INFLUENCE OF STRIDE LENGTH ON PELVIC-TRUNK SEPARATION AND PROXIMAL PLYOMETRICS IN BASEBALL PITCHING

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Summary

Stride length alters pitching biomechanics [1-5] and timing of peak pelvic-trunk separation and trunk angular velocity relative to the pelvis. Peak pelvic-trunk separation nearer to ball release concomitant with increased trunk-pelvis velocity ratios can alter trunk-arm momentum exchanges.

Introduction

Pelvis and trunk counter-rotation are key factors in pitching, where energy or momentum is transferred from the lower extremities through to the throwing hand [2,4]. Axial pelvic-trunk separation (PTS) angle, calculated by subtracting trunk position from pelvis position, is known to effect throwing arm kinematics. Perhaps altering stride length and drive leg propulsion influences axial PTS which may increase risk of throwing arm injury. Therefore, this retrospective analysis investigated stride length influences on; *i)* transverse PTS and *ii)* sequencing (trunk-to-pelvis transverse angular velocity ratio, otherwise known as the proximal plyometric effect (PPE)) during fastball pitching.

Methods

Secondary analysis of 19 healthy-skilled, competitive pitchers motion capture data previously collected and post-processed [1] was undertaken to test the a-priori hypotheses that ±25% changes from desired stride length, respective of overstride (OS) and understride (US), impacted PTS angle and PPE, The pitching cycle, as shown in figure 1, was time normalized to 100%, from peak knee height (PKH) to ball release (BR).

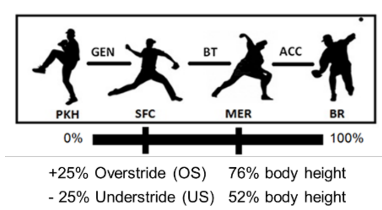

Figure 1: Normalized Pitching Cycle and Hallmark Events

Hallmark events also included stride foot contact (SFC) and maximal external rotation (MER) and phases were linked between hallmark events; Generation (GEN) from PKH to SFC; Brace-Transfer (BT) from SFC to MER; and Acceleration (ACC) from MER to BR.

Separation angles were calculated throughout the entire pitching cycle referencing pelvic position to the trunk. Mathematical formulas were used as follows to determine:

a. Pelvic-Trunk Separation Angle (PTS) = Pelvis Θ - Trunk Θ

b. Proximal Plyometric Effect (PPE) = Trunk ω /Pelvis ω

Independent t-tests were used for comparing PTS and PPE ratios between the two stride conditions at hallmark events and phases. Statistical significance was set at $p \leq 0.05$.

Results and Discussion

Pelvic-trunk separation (PTS) and proximal plyometric effects (PPE) were both affected by the ±25% changes in stride length (figure 2). Higher separation angles (-) were observed at PKH with US ($P \leq 0.05$), whereas pelvis position with OS was further ahead of the trunk, with greater separation (+) observed during the GEN phase ($p \leq 0.001$) and at SFC ($p \leq 0.05$). Proximal plyometric effects were higher with OS during BT ($P \leq 0.05$) whereas US evoked greater effect throughout ACC ($p \leq 0.05$), with greater peaks evident at BR ($p \leq 0.05$).

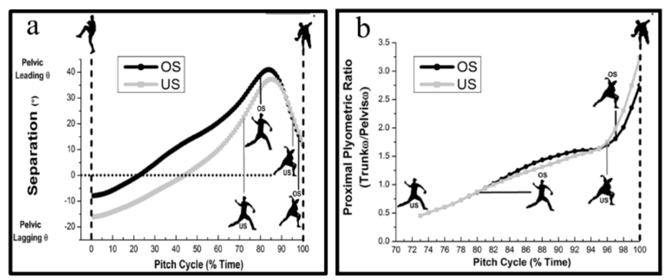

Figure 2: a) Pelvic-Trunk Separation b) the Proximal Plyometric Effect between under-stride (US) and overstride (OS) conditions. Pelvic Separation Behind Trunk (-) and Pelvic Separation Ahead of Trunk (+).

Conclusions

Peak pelvic-trunk separation (PTS) near SFC mediated greater PPE ratios earlier in the pitching delivery (SFC to MER) that may regulate trunk angular velocity relative to the pelvis at BR. Conversely, PTS concomitant with high PPE ratios near ball release may be compensatory for reduced drive leg propulsion observed during the generation phase, that could impact trunk-throwing arm momentum exchanges [3,5].

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