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Drafted Pitcher Career Outlook Comprehensive Assessment

Pitching/Performance Assessments:

- **Assessment #1: Game-like intensity pitching mechanics analysis**
  - Procedure: Collection of kinematic pitching data in a game-like intensity bullpen. 10 samples each from primary fastball pitch (4-seam, 2-seam, cutter, sinker, etc.), primary breaking ball pitch (curveball, slider, sweeper, etc.), and primary off-speed pitch (changeup, splitter, etc.). Collect samples from the windup (if applicable) and whatever delivery the pitcher utilizes with runners on base.
  - Purpose: Identify individual mechanical tendencies for performance evaluation and injury surveillance.
- **Assessment #2: On-field pitch tracking analysis**
  - Procedure: Within the same protocol as Assessment #1, collect pitched ball kinematics.
  - Purpose: Pair pitching biomechanical data with pitch quality data to drive KPIs (velocity, xERA, FIP, Whiff%, etc.).
- **Assessment #3: Handgrip strength test**
  - Procedure: Collect dominant and non-dominant hand grip maximal strength isometric tests (straight arm and at pitcher's individual elbow flexion at ball release).
  - Purpose: Maximal strength assessment, fatigue monitoring, return to play protocol.
- **Assessment #4: Joint ROM and anthropometrics testing**
  - Procedure: Measure height, weight, and limb lengths, to assess the participant's anthropometry along with joint ranges of motion.
  - Purpose: Assess the capabilities of relevant joints providing insights into biomechanical efficiency, injury risk, and potential areas for improvement in their pitching mechanics.

Equipment:

1. Motion Capture System (Assessment 1) – Precisely track and record body movements, joint angles, and kinematics
2. Inertial Measurement Unit (Assessment 1) – Measures forces and accelerations, providing valuable information on the loads experienced by the arm and body during pitching
3. Pitching Mound Force Platform (Assessment 1) - Measures the ground reaction forces exerted by the pitcher, aiding in the analysis of weight distribution, balance, and biomechanical efficiency
4. PITCHf/x / TrackMan (Assessment 2) - Tracks and analyzes pitch trajectory and movement, providing data on speed, spin rate, and movement for pitcher performance evaluation
5. Handheld Dynamometer (Assessment 3) - Measures grip strength, providing insights into hand, forearm, and maximal strength, which are essential for ball control, velocity, and general force production
6. Goniometer (Assessment 4) - Measures joint range of motion

Key Data Points:

- Elbow valgus torque – Injury prediction modeling, return to play protocol, workload monitoring
- Kinematic sequence efficiency – Optimize the transfer of energy by refining mechanics (stride length, trunk lean, etc.) and driving performance (velocity, tunneling, etc.)
- Spin Rate - Optimize pitch development, assess pitch efficacy, prevent injuries, devise game strategies, and evaluate performance
- Shoulder external / internal ROM - Assess shoulder range of motion over time
- Grip strength - Assess hand and forearm strength, track changes over time, monitor injury risk, CNS fatigue monitoring

PitcherY Kinematic Pitching Analysis

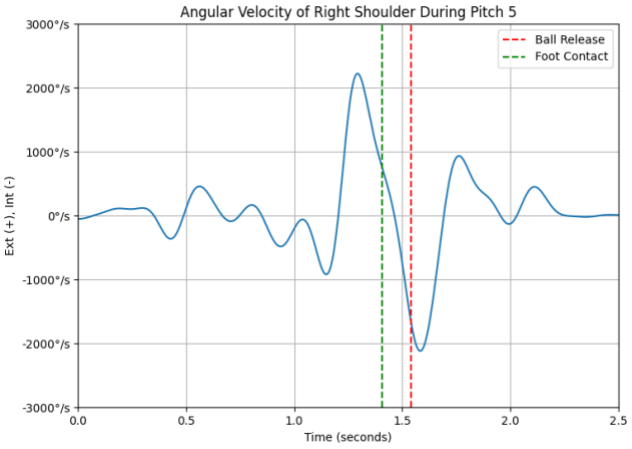

Figure 1. Angular velocities of the throwing shoulder from PitcherY with timestamps for foot contact and ball release during Pitch #5.

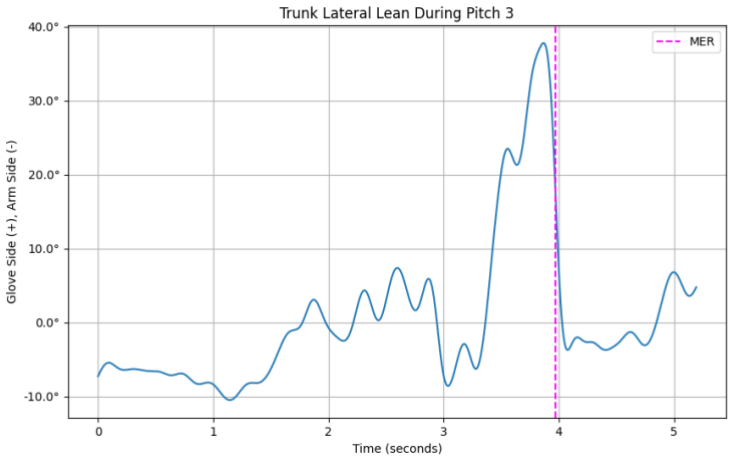

Figure 2. Trunk lateral flexion (Gloveside [+], Armside [-]) with a timestamp of maximal external rotation (MER) during Pitch #3.

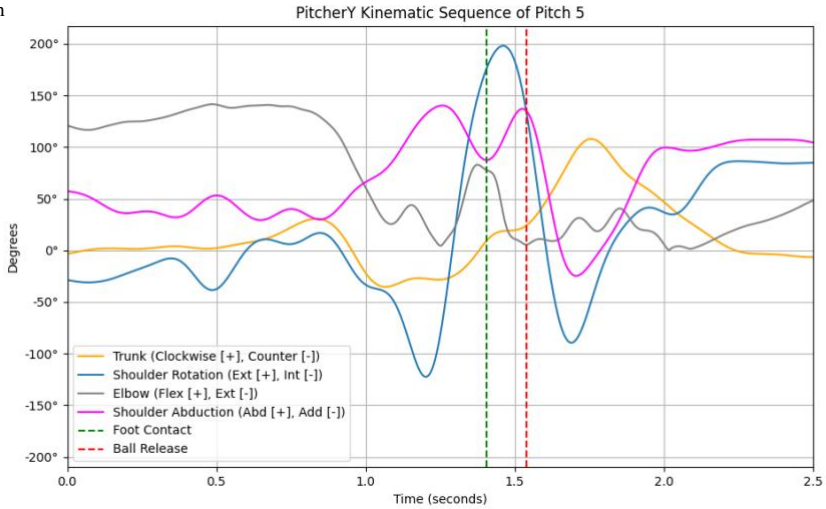

Figure 3. The kinematic sequence of PitcherY. Includes trunk twist, shoulder horizontal movement, shoulder rotation, and elbow extension from Pitch #5.

Long Term Outlook:

Given that UCL tears are the most common and resource-intensive elbow injuries in Major League pitchers, the high angular velocities of the right shoulder, and subsequently the medial elbow, must be carefully considered due to their potential to significantly impact a pitcher's career and necessitate lengthy recovery periods. While these velocities are inherent to pitching, monitoring and analysis of them is crucial for athlete health and performance. Utilizing motion capture systems, IMUs, force platforms, and anthropometrics, in Assessment #1 would aid in producing injury surveillance data that can be used throughout the pitcher's career.

Pitchers strive to gain or maintain pitch velocity throughout their careers. Trunk lateral lean is one of many mechanical qualities that plays a crucial role in pitching velocity. Analysis of trunk lean offers valuable biomechanical insights and performance advantages, particularly in power generation and throwing velocity. Achieving optimal lateral lean enables efficient energy transfer from the lower body to the arm, resulting in increased ball speeds. When coordinated with other body segments and optimized within the kinematic sequence, pitchers can achieve enhanced energy transfer from the ground to the ball, ultimately contributing to their long-term success.

Tracking the kinematic sequence allows for a comprehensive analysis of the consistency and efficiency of a pitcher's delivery while also providing historical objective data when mechanical interventions are introduced throughout the pitcher's career. Comparing biomechanical data to KPIs like xERA, FIP, spin rate, break, and accuracy can improve a pitcher's on-field success. This comparison provides valuable insights into how a pitcher's mechanics influence performance, identifying areas for improvement, and optimizing their potential and longevity on the mound. Regular evaluations and refinements of kinematic sequencing and relevant mechanics enable pitchers to enhance their performance and make data-driven career decisions.