ACUTE LUMBAR STRESS INJURY, TRUNK KINEMATICS, LUMBAR MRI AND PARASPINAL MUSCLE MORPHOLOGY IN FAST BOWLERS IN CRICKET

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This study examined the relationship between lower back injury and various etiological factors in 48 professional fast bowlers. Bowling action, lumbar spine appearance via MRI scans and lumbar paraspinal muscle asymmetry were investigated. Thirty-five percent of subjects sustained a lower back injury (>6 days missed cricket) within ± 1 season of testing and 25% suffered an acute lumbar stress injury. The latter group used less lower trunk side-flexion (%ROM) during the delivery stride and a non-significantly increased amount of lower trunk extension than bowlers who did not suffer lower trunk injury. The appearance of the non-dominant pars and absence of intervertebral disc degeneration was related to acute stress injury occurrence.

KEY WORDS: lower back injury, aetiology, motion analysis, trunk muscles

INTRODUCTION:

Stress injury of the lumbar posterior bony elements in fast bowlers accounts for the greatest amount of missed playing time in cricket. Posterior bony element stress changes predominantly occur at the lower lumbar levels, on the side contralateral to the bowling arm (Engstrom et al., 2007). Bowling technique, workload and physical risk factors have previously been associated with lower back injuries in fast bowlers (Foster et al., 1989; Elliott et al., 2000). With regard to technique factors, the adoption of a 'mixed' bowling action, characterised by large counter-rotation of the shoulders during the delivery stride, is a factor that has been repeatedly associated with lower back injury in fast bowlers (Elliott et al., 1992, Portus et al., 2004). However, the relationship between radiological findings, pain, functional disability (impairment in day to day tasks), cricket specific disability (missed games by bowlers), fast bowling technique and other potential risk factors for low back injury in fast bowlers remains unclear. Therefore, the aim of this study was to examine the relationship between lower back injury occurrence in professional fast bowlers (within ± 1 season of testing) and possible aetiological factors. Factors examined in this study were selected bowling action and delivery stride trunk kinematic variables (Ranson et al., 2008a), the lumbar MRI appearance of the partes interarticulares and intervertebral discs (Ranson et al., 2005), and lumbar paraspinal muscle asymmetry (Ranson et al., 2008b).

METHOD:

Forty-eight professional male fast bowlers from English County Cricket clubs were recruited for this study. All subjects were considered fast bowlers by the England and Wales Cricket Board (ECB) fast bowling coach. Mean (± SD) age, height and mass of subjects was 22 ± 3 years, 1.87 ± 0.06 m and 84 ± 7 kg respectively. Approval for the study was obtained from the relevant Institutional Human Research Ethics Committees.

Subjects' lower back injury occurrence/history were collected from pre-existing ECB and County Club injury records. Motion analysis and MRI scanning were performed when subjects were deemed fit to bowl by their County Physiotherapist. All subjects bowled three times/week, on average, in either practice sessions or matches during the current season.

A 12 camera Vicon Motion Analysis System (Oxford, UK) operating at 120 Hz was used to measure the degree of shoulder counter-rotation and the three-dimensional (3D) kinematics of the lower trunk during the delivery stride of fast bowling and during a standing range of motion (ROM) trial. A standard marker set placed on bony landmarks was used to define shoulder, lower thorax and pelvic reference frames. Six bowling trials were collected and the best three (maximum velocity trials with minimal marker loss) were chosen for further analysis. Full details of these procedures are outlined in Ranson et al. (2008a).
MRI scans were obtained using a GE Medical Systems 1.5 Tesla MRI scanner. The scanning protocol comprised T1 and T2-weighted sagittal and axial sequences, and sagittal STIR sequences which were used to grade the MRI appearance of the lumbar intervertebral discs and posterior bony elements. Cross-sectional imaging of the lumbar paraspinal muscles (psoas, quadratus lumborum, erector spinae and lumbar multifidii), was obtained using axial T2 weighted images at seven spinal levels (the lower vertebral end plate of L1 to L5 and the upper vertebral endplate of L5 and S1) (Ranson et al., 2005, 2006, 2008b).
Based on medical records spanning a period ± 1 season of that in which subjects underwent MRI and motion analysis testing, three lower back injury occurrence groups were formed; i) no lower back injury, ii) acute lumbar stress injury and iii) other lower back injury. Statistical analysis compared groups i) and ii) only. Fisher's exact tests examined whether associations existed between lower back injury occurrence and; bowling action type (non-mixed or mixed) and, lumbar posterior bony element and intervertebral disc MRI appearance. Independent t-tests were used to compare: shoulder counter rotation, maximal and percentage ROM of lower trunk contralateral side-flexion and ipsilateral rotation between the two groups. Non-parametric tests (Mann-Whitney U test) were used for lower trunk extension kinematic variables. Independent t-tests were also used to compare the two groups with respect to the degree of asymmetry of lumbar paraspinal muscles. The level of statistical significance was set at $p<0.05$. No attempt was made to control for the inflation of the experiment-wise alpha rate as this was an exploratory study.

RESULTS:
A total of 17/48 (35%) of the bowlers in this cohort were classified as having a lower back injury as they missed more than 6 consecutive days of cricket due to lower back injury ± 1 season of testing. Of these 17 bowlers, 12 (25% of the total cohort) were diagnosed as having suffered an acute lumbar stress injury (stress fracture or stress reaction) for which they missed an average of 106 days of cricket. The five fast bowlers who were classified as having 'other' causes of lower back injury missed an average of 29 days of cricket.

There was no difference ($p=0.7$) evident for the fast bowling action type between those who suffered acute lumbar stress injury compared to those who had no lower back injury. Further, fast bowlers who had suffered an acute lumbar stress injury utilised a lesser proportion of their ROM in contralateral side-flexion than non-lower back injured fast bowlers ($p=0.03$) but there was no difference in the percentage ROM of lower trunk extension ($p=0.4$) and ipsilateral rotation ($p=0.3$) utilised by these two groups of bowlers (Table 1).

There was a difference in the non-dominant side lumbar partes interarticulares MRI appearance of the fast bowlers who had an occurrence of acute stress injury compared with those with no lower back injury ($p=0.001$). Of note, seven (70%) of the 10 subjects who had acute stress changes on MRI when they were asymptomatic at the time of testing, suffered an acute lumbar stress injury within one season either side of the year of testing.

There was also a difference ($p=0.05$) in the lumbar intervertebral disc MRI appearance of the fast bowlers who had an occurrence of acute stress injury when compared with those with no lower back injury. Nine (75%) of the 12 subjects who had an occurrence of acute lumbar stress injury had a normal MRI appearance of all lumbar discs whilst 19 (61%) of the 31 subjects who had no occurrence of lower back injury had the MRI appearance of disc degeneration at one or more lumbar levels.

No difference was found for functional cross-sectional area asymmetry of the paraspinal muscles (at any spinal level and when all levels were summed) between bowlers who suffered acute stress injury and those with no lower back injury (p-value range = 0.2-0.9).

Table 1 Lower back injury occurrence versus the maximal percentage range of motion (%ROM) of selected movements of the lower trunk utilised during the delivery stride of fast bowling.

Maximal Lower Trunk %ROM	Lower Back Injury Occurrence	Median (Inter-quartile Range)	p-value (Mann-Whitney)
Lower Trunk Extension	No lower back injury (n=31) (0-6 days missed)	20 (6-31)	0.4
	Acute stress fracture (n=12) (>6 days missed)	27 (1-49)	
	Other lumbar injury (n=5) (>6 days missed)	10 (0-48)	
		Mean (SD)	p-value (t-test)
Contralateral Side-Flexion	No lower back injury (n=31) (0-6 days missed)	135 (26.2)	**0.03**
	Acute stress injury (n=12) (>6 days missed)	115 (22.5)	
	Other lumbar injury (n=5) (>6 days missed)	141 (43.3)	
Ipsilateral Rotation	No lower back injury (n=31) (0-6 days missed)	80 (24.5)	0.3
	Acute stress injury (n=12) (>6 days missed)	71 (24.8)	
	Other lumbar injury (n=5) (>6 days missed)	75 (17.4)	

DISCUSSION:

Our results indicate that a high number of professional fast bowlers continue to sustain lower back injuries (mostly acute lumbar stress injury). The presence of acute MRI stress changes (such as bone marrow oedema, periostitis and acute fracture lines) in the non-dominant side lumbar posterior elements seem to have a relationship with acute stress injury occurrence, pain and disability. Regular lumbar MRI scanning may assist in identifying early acute stress changes before injury occurs. Intervertebral disc degeneration was less prevalent amongst professional fast bowlers who suffered acute stress injuries than those who had no lower back injury. This finding is somewhat contrary to previous assertions that disc degeneration precipitates acute bone stress and this indicates that there may be differing mechanisms for MRI identified bony stress changes and intervertebral disc abnormalities. These differences are possibly due to factors such as bone health, genetic predisposition to bone stress injury and individual differences in robustness of the connective tissue.

Fast bowling action classification obtained when bowlers were asymptomatic was not conclusively linked to acute lumbar stress injury occurrence. This is at variance with findings of similar studies examining junior fast bowlers (Elliott et al., 1992) and may be due to: i) professional fast bowlers have already bowled for years in training and in matches and they may have already survived the high-risk period through adolescence where they are known to be prone to back injury; ii) professional fast bowlers may have different fast bowling trunk kinematic characteristics to juniors, and iii) professionals may have received greater technique coaching input aimed at reducing their injury risk. Another factor that may have influenced this finding is that due to performance, injury or unconscious reasons, some bowlers may have altered their technique in the time between testing and injury occurrence.

The finding that fast bowlers with acute lumbar stress injury utilised a lesser proportion of their contralateral side-flexion ROM was also unexpected but may be related to that group of bowlers also utilising a non-significantly greater amount of lower trunk extension, resulting in a loss of contralateral side-flexion due to joint coupling (Table 1). Further investigation of the effect of coupled lower trunk motion on non-dominant side lumbar bone stress is indicated.
Finally, although fast bowlers have a high prevalence of quadratus lumborum and lumbar multifidus being asymmetrically larger on the dominant side (Ranson et al., 2008b), there does not seem to be an obvious relationship between acute lumbar stress injury and these findings in professional fast bowlers.

CONCLUSIONS:
A high percentage of professional fast bowlers continue to sustain acute lumbar stress injuries. Action classification and lower trunk kinematic variables obtained when bowlers were asymptomatic weren't conclusively linked to acute lumbar stress injury occurrence. The presence of acute MRI stress changes in the non-dominant side posterior elements seem to have a relationship with acute stress injury occurrence, pain and disability and regular lumbar MRI scanning may help identify early acute stress changes before injury occurs.

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