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Physical Therapy Treatment in the Conservative Management of a Full-thickness Ulnar Collateral Ligament tear: A Case Report

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Abstract

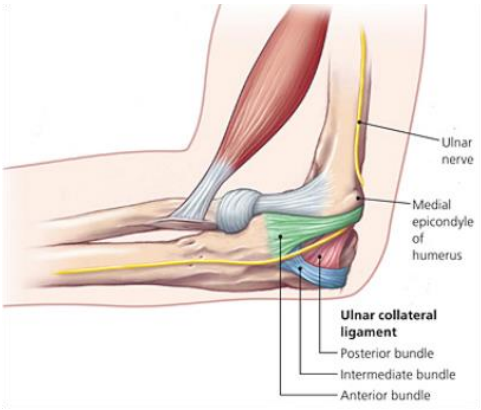
Background: Surgical reconstruction is the most common treatment for full-thickness Ulnar Collateral Ligament (UCL) tears of the elbow. However, the recovery process for a UCL reconstruction is generally 9-12 months. The purpose of this case study is to elucidate how conservative physical therapy treatment of a complete UCL tear can restore a level of athletic functionality to throwing athletes when healing time interferes with playing time. **Case Description:** The patient was a 20-year old female who sustained a full-thickness UCL tear of her right elbow. **Intervention:** Interventions included wrist flexor soft tissue mobilization, scapular strengthening, core strengthening, analysis of throwing mechanics and administration of a return to throwing program. **Outcomes:** Elbow ROM and scapular strength were evaluated. A DASH could have been performed and would have provided more insight into this patient's functional response to treatment. **Discussion:** Ulnar collateral ligament tears are on the rise among throwing athletes. Although UCL reconstruction has been reported to return patients back to sport at or near pre-injury performance, the associated recovery period invariably disrupts athletic activity for up to a year. If conservative physical therapy treatment became a more viable option for complete UCL tears long-term, throwing athletes could be provided an opportunity for amplified activity post-injury when surgery precludes participation for a prolonged period of time.

Background

Throwing athletes frequent physical therapy offices across the nation due to the high demands of their sports. Today in the United States, it is estimated that 25 million people have participated in softball or baseball at any level of competition within the past year, more than any other team sport in the nation.[8] As a result, upper extremity injuries, especially those of the shoulder and elbow are on the rise. In the last decade, a trend has developed towards earlier athletic participation with the increasing popularity of youth leagues, year-round sport-specific activity, and high-volume throwing included in training programs. Focus on technique and quality of movement takes a backseat to a high number of repetitions, which leads to an increased risk of injury. One of the injuries that has plagued throwing athletes of all ages for decades, and famously so, is the Ulnar Collateral Ligament (UCL) injury.

The upper extremity experiences significant forces during overhead throwing, especially at the elbow. The UCL is the main stabilizer to valgus force at the elbow. Separated into three bundles, the Anterior Oblique Ligament (AOL), the Posterior Oblique Ligament (POL), and the Transverse Ligament (Figure 1),[11] the UCL provides valgus restraint from 20-120 degrees of elbow flexion.[13] The Anterior Oblique Ligament is the main stabilizer to valgus stress, withstanding approximately 260 N of force or greater before failure. Collegiate athletes have been found to often surpass 300 N at the medial elbow, requiring the AOL to perpetually operate at or near its maximal level of force resistance during throwing.[13]

Figure 1



The 3 bundles of the UCL.

Ulnar Collateral Ligament injuries come in many forms, but none so well-known or career-disrupting as the full-thickness tear. One study involving analysis of throwing athletes in New York State gathered data on UCL reconstructive (UCLR) surgery from 2003 to 2014. This study found that UCLR surgeries increased 343% in 11 years, with the highest average incidence in 15 to 19-year olds.[12] UCL reconstruction, better known as Tommy John surgery, generally requires a return to sport recovery period of 9 to 12 months, with a tendency toward longer rehabilitation timelines for higher level athletes. One study found that the average return to play after UCL surgical reconstruction was 11.6 months.[2] A year-long rehabilitation period certainly disrupts athletic participation, and therefore begs an exploration of all available options, including conservative treatment, before resorting to surgical intervention.

Surgical intervention is the most common treatment recommendation when the UCL is fully torn. In a study that surveyed 159 orthopedic surgeons on their recommendations for 7 cases of athletes with different types of UCL injury, UCL reconstruction was the consensus for all of the examples with full-thickness tears.[10] Reconstruction of the UCL is the only way to restore a pre-injury level of resistance to valgus stress at the elbow. However, conservative physical therapy treatment can serve as an option to restore a level of functionality to throwing athletes in select situations, such as those athletes who don't have 9 to 12 months to recover from surgery and continue to participate in their chosen sport.

Little information is available regarding optimal physical therapy treatment for full-thickness UCL tears. Rettig, et. al. outlined a conservative 4-month rehabilitation protocol administered to 31 overhead throwing athletes with UCL insufficiency. This study reported that 42 percent of their subjects returned to play at pre-injury levels.[14] However, injury severity was not indicated among their subjects, making it unclear if their findings could be applicable to those with full-thickness tears. The purpose of this case study is to describe how conservative physical therapy care could serve as an option for restoring a level of functional throwing ability to athletes with complete UCL tears. A unique, multi-faceted conservative approach to treatment was implemented in a collegiate softball player nearing the end of her athletic career. Further, the factors influencing her decision to forgo UCLR and opt for physical therapy are discussed.

Case Description

History

The subject of this study was a 20-year old collegiate softball player in her senior year, who played primarily outfield for her team. This athlete had a history of medial elbow pain at the beginning of her junior softball season that had resolved with physical therapy treatment. However, at the end of the same season, she re-injured herself. This injury occurred while throwing a ball from the outfield during a game at her collegiate national tournament. She reported feeling a “pop” with immediate pain and subsequent mild swelling at her right medial elbow, which is her dominant upper extremity. Subsequently, she was unable to continue throwing, but continued to hit afterwards. She was evaluated by her athletic trainer, who advised her to wrap and apply ice to the elbow. She reported to physical therapy a week and a half later.

Examination and Evaluation

Upon physical therapy evaluation, she demonstrated medial elbow pain to palpation and with active end range of motion in both flexion and extension. She reported pain over her medial epicondyle and proximal common flexor group. She displayed no significant swelling to her medial elbow at that time and a negative Tinel’s sign over her ulnar nerve. She achieved full right elbow flexion to 150 degrees, but right elbow extension was limited to zero degrees versus hyperextension to five degrees on the left. She demonstrated full wrist range of motion in all planes bilaterally.

Her strength was tested at 5/5 in her right biceps, triceps, wrist flexors and wrist extensors bilaterally. Right shoulder external rotation and retraction were measured at 3+/5 versus 5/5 on the left, with 5/5 strength tested in all other motions. Importantly, she also demonstrated grade 2 laxity and pain with valgus testing to her right elbow. As a result, she was referred to an orthopedic surgeon for follow-up evaluation with concern of a UCL strain or tear.

Diagnosis and Prognosis

She was evaluated by an orthopedic surgeon, 30 days after her initial injury. MR imaging revealed a full-thickness, or significant partial-thickness, tear of the humeral insertion of the anterior bundle (AOL) of her Ulnar Collateral Ligament, with an associated grade 1 strain of her flexor digitorum superficialis muscle. The other muscles of the common flexor group, medial epicondyle of her humerus, posterior bundle of her UCL, and ulnar nerve were unaffected.

Her orthopedic surgeon offered three options. The first was to undergo Ulnar Collateral Ligament reconstruction immediately, which left her little time to return to full play by the season opener of her senior year, in approximately 6 months. The second option was to attempt a newer technique of UCL repair with an internal brace that might shorten her recovery time. However, this option gave no guarantee of a quicker timeline and was not a full reconstruction, which is the preferred surgical treatment for full UCL tears. It was also admittedly a newer technique and not well known to her evaluating orthopedic surgeon, thus would require the surgery to be performed at a different facility. Her third choice was conservative treatment with physical therapy, in the hopes that she could throw well enough by season-opener in January.

This patient was a utility player for her softball team, playing all over the infield and outfield, though her real talent was hitting. With one year of collegiate softball left, Tommy John surgery, with its long recovery period, precluded her ability to return to play in time for her last season. She expressed no interest in red-shirting to return for a fifth year of college to allow her time to recover from surgery and was not confident with the alternative surgical approach that may or may not result in a quicker recovery. Thus, she decided to take a conservative approach to her UCL injury and opted for physical therapy, with plans to return to play for her senior season starting in January.

Intervention

This patient's physical therapy treatment rationale was two-fold: to address the underlying causes of her UCL injury and restore her throwing ability to a functional level for softball participation. Therefore, the focus of PT intervention included restoration of full elbow ROM, scapular strengthening, core strengthening, neuromuscular re-education of her upper extremity and analysis with subsequent correction of throwing mechanics. Her treatment included bi-weekly treatment sessions throughout the summer and into the beginning of her school year. She then attended PT once a week, before starting a return to throwing program and transitioned to working with her athletic trainer at school with monthly PT visits.

Soft tissue massage, provided both manually and instrument-assisted (ASTYM®), was applied to the common flexor group to improve this patient's elbow extension ROM and promote blood flow for perpetuated healing of her flexor digitorum muscle strain. Occasional ulno-humeral mobilization and thoracic spine mobilization were also implemented as necessary, based on the patient's subjective complaints of elbow, shoulder, or spinal stiffness and joint restriction. The goal of joint mobilization was to restore normal mechanics of movement to the components of her upper extremity chain. With normal motion restored to each of these joints, an inordinate amount of strain would not be placed on any one joint within the chain, especially the elbow, and would allow for more effective strengthening and functional training once she was ready to return to throwing.

Upper extremity strengthening with an emphasis on scapular strengthening was initiated. Her strengthening regimen was implemented with focused application to her rotator cuff, especially her posterior chain, including scapular retractors, external rotators and lower trapezius. She was found to have deficits into scapular retraction and external rotation upon evaluation (3+/5). Weakness in these motions may have contributed to her UCL injury, in that upper extremity torque during throwing was not properly produced at the shoulder, which placed increased demands on the elbow, especially into the cocking phase of throwing. Therefore, strengthening was performed in conjunction with neuromuscular re-education of the muscles crossing each joint for improved coordination.

Wrist flexion and extension with dumbbells, scapular external rotation with Theraband, and prone Y's with sustained holds over a Swiss Ball were implemented in the initial 3 weeks of therapy. By week 4, a transition to more advanced posterior chain strengthening and neuro-muscular re-education took place, including archer rows at the cable column, use of the Body Blade, and scapular external rotation seated on a Swiss Ball in single-leg stance to concurrently incorporate core strengthening for a more functionally-based strengthening activity. External rotation weighted ball tosses against a wall were implemented at week 6 and lower trapezius wall slides with Theraband were incorporated by week 7.

Core strengthening was utilized throughout the plan of care to encompass the interdependent relationship between the hips, core and upper extremity during throwing. Core activities with a concurrent upper extremity component were chosen to promote smooth coordination of each segment in the chain and promote functionality. The patient started with planks on a Swiss Ball at week 6, started performing Dead Bugs at week 7, transitioning to planks in full push-up position on a Bosu ball with concurrent rhythmic stabilization at week 11. Cable column chops (in D1/D2 pattern with bilateral upper extremities) on Dyna Discs were added at 11 weeks, as well. These activities promoted core activation in conjunction with upper extremity activity, an important relationship to reinforce for throwing athletes to promote further injury prevention and proper throwing mechanics.

Return to throwing activities were initiated at week 8 with half-kneeling ball tosses against a rebounder, in a 90/90 starting position at the shoulder and elbow. She was progressed to full throws in half-kneeling with the rebounder at 9 weeks. Beginning at 10 weeks, she began light full throwing from about 15 feet with a baseball, transitioning to throwing with a baseball and softball from 25-30 feet at the end of week 10, with instructions to throw at 50% effort. In week 11, she was instructed to throw with 75% effort from 25-30 feet with a baseball and softball. Her throwing mechanics were analyzed during this activity and it was noted that her elbow was held anterior to the plane of her body by the late cocking phase of throwing, placing increased valgus stress at her elbow. She also demonstrated limited

lower extremity and hip motion while throwing. A return to throwing program[1] by Brotzman et. al. (Chart 1) was outlined for her at week 11, at which point throwing within PT sessions was discontinued, for continued focus on strengthening. She performed this protocol every two days initially, progressed to every other day after one month, then began daily throwing once she was able to complete step 5 pain-free.

Each treatment session included some component of the interventions and exercises outlined above. The patient would begin each session by warming up on the upper extremity ergometer for 5 minutes, followed by assessment of active elbow ROM and pain. Based on her subjective report of pain or stiffness, joint mobilization was sometimes implemented, based on the therapist's clinical judgement of its appropriateness. Soft tissue massage to her common flexor group was always provided at the beginning of each treatment session, whether she received joint mobilization or not. A combination of the outlined exercises would then take place, with throwing practice performed at the end of the treatment session, if it was implemented that day. Independent of PT treatment, this subject participated in softball practice at school, which included lower body weightlifting starting 8 weeks post-injury. She also began independently practicing left-handed throwing for further distances, such as from the outfield.

Return to Throwing Protocol

Steps	Number of Throws	Distance
Step 1	5 10 5	20 (warm-up) 30 20 (cool-down)
Step 2	5 5 10 5	30 (warm-up) 40 50 30 (cool-down)
Step 3	5 5 10 5	50 (warm-up) 60 70 50 (cool-down)
Step 4	5 5 10 5	60 (warm-up) 70 80 60 (cool-down)
Step 5	5 5 10 5	70 (warm-up) 90 100 80 (cool-down)
Step 6	5 5 5 5 5	80 (warm-up) 80-90 90-100 110-120 80 (cool-down)
Step 7	5 5 5 5 5	80 (warm-up) 80-90 90-100 110-120 80 (cool-down)

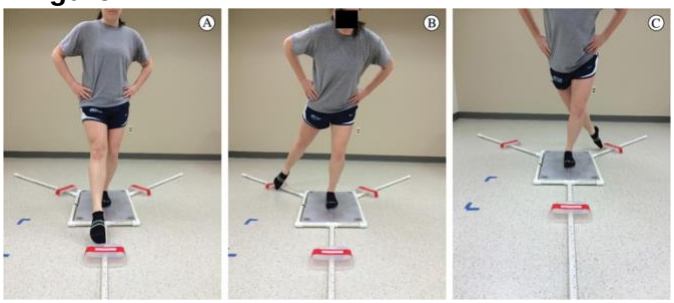
Chart 1. The return to throwing protocol initiated independently of PT sessions at 11 weeks post-injury.

Outcomes

The outcomes assessed in this case included ROM and strength. Upon initial evaluation, she was found to have strength deficits of 3+/5 in her scapular retractors and external rotators. When her progress was assessed at week 13, her right external rotation strength had increased to 4+/5 and her middle and lower trapezius were assessed at 4+/5 as well. Her right elbow ROM had increased from neutral to 2-3 degrees of hyperextension versus 5 degrees hyperextension on the left. She continued to demonstrate grade 2 laxity with valgus stress testing of the right elbow. Pain was not recorded via the Numeric Pain Rating Scale (NPRS) throughout her physical therapy treatment, but she was noted to be moderately tender to palpation over the right medial epicondyle near the UCL insertion site upon initial evaluation. She was also unable to throw or perform press activities with her right arm at that time.

At 6 months post-injury, this subject had made functional gains in right-handed throwing distance from the infield at 60-70 feet with decreased velocity compared to before her injury, but with minimal pain. By this time, she had also returned to completing full weightlifting workouts with her softball team with modified weights for upper body lifts. She also subjectively reported to have improved her left-handed functional strength and accuracy with throwing from the outfield. Based on her throwing

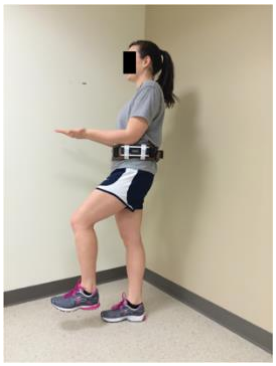
Figure 2



ability at this time, she developed a plan with her coaches for her to play designated hitter, as well as back-up for the first-base, second-base, and outfield positions. She demonstrated 5/5 bilateral shoulder, elbow, and wrist strength, as well as full elbow ROM.

Additional standardized outcome measures would have been valuable to assess that could be included in the future. For example, the Disabilities of the Arm and Hand (DASH) would have provided valuable data on this patient's functional deficits post-injury, and her functional progression throughout her physical therapy plan of care. The DASH has a reported 82% sensitivity and 74% specificity, with a MCID of 10.8 points.[5] Based on her deficits at the time of PT evaluation, an estimate of her initial DASH score is 23.3 points. After 13 weeks of intervention, her DASH score would likely have been 11.7 points. With this estimated change in DASH scores over time, she achieved an 11.6-point difference over the 13 weeks of intervention represented. She presented with less pain and was able to weightlift with her softball team regularly without significant pain, which were the factors behind the estimation of her second DASH score. Her upper extremity functionality could have been assessed again on the DASH before her season opener, 7 months after her initial injury.

Figure 3



The Sports Module of the DASH would also have provided an appropriate objective measure of the subject's functional progress athletically, as opposed to her subjective reports of disability and pain. Using the Sports Module, her estimated initial score was 75 points, considering her difficulty throwing, pain with active elbow extension at end-range, and disruption of athletic participation. After 13 weeks, her Sports Module estimated score improved to 50 points, as she was able to throw with less pain, weightlift with her team, and had begun a return to throwing program. The DASH was not the only outcome measure that could have been included to more accurately assess this athlete's improvement over time.

Research indicates that athletes with decreased balance in the stance leg while throwing have a higher rate of UCL injury.[6] Thus, another functional measurement that could have been assessed is the Y balance test (Figure 2).[15] A study by Garrison, et. al. suggested the Y balance test can capture the functional strength and neuromuscular control of the stance limb during throwing. It has been proposed that the torque generated by the upper extremity during throwing originates from the lower extremities. Inadequate balance could represent a lower extremity deficit that alters throwing mechanics and sets overhead throwing athletes up for injury to the upper extremity. In Garrison's study, a composite score of less than 94% existed in both the stance and lead legs of those players with UCL injuries.[6] While a lack of balance and UCL injury isn't necessarily a causal relationship, imbalance could represent a myriad of deficits that disrupts the interdependence between the upper extremities and lower extremities needed for proper throwing mechanics. These deficits could include a lack of ROM or strength at the hip, knee, or ankle, as well as decreased core stability. A lack of lower extremity neuromuscular control, with improperly synchronized activation patterns, could also disrupt coordination of force transmission from the legs to the arms in throwing.

Another study focused primarily on the lumbopelvic control of throwing athletes and its association to upper extremity injury. This study found that poor lumbopelvic control was associated with increased risk of missing playing time due to injury.[3] Lumbopelvic control was measured in this study by a Single Leg Raise Test (Figure 3),[15] in which the subject stands with feet shoulder-width apart, lifts one leg approximately 3 inches off the ground (possibly over a 2x4 piece of wood or phone book), holds that position for 2 seconds then lowers the leg back down to the ground slowly. An iPod-based tilt sensor, with a validity of 89%, was used to measure pelvic tilt during the activity, with

increased tilt indicating decreased lumbopelvic control.[3] This method could have been another possible evaluative measure to indicate if lumbopelvic control was a deficit in this case study subject.

Discussion

When the UCL of the elbow is torn completely, or partially torn to a significant degree, surgical intervention is the only treatment that will truly restore soft tissue integrity. The purpose of this case study was not to propose physical therapy as a replacement of UCLR for complete tears as the recommended intervention, but rather as a viable option in certain situations. This case study provides a brief literature review of possible physical therapy treatment techniques for full-thickness UCL tears, a framework for future studies to assess whether conservative physical therapy treatment can provide an acceptable level of functionality in overhead throwing athletes, and offers suggestions to improve future treatment plans. The interventions implemented in this patient's physical therapy plan of care were meant to address the possible causes of injury to reduce valgus stress at the elbow, as well as improve throwing technique for return to play.

Throwing mechanics are often cited as the culprit of upper extremity injuries in throwing athletes. However, many factors play a role in predisposing these athletes to injury, including decreased elbow ROM, decreased scapular strength, improper neuromuscular coordination between adjacent upper extremity joints, and inadequate core strength. These were some of the areas of focus for the interventions included in this case study. In this way, the subject's throwing arm and elbow were not only provided the strength and stability needed to throw with a compromised UCL, but also improve the quality of her throwing performance overall. Optimized throwing mechanics would decrease the shear force generated at the elbow.[13] By providing her with an improved set of tools necessary for throwing, she would be able to execute the return to throwing program with greater ease and success.

Scapular and rotator cuff strengthening was initiated not only due to the fact that the subject in question demonstrated deficits in her upper extremity posterior chain, but also in response to research indicating that imbalances of rotational strength at the shoulder places one at increased risk of shoulder and elbow injury.[7] By addressing these deficits through strengthening, she was working to, in essence, re-distribute forces experienced at the injured elbow to the shoulder and maximize kinetic chain mechanics. Maximal elbow valgus forces are experienced in the late cocking phase of throwing, which is the phase in which the subscapularis is found to have the greatest activation, eccentrically, on EMG analysis.[9,16] Therefore, rotator cuff strengthening was a large focus of this subject's exercise regimen.

Components of the Thrower's Ten exercise set, the standard strengthening regimen prescribed to those with UCL injuries,[13] were implemented in this subject's case. However, in an effort to individualize and functionalize this program, many of the standard upper extremity exercises were combined with other exercises that focused on kinetic chain optimization. This focus on neuromuscular control and activation patterns that reflect functional throwing mechanics allowed this subject to create neural connections she could theoretically utilize while throwing. Exercises such as scapular external rotation seated on a Swiss Ball in single-leg stance and prone T's and Y's over a Swiss Ball, as well as cable column chops on Dyna Discs in D1/D2 patterns are examples of this. These exercises combine scapular activation with concomitant core contraction.

Core strengthening, especially as it pertains to pelvic control, was a major focus of this patient's physical therapy plan of care. Research indicates that impaired lumbopelvic core control in the throwing athlete can lead to an increased risk of upper extremity injury, with one study indicating the risk of missing greater than 30 days of athletic participation due to injury increases as lumbopelvic control decreases.[3] Therefore, isolated and integrated core strengthening was implemented. The aforementioned study found that the baseball players in their cohort that demonstrated an anterior pelvic tilt with a standing Single Leg Raise test were classified into the "poor lumbopelvic control group." Increased contralateral trunk tilt has been associated with increased valgus forces generated at the elbow.[3] Of note, the subject of the present study reported difficulty with pelvic control during the Dead Bug exercise. By addressing this deficit, she was working to decrease the valgus forces she experiences during throwing, thus decreasing the functional demand on her already compromised UCL.

While this case study presents an innovative treatment approach to complete UCL tear management, there exist some interventions that weren't employed into the plan of care with good evidence to support their implementation. These treatments included shoulder range of motion, balance, and lower extremity strengthening. One study found that decreased total range of motion (TRM) at the shoulder of, on average, 5.57 degrees existed in those who had sustained a UCL injury.[6] In the same study, balance was measured via the Y balance test. UCL-injured athletes achieved a composite score of less than 94%, which is a score found to be associated with an increased risk of lower extremity injury in unrelated research. These findings were extrapolated to UCL-injured subjects.[3] Additionally, lower extremity strength has been associated with decreased upper extremity stress with throwing. Research indicates that a 20% decrease in kinetic energy created at the hip and trunk during throwing necessitates a 34% increase in shoulder rotational velocity, which translates down the upper extremity kinetic chain.[13] While focused lower extremity strengthening was not implemented into this patient's plan of care, she began lower body weightlifting at school as part of her softball training at week 8. Therefore, the limited time this patient spent in PT was focused on her upper extremity deficits.

Throwing mechanics were grossly observed and corrected in treatment sessions, but could have been more closely analyzed with motion capture software, such as Dartfish or Ubersense. Employing this technology would have more readily enabled identification of the phases of throwing that needed the most attention. Additionally, the phases that needed rectification could have been more easily demonstrated to the patient. Early implementation of correction to throwing mechanics can greatly benefit the patient in their recovery process, providing the patient more time to create the neuromuscular connections necessary to solidify correct mechanics in their throwing motor programs. As a result, the benefits gained from the intervention implemented to address her ROM, strength, neuromuscular control, and kinetic chain optimization could be utilized by being implemented functionally, preventing future re-injury.

Physical therapy treatment is usually recommended for 3 months after full UCL tear to prepare athletes for surgery.[2] In the present study, a physical therapy plan of care was, instead, executed to restore a level of functionality in a throwing athlete when healing time disrupted playing time. UCLR has been found to generate a return to play rate of 95% for collegiate athletes, with an average longevity of play after surgery of 3.6 years.[2] However, some athletes nearing the end of their career may not have the time to recover from such a surgery, or reap the benefits of this longevity of play.

Since UCL injuries overall are on the rise, these injuries occurring later in an athlete's career could become a more prevalent problem. Therefore, time as a significant factor in surgical decision-making and approaches that reduce the time required for healing and rehabilitation are important elements for recovery. Since baseball and softball seasons last anywhere from 3-6 months, physical therapy as an option for return to at least an attenuated level of play could become a standard UCL tear treatment, especially when surgical healing time limits an athlete's participation in their sport for the remainder of their career. While this case study examines conservative treatment in a collegiate softball player, it is of note that UCL injuries are not unique to baseball or softball, occurring in other sports such as tennis, football, volleyball, wrestling, gymnastics, water polo, and javelin throwing.[4]

Conclusion

This case study demonstrates an example of an athlete with a complete UCL tear who opted to forgo the standard treatment, UCLR, in favor of conservative physical therapy treatment. Consequently, a plan of care was developed and implemented to allow her to return to play within 7 months for her final competitive season of softball. This patient's situation is not a unique scenario in the athletic world, and is likely to be a more common scenario with the high participation rate of throwing sports, such as baseball and softball, and rising incidence of UCL tears. By addressing the predisposing factors to UCL injury and maintaining a functional approach to PT treatment, it may be possible to allow those with UCL tears to return to play at an acceptable level to finish a season. In this way, physical therapy can give what many athletes thought they lost as a result of their injury: a fulfilling end to an athletic career.

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