An Alternative Method for Identifying the Onset of Arm Acceleration in Throwing.

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Summary

In throwing research, maximal shoulder external rotation (MER) is typically used to indicate the onset of the arm acceleration phase. However, MER occurs approximately 5% of the throwing cycle later than the first movement of the arm towards the target. Maximal arm withdrawal (MAW) may serve as a viable alternative owing to its closer alignment to mechanical principles underlying the throwing motion. Consequently, it may facilitate the capture of the first motion of the arm towards the target and, therefore, complete arm kinematics when throwing.

Introduction

Quantifying movement in biomechanics relies on appropriately segmenting the motion into relevant phases. Segmentation enables a more focused analysis of specific motion components, facilitating a deeper understanding of a movement's underlying mechanisms. To partition a movement suitably, key timepoints or events are used to mark the start and end of phases. Therefore, selecting appropriate events is essential for effective movement analysis.

In throwing research, arm acceleration is traditionally defined from maximal shoulder external rotation (MER) to ball release (BR) [1,2]. However, this approach overlooks fundamental principles of mechanical movement utilised during execution of the skill. The magnitudes of shoulder abduction and elbow flexion (approx. 90° each) as the arm 'sets' early in the throw increase the moment arm about the long axis of the humerus [3]. Thus, rotation about this axis (shoulder internal rotation) is mechanically disadvantageous, and a different motion (i.e. horizontal plane shoulder motion) is likely to occur first. While MER may have clinical implications as a discrete measure, it may not truly mark the start of the arm acceleration phase.

The purpose of this study is to present an alternative to MER aimed at identifying the first instance of arm segment acceleration towards the target. We offer maximal arm withdrawal (MAW) owing to its alignment with the mechanical properties underlying the throwing motion.

Methods

Kinematic data for eight NCAA college pitchers (1.85 ± 0.04m; m: 91.9 ± 10.4kg; 20 ± 2y) were collected using an electromagnetic motion capture system (240Hz). Each pitcher threw three game-intensity fastballs from a mound towards a target strike zone. MAW and MER were calculated from subsequent segment orientations and joint rotations. MAW was defined as the most posterior position of the upper-arm's COM relative to the thorax in the direction of the throw, whilst MER was defined per conventional methods.

Results

The mean incidence of MAW and MER as a percentage of the throwing cycle (0% = first vertical movement of the front ankle, 100% = end of follow-through) for each player are reported in Table 1. On average, MER occurred 5% after MAW.

Table 1: Occurrence of MAW & MER in the throwing cycle.

Player	MAW (% cycle)			MER (% cycle)		
1	69.3	±	1.5	78.3	±	1.5
2	79.0	±	0.0	77.0	±	1.4
3	70.0	±	0.0	75.7	±	0.6
4	76.0	±	1.0	77.3	±	1.2
5	80.0	±	0.0	86.7	±	0.6
6	75.0	±	1.0	82.0	±	1.0
7	76.7	±	2.3	84.3	±	0.6
8	77.0	±	0.0	81.3	±	0.6
μ	*75.2*	±	*0.7*	*80.5*	±	*0.9*

Note. μ = means across all participants.

Discussion

This study set out to propose an alternative event to signify the onset of arm acceleration for use in throwing research. Whilst MER is currently used, it was believed MAW would be more suitable owing to it being more closely aligned with the mechanical properties underlying the throwing motion.

Upon investigation, we observed that the instance of MER occurred 5% of the throwing cycle later than MAW (Table 1). MER remains clinically relevant; however, relying on it to indicate the start of arm acceleration is problematic. Not only does MAW better indicate the onset of upper arm segment acceleration towards the target, but an added benefit is its applicability across a variety of throwing styles, sports, and populations.

Conclusions

MAW may serve as a more appropriate event to identify the onset of arm acceleration owing to it better aligning with the mechanical principles underpinning the throwing motion. We recommend throwing research consider this new event definition going forward.

References

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