EDITORIAL

Elbow Injuries in Baseball Players: An Orthopedic Perspective

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The management of elbow injuries in baseball players, especially pitchers, represents a multifaceted challenge for orthopedic surgeons and demands a comprehensive understanding of the biomechanics, preventive measures, treatment modalities, and long-term outcomes associated with these injuries. The elbow of professional baseball pitchers is subjected to forces that could potentially lead to a spectrum of adaptive or pathological changes.[1] Awareness of the asymptomatic adaptive changes that may be present, such as ulnar collateral ligament (UCL) anterior band thickening[2] and ulnotrochlear and/or capitellar subchondral sclerosis,[3] is crucial in correctly diagnosing and treating the injuries.[4]

As an orthopedic surgeon specializing in not only sports medicine but also baseball medicine, I navigate the intricate landscape of evidence-based medicine to identify causative injury factors, integrate prevention strategies, and formulate athlete-specific treatment options to ultimately optimize and streamline orthopedic care to decrease time out of play and increase success to obtain high-quality outcomes when treating elbow injuries, especially in baseball players.

UNDERSTANDING THE CAUSATIVE INJURY FACTORS:

Overhead throwing can put significant stress on the medial side of the elbow, especially if biomechanical factors result in increased load, as timing, fatigue, and the kinetic chain can create a sub-optimal environment.[5] The central structure of stability to the medial elbow is ultimately the anterior band of the ulnar collateral ligament, and depending upon age and other factors, these other structures can become adversely affected. In younger throwers, growth plate status must be considered as increased stress can result in pain and/or fracture, especially involving the medial epicondyle and/or olecranon growth plate. As the growth plates close, sub-optimal stress to the elbow is subsequently transferred to other structures, including the ulnar collateral ligament and flexor-pronator tendon. Before and after growth plate closure, excessive load to the elbow can additionally lead to capitellar cartilage and bone stress resulting in subsequent pathology.

Several factors contribute to the surge in elbow injuries sustained by baseball players, including improper pitching mechanics, inadequate rest, and lack of comprehensive injury prevention programs. Overall, the baseball players' entire kinetic chain is interconnected and must be considered when preventing injuries in throwers. It is important to consider that the lower extremity deficits in addition to the upper extremity kinetics are both critically important to decreasing the risk of elbow injuries.[6] The repetitive and high-intensity nature of the throwing motion can ultimately place immense stress on the elbow joint and can result in acute and chronic injury.[7,8]

THE IMPORTANCE OF PREVENTION:

Preventing elbow injuries in baseball throwers is even more ideal than optimizing treatment after injury. Biomechanical assessments and emphasizing proper pitching mechanics are pivotal in reducing the risk of injuries. A positive correlation exists between pitch counts and injury rates.[9] Thus, emphasizing adherence to Pitch Smart guidelines is important for injury prevention.[10]

The kinetic chain plays a crucial role in the mechanism of throwing, as efficient energy transfer from the lower body to the upper body is essential for both performance and injury prevention. Disruptions in this chain can lead to mechanical inefficiencies that increase stress on various joints, particularly the elbow. Timing issues, such as early trunk rotation or a delayed arm that lags behind the kinetic chain, can further exacerbate these stresses, leading to a higher risk of injury or pain in overhead athletes, including baseball players.[11] A "late arm", characterized by the arm not being in the proper layback position at foot contact, can trigger a series of mechanical problems that heighten the likelihood of elbow injuries. Given these interconnected factors, it is vital to consider lower extremity deficits – such as limited hip range of motion, poor balance, and improper foot posture – as potential contributors to elbow injuries. Physicians should emphasize screening and intervention programs that address the entire kinetic chain to help reduce injury risk in baseball players.[6]

Players, coaches, parents, and healthcare professionals

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must be educated to create a culture of injury awareness. Depending upon the age and amateur status of the elite baseball player, they require a collaborative team of healthcare providers and personal advisors to maintain health, including a doctor, physical therapist, performance specialist, coach, parent, advisor, and/or agent. Collaboration between these stakeholders is essential to implement comprehensive injury prevention programs. Encouraging open communication about physical discomfort, emphasizing the importance of rest and recovery, and promoting a holistic approach to player development are key components of a proactive preventive strategy.[10]

TREATMENT, REHABILITATION, AND RETURN TO PLAY:

A thorough clinical assessment and accurate diagnosis are essential for setting realistic expectations regarding the potential return to play and overall prognosis. Additionally, understanding the biomechanical and adaptive nuances of elbow injuries in baseball players is paramount for physicians as it enables the sports medicine team to tailor interventions based on individual athlete needs.[12] Even when addressing pathology through intervention, it is necessary to address potential biomechanical issues and causative factors; otherwise, clinical symptoms can recur, resulting in suboptimal outcomes.

UCL injuries represent the most common elbow injury in throwers; however, there can be a multitude of other pathologies that need to be considered, including olecranon stress fractures, flexor-pronator strains, ulnar neuritis, and/or neuropathy. Treatment modalities for UCL injuries range from non-operative measures, including rest, physical therapy, and platelet-rich plasma (PRP) injections, to surgical interventions, including UCL repair and/or reconstruction (i.e., Tommy John Surgery).

Regarding the UCL, the first goal is to accurately identify whether the UCL is torn or insufficient, as both can contribute to pain and the inability to throw. From a diagnostic perspective, we use a combination of radiographs, MRI with or without intra-articular contrast, and dynamic ultrasound to properly characterize pathology relating to the UCL as well as surrounding structures.[13] although utilization of MRI with intra-articular contrast can be controversial, we feel it is beneficial in cases where more subtle UCL pathology needs to be identified. When characterizing UCL pathology manifesting as pathologic ulnohumeral joint space opening, especially in more subtle UCL insufficiency cases, we utilize MRI with a FEVER view and/or dynamic stress ultrasound to help elucidate pathology.[14,15]

Rest from throwing is frequently the initial prescription for elbow injuries in baseball players.[16] this period of enforced inactivity allows the injured tissues to heal without the added stress of throwing. However, rest alone is often insufficient for a complete recovery. In fact, physical therapy is essential early in the treatment plan to appropriately focus on the sequential order of restoring range of motion, postural control, muscle strengthening, proprioceptive training, neuromuscular control, kinetic chain optimization, and progressively increasing loads to the healing tissues. A well-structured physical therapy program with a baseball medicine physical therapist not only aids recovery but also helps prevent future injuries by addressing biomechanical issues and imbalances.[17]

Platelet rich plasma (PRP) therapy has gained popularity in recent years as a non-surgical intervention for elbow injuries. PRP hypothetically promotes and stimulates tissue healing in partial UCL tears,[18] making it an appealing option for baseball players to return to the field without surgery. Despite several studies reporting promising results with utilization of PRP in chronic tendinopathies, partial ligament tears, and epicondylitis, the literature still lacks high-quality evidence to support the superiority of PRP over placebo in baseball elbow injuries.[19-22]

In cases where non-operative treatment proves inadequate, surgical intervention may be offered. UCL reconstruction, or so-called Tommy John surgery, is named after the legendary pitcher who underwent the procedure in 1974 by Dr. Frank Jobe. Before that time, the diagnosis of a UCL injury was often career-ending. The original technique entailed reconstruction of the UCL anterior band in a figure-of-eight fashion and suturing the graft to itself. The flexor-pronator complex was detached, and submuscular ulnar nerve transposition was performed, resulting in a 63% return to the prior level of sports.[23] Along with ongoing utilization of the figure-of-eight technique, subsequent modification of the approach through a flexor-pronator split in the setting of a modified docking technique procedure has also been subsequently proposed with successful return to play in many studies between 80-90% of baseball players.[24-26] The muscle-splitting approach, with or without concomitant ulnar nerve transposition, has become standard for treating UCL injuries and has successfully resurrected many careers.[27] Long-term follow-up of UCL reconstruction in baseball players indicates that most patients were satisfied and had excellent results during daily, work, and sporting activities.[24] In their 10-year minimum follow-up study, Osbahr et al. reported that 83% of competitive baseball athletes successfully return to play at a high level in less than 1 year.[24]

A UCL repair with an internal brace has more recently been championed as an option in acute avulsion injuries involving the proximal or distal attachment of the UCL. A study by Wilk et al. analyzing 350 athletes who underwent UCL repair with internal ligament bracing found an earlier average return to play of 7 months, approximately five months shorter than the average length of return to play associated with UCL reconstruction.[28] This is consistent with a previous study by Dugas et al., which identified a mean 6.7-month return to sport time following UCL repair with an internal brace.[29] These findings suggest that appropriate surgical patients with avulsion injuries in the setting of good quality ligament may be great candidates for UCL repair with an internal ligament brace and potentially return to play faster than UCL reconstruction.[27,28] However, further longitudinal studies are required to verify the effectiveness and longevity of UCL repair with an internal ligament brace over a longer follow-up period.

Conclusion

Elbow injuries in baseball players, particularly pitchers, pose significant challenges for orthopedic surgeons, given the unique biomechanical stresses of overhead throwing. These injuries often involve the UCL, though other

structures like the flexor-pronator tendon and growth plates in younger athletes can also be affected. Treatment strategies vary based on injury severity, ranging from rest, physical therapy, and PRP therapy to surgical interventions like UCL repair and reconstruction. Collaborative efforts between baseball medicine physicians, physical therapists, performance specialists, coaches, parents, and the athletes themselves are essential to tailor treatment plans that prevent injuries and appropriately treat injuries to allow for efficient return to play and decreased risk for subsequent re-injury.

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References

1. Atanda Jr A, Averill LW, Wallace M, Niiler TA, Nazarian LN, Ciccotti MG. Factors Related to Increased Ulnar Collateral Ligament Thickness on Stress Sonography of the Elbow in Asymptomatic Youth and Adolescent Baseball Pitchers. Am J Sports Med. 2016; 44(12):3179-3187. doi:10.1177/0363546516661010.
2- Marshall NE, Keller RA, Van Holsbeeck M, Moutzouros V. Ulnar Collateral Ligament and Elbow Adaptations in High School Baseball Pitchers. Sports Health. 2015; 7(6):484-488. doi:10.1177/1941738115604577.
3- Lobb NJ, Lu Z, Long E, Chow K, Michener LA. Sonographic morphological and qualitative deficits in the elbow ulnar collateral ligament and ulnohumeral joint in throwing arms of asymptomatic collegiate baseball pitchers. Skeletal Radiol. 2023; 52(1):31-37. doi:10.1007/s00256-022-04116-3.
4- Sada K, Chiba K, Kajiyama S, et al. Bone Mineral Density and Microstructure of the Elbow in Baseball Pitchers: An Analysis by Second-Generation HR-pQCT. J Clin Densitom. 2020; 23(2):322-328. doi:10.1016/j.jocd.2019.03.001.
5- Triplet JJ, Labott JR, Leland DP, et al. Factors that Increase Elbow Stress in the Throwing Athlete: A Systematic Review of Biomechanical and Motion Analysis Studies of Baseball Pitching and Throwing. Curr Rev Musculoskelet Med. 2023; 16(4):115-122. doi:10.1007/s12178-022-09800-4.
6- Deal MJ, Richey BP, Pumilia CA, et al. Regional Interdependence and the Role of the Lower Body in Elbow Injury in Baseball Players: A Systematic Review. Am J Sports Med. 2020; 48(14):3652-3660. doi:10.1177/0363546520910138.
7- Osbahr DC, Swaminathan SS, Allen AA, Dines JS, Coleman SH, Altchek DW. Combined flexor-pronator mass and ulnar collateral ligament injuries in the elbows of older baseball players. Am J Sports Med. 2010; 38(4):733-739. doi:10.1177/0363546509351558.
8- Olsen SJ, Fleisig GS, Dun S, Loftice J, Andrews JR. Risk factors for shoulder and elbow injuries in adolescent baseball pitchers. Am J Sports Med. 2006; 34(6):905-912. doi: 10.1177/0363546505284188.
9- Fleisig GS, Andrews JR, Cutter GR, et al. Risk of serious injury for young baseball pitchers: A 10-year prospective study. Am J Sports Med. 2011; 39(2):253-257. doi: 10.1177/0363546510384224.
10- Fleisig GS, Gaski M, Rhyne L, D'Angelo J, Osbahr DC, Andrews JR. Pitching Behaviors in Youth Baseball: Comparison With the Pitch Smart Guidelines: Letter to the Editor. Orthop J Sports Med. 2022; 10(4). doi:10.1177/23259671221088814.
11- Fleisig GS, Diffendaffer AZ, Ivey B, Aune KT. Do mechanics in youth baseball pitchers change with increased inning workload? Orthop J Sports Med. 2015; 3(4):2325967115581594. doi:10.1177/2325967115581594.
12- Osbahr DC, Dines JS, Rosenbaum AJ, Nguyen JT, Altchek DW. Does posteromedial chondromalacia reduce rate of return to play after ulnar collateral ligament reconstruction? Clin Orthop Relat Res. 2012; 470(6):1558-1564. doi:10.1007/s11999-011-2132-3.
13- Moen P, Hill B, Teytelbaum D, Kim C, Kaar S. Radiographic Description of Soft Tissue Attachments around the Elbow. Arch Bone Jt Surg. 2023; 11(9):556-564. doi:10.22038/ABJS.2023.49879.2491.
14- Nazarian LN, McShane JM, Ciccotti MG, O'Kane PL, Harwood MI. Dynamic US of the anterior band of the ulnar collateral ligament of the elbow in asymptomatic major league baseball pitchers. Radiology. 2003; 227(1):149-154. doi:10.1148/radiol.2271020288.
15- Whitney J. Palmer. Catch the MLB "FEVER" – Using a New Elbow MRI View for Improved Injury Assessment. Diagnostic Imaging. Available at: https://www.diagnosticimaging.com/view/catch-the-mlb-fever-using-a-new-elbow-mri-view-for-improved-injury-assessment. Accessed June 5, 2021.
16- Kibler WB, Chandler TJ. Baseball. In: Brukner P, Khan K, eds. Clinical Sports Medicine. 4th ed. Sydney: McGraw-Hill; 2012.
17- Wilk KE, Macrina LC, Cain EL. Rehabilitation of the thrower's elbow. J Orthop Sports Phys Ther. 2016; 46(3):163-177.
18- Mills IV FB, Misra AK, Goyeneche N, Hackel JG, Andrews JR, Joyner PW. Return to Play After Platelet-Rich Plasma Injection for Elbow UCL Injury: Outcomes Based on Injury Severity. Orthop J Sports Med. 2021; 9(3):2325967121991135. doi:10.1177/2325967121991135.
19- Mishra A, Pavelko T. Treatment of chronic elbow tendinosis with buffered platelet-rich plasma. Am J Sports Med. 2006; 34(11):1774-1778. doi: 10.1177/0363546506288850.
20- Dines JS, Williams PN, ElAttrache N, et al. Platelet-Rich Plasma Can Be Used to Successfully Treat Elbow Ulnar Collateral Ligament Insufficiency in High-Level Throwers. Am J Orthop (Belle Mead NJ). 2016; 45(5):296-300.
21- Podesta L, Crow SA, Volkmer D, Bert T, Yocum LA. Treatment of partial ulnar collateral ligament tears in the elbow with

Platelet-rich plasma. Am J Sports Med. 2013; 41(7):1689-1694. doi:10.1177/0363546513487979.

22- Chauhan A, McQueen P, Chalmers PN, et al. Nonoperative Treatment of Elbow Ulnar Collateral Ligament Injuries With and Without Platelet-Rich Plasma in Professional Baseball Players: A Comparative and Matched Cohort Analysis. Am J Sports Med. 2019; 47(13):3107-3119. doi:10.1177/0363546519876305.

23- Jobe FW, Stark H, Lombardo SJ. Reconstruction of the ulnar collateral ligament in athletes. J Bone Joint Surg Am. 1986; 68(8):1158-1163.

24- Osbahr DC, Cain Jr EL, Raines BT, Fortenbaugh D, Dugas JR, Andrews JR. Long-term Outcomes after Ulnar Collateral Ligament Reconstruction in Competitive Baseball Players: Minimum 10-Year Follow-up. Am J Sports Med. 2014; 42(6):1333-1342. doi:10.1177/0363546514528870.

25- Arner JW, Chang ES, Bayer S, Bradley JP. Direct Comparison of Modified Jobe and Docking Ulnar Collateral Ligament Reconstruction at Midterm Follow-up. Am J Sports Med. 2019; 47(1):144-150. doi:10.1177/0363546518812421.

26- Paletta GA Jr, Wright RW. The modified docking procedure for elbow ulnar collateral ligament reconstruction: 2-year follow-up in elite throwers. Am J Sports Med. 2006; 34(10):1594-1598. doi:10.1177/0363546506289884.

27- Smith GR, Altchek DW, Pagnani MJ, Keeley JR. A muscle-splitting approach to the ulnar collateral ligament of the elbow. Am J Sports Med. 1996; 24(5):575-580. doi:10.1177/036354659602400503.

28- Wilk KE, Thomas ZM, Arrigo CA, Campbell AM, Shahien A, Dugas JR. The Use of the Internal Brace to Repair the UCL Injury of the Elbow in Athletes. Int J Sports Phys Ther. 2022; 17(7):1208-1218. doi:10.26603/001c.39614.

29- Dugas JR, Walters BL, Beason DP, et al. Biomechanical comparison of ulnar collateral ligament repair with internal bracing versus modified Jobe reconstruction. Am J Sports Med. 2016; 44(3):735-741. doi:10.1177/0363546515618380.