



CENTER FOR HUMAN PERFORMANCE

Motion Analysis Laboratory
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MOTION ANALYSIS OF BASEBALL PITCHING (Information Sheet)

It's no secret throwing a baseball is a very fast moving activity. Some say it's one of the fastest known human movements in all of sports! In fact, at the Center for Human Performance and other similar motion analysis facilities, the arm has been clocked at rotating up to 5000 degrees per second! The amount of accelerations that the body and arm generate and absorb can place the throwing shoulder and elbow under significant amounts of stress. Thus, throwing-related injuries to these joints remain the most common medical problem in all levels of baseball.

At the Center for Human Performance, biomechanically analyzing the pitcher's mechanics during a throwing session remains at the forefront of our research and service-based programs. Since 2003, the Center has studied over 200 pitchers from the little league to the MLB ranks with the goal of identifying injury pathomechanics and potentially lowering its risk.



WHAT TO EXPECT FROM A PITCHING MOTION ANALYSIS

- During a motion analysis session, the pitcher will be asked to wear sliding shorts and a baseball cap to allow for motion analysis preparation. A kinesiologist will then place 40 reflective markers on the skin overlying specific bony landmarks of the pitcher's entire body.
- The kinesiologist will ask the pitcher to stand in the middle of motion analysis laboratory for a few seconds while 10 special motion capture cameras record the locations of each marker.
- Once all the marker locations have been verified, the pitcher will be allowed ample time to warm-up by throwing bullpen-like pitches to a simulated strike zone 60.5 feet away from an indoor mound.
- After the warm-up period, the pitcher will then throw 15-20 fastballs off the mound from either the stretch or wind-up depending on the preference of his coach or the pitcher himself.
- The staff will capture the movements of the markers with the motion analysis system while the pitcher makes his deliveries.
- The pitcher will have the option to throw with different pitchers or in varying conditions (ie, instruction style). This will be left at the discretion of the coach and/or player.
- The entire session should take 1 to 1.5 hours to complete, after which the pitcher can view his 3D "stick figure" in motion on the computer screen.
- Depending on the nature of the visit, a report summarizing the biomechanical findings will be sent out to the player, coach, trainer, or in some instances, his physician. A CD of his 3D stick figure and videos from the session will also be produced and sent, usually within a week or two.

To schedule an appointment, please call the Center at (858) 966-8415 or visit www.sdchp.com.

Summary of Biomechanical Evaluation Guidelines

The Center for Human Performance (CHP) uses the following set of biomechanical variables as guidelines to evaluate the risk of overuse injury during baseball pitching. This assessment is based on clinical relevant data collected at the CHP as well as from data published in the scientific literature. Please note that the following guidelines are used primarily to assess the risk of injury at the shoulder and elbow related to overarm throwing and may vary between pitchers. Depending on the specific case, all or a combination of selected variables may be used in conjunction with the subject's history and differential diagnosis for an overall assessment. Any performance based evaluation is performed in collaboration with a qualified coach or pitching instructor along with the motion analysis tool CD provided by the CHP.

***Kinetics** – direct extrinsic determinants influencing the risk of injury at the shoulder and elbow*

Variable	Description	Reported Range	Sources
Shoulder Internal Rotation Torque	Torque at the shoulder resisting glenohumeral external rotation	50 – 90 N-m	2,3,4
Shoulder Compression Force	Compressive force at the glenohumeral joint resisting distraction of the humerus	800 – 1100 N	3,4
Elbow Valgus Force	Bending force at the elbow that places tension at medial side and compression on the lateral side	200 – 480 N	1,3,4,5
Elbow Flexion Force	Force resisting extension of the elbow	40 – 120 N	4

***Kinematics** – factors influencing the kinetic determinants of risk of injury at the shoulder and elbow*

Variable	Description	Reported Range	Sources
Max Trunk Rotation Timing	Timing within the pitching cycle when the max trunk rotation occurs (initiation of opening up)	14-40 % PC	1,2
Max Horizontal Abduction	Shoulder horizontal abduction prior to max external rotation	10° – 30°	4,7
Max Shoulder Horizontal Adduction Velocity	Angular velocity of shoulder horizontal adduction	750 -1000 deg/s	1,6
Elbow Flexion Angle	Elbow flexion angle at peak elbow valgus force	80° - 110°	4,6

Muscle Activation Patterns (Electromyography) - These patterns are compared to normal firing patterns of various upper body muscles reported by DiGiovine et al.⁸

SOURCE LIST

1. Aguinaldo, A.L. and Chambers, H.G. (2008). Effects of sequential body motion on elbow valgus load during baseball pitching. (submitted to the American Journal of Sports Medicine)
2. Aguinaldo, A.L., Buttermore, J, and Chambers, HG. (2007). Effects of upper trunk rotation on shoulder joint torque between baseball pitchers of various levels. *Journal of Applied Biomechanics*, **23**, 42-51.
3. Fleisig, G.S., Andrews, J.R., Dillman, C.J. and Escamilla, R.F. (1995). Kinetics of baseball pitching with implications about injury mechanisms. *American Journal of Sports Medicine*, **23**(2), 233-9
4. Feltner, M.E. and Dapena, J. (1986). Dynamics of the shoulder and elbow joints of the throwing arm during a baseball pitch. *International Journal of Sports Biomechanics*, **2**, 235-259.
5. Werner, S.L., Fleisig, G.S., Dillman, C.J. and Andrews, J.R. (1993). Biomechanics of the elbow during baseball pitching. *Journal of Orthopedic Sports Physical Therapy*, **17**(6), 274-8
6. Werner, SL, Murray, TA, Hawkins, RJ, and Gill, TJ (2002). Relationship between throwing mechanics and elbow valgus in professional baseball pitchers. *J Shoulder Elbow Surg*, **11**(2), 151-5.
7. Dillman, C.J., Fleisig, G.S. and Andrews, J.R. (1993). Biomechanics of pitching with emphasis upon shoulder kinematics. *Journal of Sports Physical Therapy*, **18**(2), 402-8.
8. DiGiovine, N.M., Jobe, F.W., Pink, M, Perry, J. (1992). An electromyographic analysis of the upper extremity in pitching. *J Shoulder and Elbow Surgery*, **1**, 15-25.