The Timing and Magnitude of Upper Body Muscular Activity During a Field Hockey Hit

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Introduction

The field hockey hit is one of the most important skills used in the game, but surprisingly little is known about its underlying kinetics. The aim of this study was to investigate the contributions to stick motion by monitoring muscle activity in the arms and trunk and synchronising these with arm and stick kinematics.

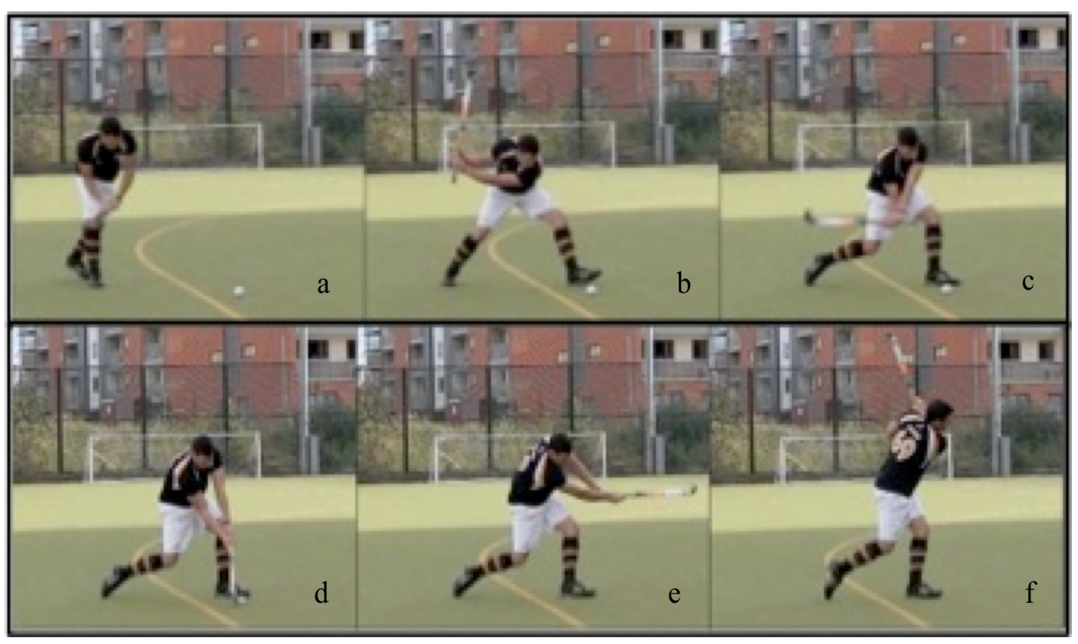

Figure 1. The field hockey hit: a) initiation of the hit and start of the backswing; b) top of the hit, the end of the backswing and the start of the early forward swing; c) stick horizontal in the downswing, the end of the early forward swing and the start of the acceleration phase; d) ball impact, the end of the acceleration phase and the start of the early follow-through; e) stick horizontal, the end of the early follow-through and the start of the late follow through; f) end of the hit.

Methods

The hits of ten male, university-level field hockey players were analysed using surface EMG (Myomonitor IV, Delsys). Bilaterally, activity was recorded at 2000Hz from the biceps brachii, triceps brachii, anterior and posterior deltoids, upper trapezius, latissimus dorsi and sternal and clavicular pectoralis major muscles. Stick, elbow and wrist kinematics were tracked at 240Hz using eight Qualisys ProReflex 500 cameras, and each hit was broken down into four phases: the backswing (BSw), early forward swing (EFSw), acceleration (Acc) and early follow-through (EFTh). Kinematic and EMG data were then synchronised and temporally normalised to % of each phase. EMG amplitudes were normalised to maximal voluntary contractions.

Results

The elbow and wrist motions (Figure 2) confirmed Chivers and Elliott's (1987) suggestion that the left arm and stick act as a double pendulum, but the right arm and stick act as a triple pendulum. Table 1 shows the peak EMG amplitude in each phase for selected muscles, but detailed activity patterns were also established relative to the kinematic data.

Table 1. Peak amplitude (%MVC) of muscle activity by swing phase during the field hockey hit (mean ± SD, across all participants)

	Swing phase			
Muscle	BSw	EFSw	Acc	EFTh
Left				
Anterior deltoid	18±17	19±25	50±49	50±49
Latissimus dorsi	62±59	153±120	102±90	33±30
Clav. pec. major	16±19	45±37	67±62	42±28
Stern. pec. major	17±18	57±73	54±42	61±145
Right				
Anterior deltoid	100±81	115±124	64±76	26±32
Latissimus dorsi	54±52	88±85	79±70	72±78
Clav. pec. major	40±36	76±66	66±70	26±21
Stern pec. major	29±16	81±52	51±26	27±30

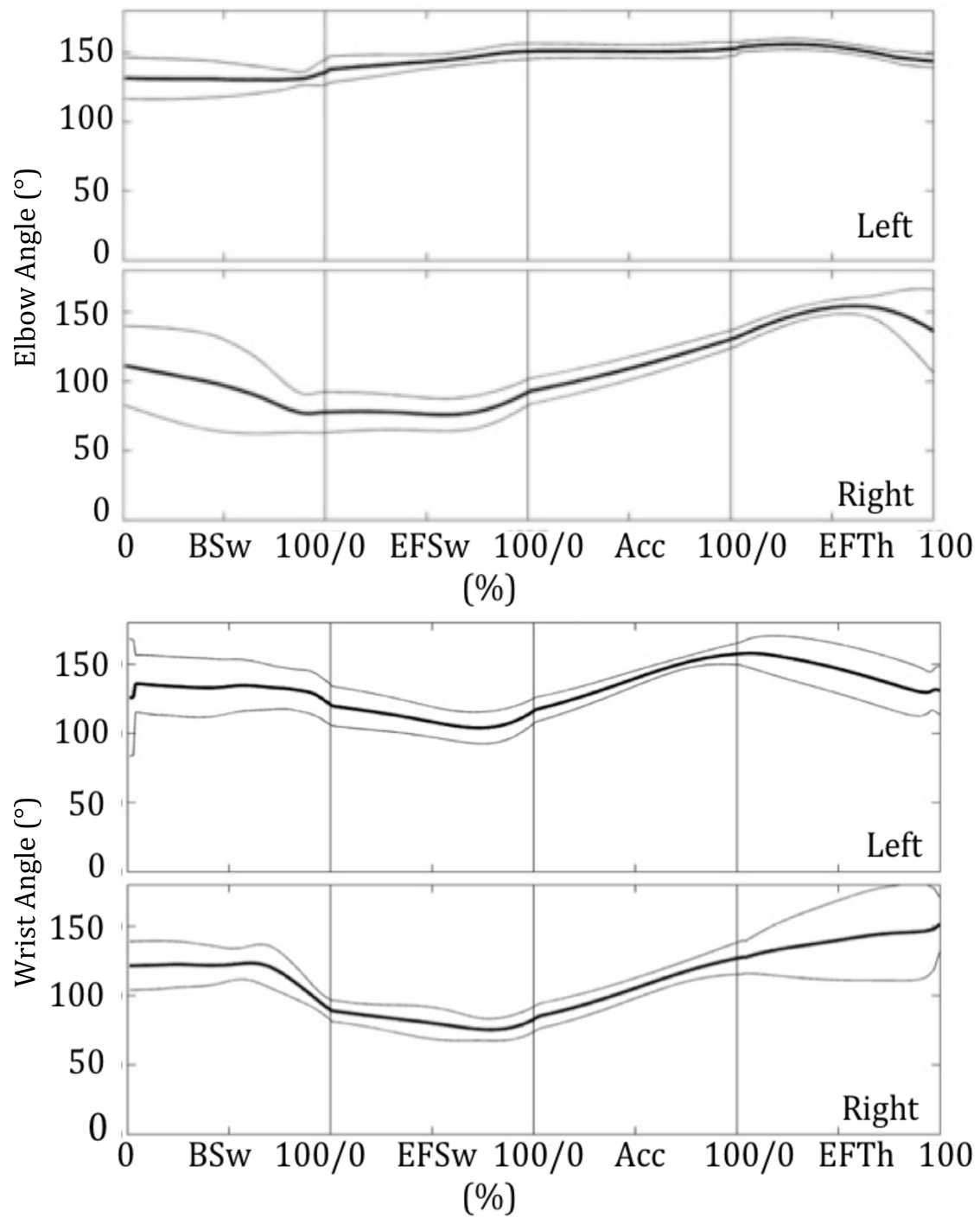

Figure 2. Elbow and wrist angles during the field hockey hit. Values shown are the mean angles ± SD across all participants for each normalised percentage of each swing phase, where 180 degrees is full extension.

Discussion

Activity of the right anterior deltoid, right pectoralis major and both latissimus dorsi initiates the EFSw, accelerating the arms. Segmental interactions, arising from these accelerations, cause the wrists to 'cock'. A combination of left anterior deltoid, left latissimus dorsi and bilateral pectoralis major activity continue to accelerate the arms during the early downswing whilst elbow musculature appears to control the elbow flexion tendency of both arms arising from segmental interactions. The 'locking' of the elbows means the effect of segmental interactions are seen at the wrists, which become involved in wrist 'uncocking' as the stick accelerates towards impact with the ball. With relation to the whole motion, the elbows differ as the combined effects of muscular activity and segmental interactions cause the right elbow to flex then extend, whereas the left elbow maintains a more constant degree of extension throughout the hit.

Conclusions

Whilst their interpretation is complicated by the closed kinetic loop formed by the arms and stick, the data collected here represent a step forward in establishing the contributions from muscular activity and segmental interactions to the field hockey hit. This study has shown that EMG analysis alone is not sufficient to explain the nature of muscular activity patterns and that the temporal aspects of EMG need to be examined in combination with kinematic data to ascertain the role of muscular activity during movement.

References

Chivers, L. and Elliott, B.C. (1987) The penalty corner in field hockey. *Excel*. 4: 5-8.