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An inferential investigation into how stride length influences temporal parameters within the baseball pitching delivery

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ABSTRACT

Motion analyses of lower body mechanics offer new schemas to address injury prevention strategies among baseball pitchers, where the influence of stride length remains unknown. This study examined the temporal effect of stride length at constituent pitching events and phases. Nineteen competitive pitchers (15 collegiate, 4 high school) were randomly assigned to pitch two simulated, 80-pitch games at ±25% of their desired stride length. An integrated, three-dimensional motion capture system recorded each pitch. Paired *t*-tests were used to determine whether differences between stride conditions at respective events and within phases were significantly different. The results demonstrate the shorter strides mediated earlier onset of stride foot contact, reduced time in single support whereas double support intervals increased ($p < .001$). The opposite was observed with the longer strides. However, the acceleration phase, which comprises the highest throwing arm kinematics and kinetics, remained unchanged. The interaction between stride length, stride foot contact onsets, and time in single support is inferentially evidenced. The equivalent acceleration phases suggest stride length alone influenced time in single and double support by altering the onset of stride foot contact, which perhaps affects the mechanics in preparing the throwing arm for maximal external shoulder rotation.

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1. Introduction

Mechanical energy is required in the pitching delivery that is first generated by the drive leg through the pitching stride, then braced by stride leg, and is subsequently transferred up through the kinetic chain to the throwing hand via the pelvis, trunk, humerus, and forearm segmental interactions (Lin, Su, Nakamura, & Chao, 2003; Seroyer et al., 2010). The high velocity nature of baseball pitching demands that the kinetic energy of the throwing hand be maximized through effectively sequenced linear and rotational segment momentum transfers, which are observed throughout the sequence of discrete events and phases (Lin et al., 2003; MacWilliams, Choi, Perezous, Chao, & McFarland, 1998; Seroyer et al., 2010; Urbin, Fleisig, Abebe, & Andrews, 2013). The chronological flow of pitching events and phases as described below follow specific timing about the pitching delivery, where variation in throwing mechanics may affect hallmark event onsets and accompanied phase durations.

Traditional pitching phases from onset of the wind-up to ball release are separated by the following hallmark events: (1) *peak knee height*, (2) *stride foot contact*, (3) *maximal external rotation at the Shoulder*, (4) *ball release*, and (5) *maximal internal rotation at the Shoulder* (Dillman, Fleisig, & Andrews, 1993; Escamilla et al., 2007; Fleisig, Andrews, Dillman, & Escamilla, 1995; Seroyer et al., 2010) (Fig. 1). During the *wind-up* phase the stride leg (contralateral to the throwing arm) is lifted to peak knee height as the pitcher produces mechanical energy through ground reaction forces and manipulation of the center of gravity (Seroyer et al., 2010). The pitching stride is instrumental to the pitching delivery and is executed during the *early cocking* phase, which refers to the arm motion during "single support". Single support refers to only the drive foot having contact with the ground while the stride foot remains airborne until stride foot contact. During single support the drive leg generates the greatest linear energy thereby moving the total body center of mass forward, and therefore from a lower body mechanics perspective, single support may be considered the *generation phase* of the pitching cycle.

Following the instant of stride foot contact, maximal external shoulder rotation is achieved through a combination of upward scapular rotation, retraction, and posterior tipping, allowing shoulder abduction (Kibler, Press, & Sciascia, 2006; Seroyer et al., 2010), which comprises the critical throwing arm event featured in the *late cocking phase*. From a lower body perspective, the interval from stride foot contact to maximal external shoulder rotation can be described as the *brace-transfer phase*, which encompasses stride leg braking and transfer of linear energy to rotation of the pelvis and trunk in "double support" (two-foot ground contact) (Seroyer et al., 2010). Lastly, the *acceleration phase* follows brace-transfer, which is initiated at maximal external shoulder rotation and culminates at ball release. During the *acceleration phase,* pitchers may be in either double or single support. In this phase the humeral internal rotators transition from an eccentric pre-stretch to concentric contraction,

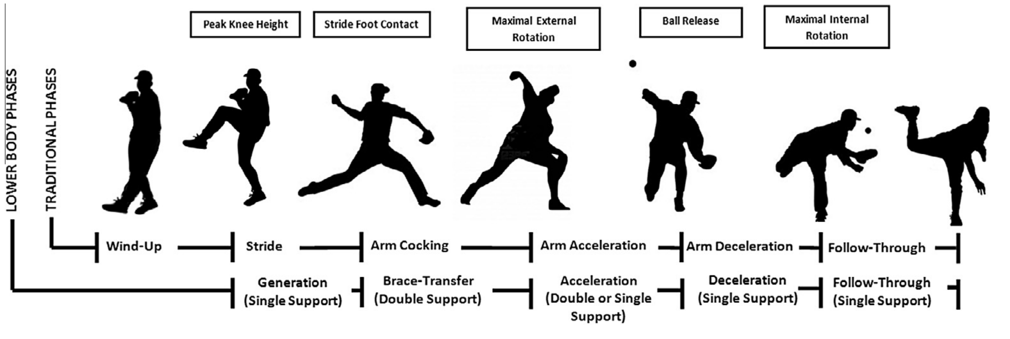

Fig. 1. Traditional, as well as lower body pitching delivery phases transitioned by discrete events. Wind-up to knee up (peak knee height) initiates the delivery, where the pitcher is in single support generation until stride to foot contact. Following foot contact, forward momentum is braced then transferred to internal rotation of the trunk. Following maximal external shoulder rotation, acceleration of the throwing arm occurs until ball release, where deceleration then transitions to follow-through in single support.