testing was performed two years later. An 18 camera Vicon Motion Analysis System (OMG Plc, Oxford UK) operating at 300 Hz was used to capture: a static trial; a range of motion (ROM) trial (as described by Ranson, *et al.*, 2008a); and six maximum velocity fast bowling deliveries for each bowler. All testing was conducted in an indoor practice facility, allowing subjects to bowl using their normal length run-up on a standard size artificial cricket pitch. Fourteen millimetre diameter, spherical retroflective markers were positioned on anatomical landmarks to define: shoulder; lower trunk; pelvic; thigh; shank; upper arm; and forearm motion. A square of reflective tape (1.5 cm × 1.5 cm) was fixed to one side of the ball, enabling the instant of ball release and ball velocity to be determined.

Trials were manually labelled and the best 3 selected for each bowler (maximum velocity with minimal marker loss). Hip joint centres were located according to the methodology of Davis, *et al.* (1991) and the lower trunk and pelvis joint centres were calculated as described by Ranson, *et al.* (2008a). All other joint centres were defined as the mid-point of a pair of strategically positioned markers. Local reference frames were defined and joint angles calculated using the methodology of Ranson, *et al.* (2008a). Orientation angles of the lower back relative to the pelvis were normalised using a neutral position from the ROM trial. Shoulder and pelvis angles were defined by projecting the respective joint centres onto a horizontal plane (180º = side-on, 270º = aligned with the bowling crease), corresponding to previous fast bowling research (Portus, *et al.*, 2004).

Data Analysis & Coaching Intervention: Parameters determined for each trial consisted of: shoulder alignment at BFC; amount of SCR; back knee angle at BFC and the amount of flexion occurring during the BFC phase; front knee angle at FFC and the amount of knee flexion from the instant of FFC to ball release; and ball velocity. The time histories of each kinematic descriptor were fitted using quintic splines (Wood & Jennings, 1979). The closeness of fit at each point was based on the difference between the descriptor value and the average value from the two adjacent times (Yeadon & King, 2002).
Aspects of technique requiring coaching intervention were identified for each bowler, based on these kinematic parameters. Remediation, utilising coaching techniques such as verbal feedback, video feedback and part drills (exercises focused on specific part components of the delivery stride) were instituted during both Club and ECB coaching sessions over the ensuing two years. Coaching interventions encouraged: a reduced shoulder angle at BFC (causing a consequent reduction in SCR); decreased knee flexion during FFC and/or BFC; a more upright trunk alignment during FFC (i.e. less side-flexion). Interventions were only provided to those bowlers identified as requiring them, the remainder of the bowlers formed the un-coached group for that specific aspect of technique.

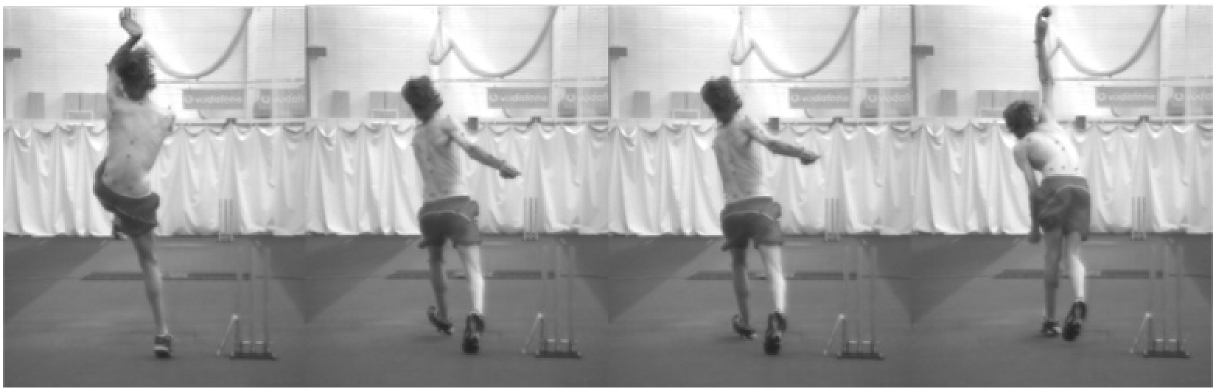

Figure 1 – Illustration of a bowler with a large shoulder counter-rotation (SCR).

Statistical Analysis: The inter-trial reliability of the kinematic data was assessed using the Intra-Class Correlation Coefficient (ICC) and the Standard Error of Measurement (SEM). Good reliability was found for all kinematic variables (Initial Testing: ICC = 0.27-0.98, SEM = 1.2-7.9; Follow-up Testing: ICC = 0.54-0.98, SEM = 0.9-5.8). Consequently, the three trials selected for each bowler were averaged to provide representative data. Mann-Whitney tests were performed (Statistical Package for Social Sciences V15) to identify significant differences in the amount of change in the kinematic variables over the two year period, between bowlers who received specific coaching on that variable and those who did not (from the group of 14).

RESULTS:

Table 1 Kinematic parameters for the coached and un-coached subjects, pre and post intervention period. P-values were calculated using a Mann-Whitney non-parametric test.

Kinematic Variable	Coached? (group size)	Initial testing Mean (°)	SD (°)	Follow-up testing Mean (°)	SD (°)	Difference (°)	P Value
Shoulder angle at BFC	Yes (n = 8)	254	16	233	12	21	0.002
	No (n = 6)	228	13	228	11	0	
SCR	Yes (n = 8)	52	11	32	12	20	0.001
	No (n = 6)	37	16	37	14	0	
Back knee angle at BFC	Yes (n = 9)	41	8	36	10	5	0.226
	No (n = 5)	33	5	31	7	2	
Back knee flexion	Yes (n = 9)	22	10	25	12	-3	0.332
	No (n = 5)	32	7	33	5	-1	
Front knee angle at FFC	Yes (n = 9)	14	8	18	3	-4	0.358
	No (n = 5)	5	7	11	2	-6	
Front knee flexion	Yes (n = 9)	20	13	17	15	3	0.072
	No (n = 5)	5	3	6	6	-1	
Lower trunk peak side-flexion	Yes (n = 8)	39	5	37	6	2	0.247
	No (n = 6)	29	6	29	4	0	

DISCUSSION: The use of a mixed type action, characterised by a large amount of SCR, has previously been associated with low back injury in fast bowlers (Foster, *et al.*, 1989; Portus, *et al.*, 2004). Increased SCR has been linked to large shoulder angles at BFC (a more front-on alignment) (Portus, *et al.*, 2004; Ranson, *et al.*, 2008a). Bowlers receiving coaching interventions targeted at reducing their SCR and shoulder angle at BFC evidenced a significant change in these parameters over the two year period (P = 0.002 and 0.001, respectively), relative to the un-coached bowlers.

The specific pathomechanics of the highly prevalent non-bowling arm side lumbar stress injuries are thought to be related to the repetition of end range lower trunk side-flexion, rotation and extension typically adopted during the FFC phase of the delivery stride (Elliott, 2000; Ranson, *et al.*, 2008a). Although the amount of SCR and the number of mixed action bowlers decreased over the two year period, there was no significant change in the lower trunk peak side-flexion of the coached subjects. Ranson, *et al.* (2008a) suggested a greater coaching emphasis on obtaining less stressful (less extreme side-flexion, extension and rotation) lower trunk postures during the FFC phase may have a greater influence on back injury pathomechanics than a focus on shoulder alignment and SCR during BFC.

Actions in which the front knee remains relatively straight during FFC have been associated with an ability to produce faster ball speeds (Portus, *et al.*, 2004; Loram, *et al.*, 2005). Bowlers in this study tended to display a more flexed front knee at the instant of FFC in the follow-up testing than in the baseline testing. However, there was no significant difference in the change in either front knee angle at FFC, or the amount of knee flexion occurring up to ball release, between the the coached and un-coached groups. Ball velocity increased by an average of 3 mph over the course of the study, this is likely to be due to the physical maturation of the subjects, rather than any coaching interventions. Bowlers receiving coaching intervention regarding back knee technique did not exhibit a significant change in back knee kinematics in comparison with the un-coached subjects.

Although small group sizes are a perennial problem when investigating elite sporting sub-groups such as fast bowlers in cricket, the cohort investigated in this study was homogenous and the effect size for significant statistics were large. Apart from coaches and participants agreeing to follow general principles, it was not possible to standardise the amount and quality of coaching intervention delivered. As previously mentioned, aside from coaching, extraneous variables such as age, physical development and injury might have had a significant impact on participants' technique and ball velocity. Although there was no specific "control" group in this investigation, bowlers who did not receive a particular intervention essentially acted as a control group. Neither outcome data (e.g. change in injury status), nor other deliveries (e.g. Yorkers or bouncers) were examined in this study.

CONCLUSION: This study showed that specific aspects of fast bowling technique in elite young players can change over a two year period. Shoulder alignment at BFC and the amount of SCR demonstrated a significant change over the two year intervention period in the coached bowlers relative to those who were un-coached on these aspects of technique. This may be due to coaching intervention and warrants future investigation.

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