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Evolving Physical Therapy Treatment in Arm Pain of an Adolescent Throwing Athlete: A traditional Case Report

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Background: It is becoming increasingly common for throwing athletes to experience upper extremity injuries, which can affect sport performance. There is a wide range of possible causes of upper extremity pain, and it is important to perform a thorough evaluation in order to accurately assess the full scope of the injury throughout the entire upper extremity kinetic chain. Treatment interventions may need to be altered throughout the plan of care in order to provide the most specific, patient-centered rehabilitation enabling successful return to sport if possible. The purpose of this case report is to describe the continuous assessment and evolving interventions provided to an adolescent throwing athlete with complaints of unilateral arm pain. **Case Description:** The patient in this report is an adolescent baseball pitcher with complaints of increased dominant arm pain over the course of the season. After a throwing assessment and additional information was discovered, interventions were shifted to provide a more specific, patient-centered rehabilitation program. **Outcome Measures:** The patient was examined and treated for 14 visits over the course of 6 weeks. Primary outcomes measured in this case were verbal pain ratings, functional limitations, and successful return to sport. More objective measurements could have been performed, such as hand-held dynamometry, QuickDash, and the SPADI, however, these were not performed secondary to a ceiling effect of the patient's functional abilities and the symptoms only presenting following pitching. **Discussion**: Upper extremity injuries are common amongst adolescent throwing athletes. It is important to evaluate the entire kinetic chain as well as continuously assess the patient's response to treatment and the need to shift interventions in order to provide a patient-centered rehabilitation program for a successful return to sport.

Keywords: Elbow; shoulder; musculoskeletal pain; cervical spine; orthopedics; physical therapy; rehabilitation; throwing athlete; adolescent athlete

Introduction

Adolescent throwing athletes are a challenging patient population to treat and are at risk of developing a wide variety of injuries. The pitching motion, in particular, places great stress on many tissues surrounding the shoulder and elbow joints, requiring adaptations such as excessive external rotation in order to produce angular velocities at the glenohumeral joint up to 7,000 degrees/second[2]. The incidence of overuse injuries in the high school baseball population is on the rise, and 28% of youth pitchers report a history of elbow pain[2, 18]. Young athletes are at additional risk of pathology due to the high stresses repeatedly produced on the immature skeleton. Some of the most common injuries that can occur with throwing athletes include ligament sprains or ruptures, muscle strains, tendinitis, scapular dyskinesia, glenohumeral internal rotation deficit (GIRD), nerve trauma, labral lesions, and more. Additionally, it is important to note that a patient might have multiple pathologies coexist simultaneously and contribute to increased pain and impair the ability to return to sport successfully[2].

During the subjective history, there are several established modifiable and non-modifiable risk factors for developing overuse injuries the clinician should be aware of. Modifiable risk factors include pitching mechanics, frequency and volume of pitches, shoulder rotational range of motion (ROM), impaired posterior shoulder capsule flexibility, rotator cuff weakness and imbalance, and poor neuromuscular control of scapular, core, and lower extremity musculature[18]. Non-modifiable risk factors for upper extremity injuries include age, height, coaching habits, and pitching performance satisfaction[18]. Other factors that increase a player's risk for serious upper extremity injuries include playing both catcher and pitcher, playing on multiple teams throughout the year, pitching more than 80 pitches per game, pitching at least 8 months of the year, increased frequency of the slider pitch type, pitching with arm fatigue, and pitching with improper mechanics[18].

There is an extensive list of possible etiologies of arm pain in the throwing athlete, and it is important to investigate for potential cervical spine or brachial plexus involvement during the initial evaluation[9]. Additionally, with this population, it is imperative to perform a thorough biomechanical assessment of the patient and the entire kinetic chain during the pitching motion. The pitching sequence is typically divided into six separate phases, which include windup, stride, arm cocking, acceleration, deceleration, and follow through[12]. If a flaw is detected in any of the individual phases of throwing, it can significantly impact the biomechanics of the entire motion and lead to pain, an impaired ability to pitch, and ultimately tissue damage. Most throwing athletes with upper extremity injuries respond well to conservative management, which typically includes rest from throwing, ice and anti-inflammatory interventions, range of motion, and stretching to increase tissue flexibility[9, 12,18]. Following the initial evaluation, it is crucial for the physical therapist to continually reassess the patient's response to treatment and throwing tolerance throughout the plan of care. Thus, this case report presents an example of modifying treatment throughout an episode of care for an adolescent baseball pitcher with complaints of increased dominant arm pain over the course of the season. Care was successfully adjusted based on results from a throwing assessment and the addition of information that was not available initially, producing a more specific, patient-centered rehabilitation program which enabled the patient to experience improved pain levels, tissue flexibility, strength, and symptom relief as well as return to throwing after 6 weeks.

Case Description

A 17-year old male presented to physical therapy with a diagnosis from his primary care physician of right biceps tendinitis. He was actively participating on a local high school baseball team and had complaints of right elbow pain with throwing that was affecting his accuracy and velocity. Although he had been throwing for a few months prior to the start of the season, the pain started after his first day of throwing 50 pitches in one game. He reported this pain initially began about a year ago during the previous baseball season, but it had improved after baseball season ended. He reported his current pain was 2/10, but the pain could become so severe that he would be unable to tie his own

shoes. He described the pain as dull, achy, and throbbing. Aggravating factors included throwing, sleeping on his right side, and lifting weights. Easing factors included not pitching. He added that his father and baseball coach were very aware of his symptoms and were involved in resolving his recurrent pain. The patient's father had taken videos of his pitching form and purchased a brace to help correct the angle of his elbow during the pitching motion prior to ball release. At the initiation of physical therapy, the patient was resting his arm by not participating in throwing during baseball. This patient had a past medical history significant for anxiety and a concussion three years earlier.

During the initial evaluation, observations, palpation, joint play, range of motion, as well as strength assessments were completed in addition to specific special tests that would be useful for diagnostic purposes, and identifying pathologies that could be contributing to his symptoms. The patient presented with a forward head, rounded shoulders posture. Upon palpation, the patient reported normal sensation throughout both upper extremities, but tenderness over the distal right biceps tendon, right medial elbow joint, and right wrist flexor group toward the proximal attachment on the medial epicondyle. There was no tenderness over the triceps tendon. The joint-play assessment revealed limited posterior glide of the glenohumeral joint with increased laxity of the anterior joint capsule. This patient exhibited fairly normal motion throughout his cervical spine, shoulders, and elbows, as described in Table 1. However, he demonstrated excessive shoulder external rotation coupled with limited shoulder internal rotation, which is a common finding among baseball pitchers[2, 5]. A strength assessment was performed, with the results summarized in Table 2. He maintained full strength of both upper extremities, except for mild weakness of 4+/5 with "pulling" noted with right elbow extension. The special tests performed during the initial evaluation are reported in Table 3 and included the elbow valgus test, which assessed the integrity of the ulnar collateral ligament, Mill's and Cozen's tests, which evaluated for lateral epicondylitis, and a first rib assessment, which should indicate the presence of an elevated first rib.

Table 1: ROM Assessment	
Cervical spine	Within normal limits
Shoulder flexion	Within normal limits
Shoulder ER	T4 bilaterally
Shoulder IR	T9 bilaterally
Elbow flexion	Within normal limits
Elbow extension	Within normal limits
* No complaints of pain during ROM assessment	

Table 2: Strength Assessment		
Shoulder flexion	5/5 bilaterally	
Shoulder abduction	5/5 bilaterally	
Elbow flexion	5/5 bilaterally	
Elbow extension	Right- 4+/5 with "pulling"	Left- 5/5
Wrist flexion	5/5 bilaterally	
Wrist extension	5/5 bilaterally	
Supination	Right- 5/5	
Pronation	Right- 5/5	

Table 3: Special Tests	
Elbow Valgus Test	Negative and nonpainful
Mill's Test	Positive
Cozen's Test	Positive
First rib assessment	Not elevated

Clinical Impression #1

The patient in this case report presented with a medical diagnosis of right biceps tendonitis that was aggravated by pitching. It was important to first rule out any ulnar collateral ligament damage by performing a valgus stress test, as this is a common injury for baseball pitchers. Even though the ulnar collateral ligament appeared to be healthy, the patient reported pain to palpation surrounding the medial elbow joint including the common flexor group, pronator teres, and distal biceps tendon. However, given the patient's positive Mill's and Cozen's Tests, there appeared to be some irritation around the lateral epicondyle as well. Given the information gathered from the subjective history and the physical examination, this appeared to be a fairly typical over-use injury of the biceps and elbow

flexors of a very active, growing adolescent throwing athlete. A patient with this type of injury would typically benefit from initial treatments targeted towards improving eccentric strength[1, 14], extensibility through the biceps and anterior forearm[1, 5], deep friction massage (DFM) over the tendons crossing the elbow joint, thought to increase blood flow and reduction of cross-linking scar tissue[10], physical modalities in the acute phase to increase the rate of healing[13], and rest from pitching[5, 9, 12], as this is the most aggravating factor. Although these evidence-based interventions are a great starting point, it is important to continually reassess the patient's response to treatment and be prepared to alter interventions if necessary in order to provide the most specific, patient-centered rehabilitation and successful return to sport possible. The goals for this patient included decreased resting pain to 0/10, improved right triceps strength to 5/5, and successful return to sport.

Interventions

The initial treatment interventions for this patient involved heavy emphasis on a form of instrument-assisted soft tissue mobilization (IASTM), called sound-assisted soft tissue mobilization (SASTM), DFM, stretching, eccentric strengthening, and iontophoresis. A summary of the initial treatments provided over the first nine sessions of physical therapy is outlined in Table 4, below. A literature review of the evidence-based treatments performed with this patient is provided in the subsequent paragraphs.

Table 4: Initial Interventions

Visit #	Intervention	Outcomes
1	• SASTM to right wrist flexor group, distal biceps, medial elbow • DFM over tendons crossing medial elbow • Stretching of wrist and elbow flexors • Iontophoresis with 80mA*min dosage at 3.5 intensity • Initiated HEP with elbow and wrist eccentric exercises	• Patient was sensitive to palpation and manual therapy • Able to throw 20 times with no pain
2-5	• Continued SASTM, DFM, stretching, iontophoresis • Progressed eccentric exercises to include pronation/supination • Progressed to Theraband diagonals, rotator cuff and serratus anterior exercises • Body Blade	• Patient began playing second base/shortstop • Able to throw 15 pitches, which caused soreness
6-9	• SASTM expanded to distal pectoral and entire length of biceps • Initiated stretching of bilateral pectoralis major and minor, Sleeper Stretch • Posterior and inferior humeral glides • Progressed to scapular and core stabilization exercise plan	• Increased vague complaints of shoulder pain • AC Shear test, Speed's test, Yergason's: negative • Scapular dyskinesia noted

To best improve the extensibility of the biceps and forearm musculature, stretching and SASTM were heavily utilized throughout the plan of care. IASTM is becoming more popular in the field of sports medicine, and is thought to decrease the rehabilitation time for return to sport[11]. The proposed mechanism of IASTM facilitates the synthesis and realignment of collagen fibers, and improving the blood and oxygen supply within the injured soft tissue[11]. IASTM is also thought to reduce pain levels and break up scar tissue and adhesions that have already formed within the tissues[11]. By promoting

better alignment and decreasing the number of adhesions, the patient should be able to see noticeable improvements in tissue flexibility and extensibility more quickly than soft tissue mobilization performed by hand[11]. Astym and Gua sha are other types of IASTM, similar to the SASTM used in this case report. There is research to suggest Astym is an effective treatment option for patients with tendinopathy surrounding the elbow[17]. There is also research to support the use of Gua sha for patients with neck pain[4], and impaired tissue flexibility[3]. Additionally, Gua sha contributed to pain relief and increased mobility in elderly patients with chronic low back pain, potentially promoting an anti-inflammatory effect[19].

Because the patient came into the physical therapy clinic with a diagnosis of tendinitis, he reported tenderness to palpation along the distal biceps tendon and proximal wrist flexor group, and had positive Mill's and Cozen's tests, it was important to incorporate treatment for tendinopathy into his plan of care. In the past, inflammation was thought to be the root cause of tendinopathy. However, over the past decade there has been increased histopathological evidence that supports tendinopathy to be caused more by a failed healing response[15]. Additionally, research suggests that 50% of tendinopathy injuries are due to overuse[15], which certainly needs to be taken into consideration in the rehabilitation of a baseball pitcher. The patient in this case report was a regular weight lifter and participated in four varsity sports with very little time to rest in between seasons. This information, along with the evidence which shows repetitive loading associated with athletic activity leads to increased tendinopathy[15], suggested that this patient might suffer from tendinopathy surrounding his elbow joint, which is placed under such high stress during baseball season. The current evidence for conservative management of tendinopathy favors treatments focused on rest, throwing mechanics modification, taping, cryotherapy, and nonsteroidal anti-inflammatory drugs (NSAIDs)[15]. Additionally, addressing soft tissue flexibility of the structures surrounding the tendon could help to improve symptoms in the acute stages of tendon pain[15].

Furthermore, there is evidence to support that eccentric strengthening, stretching, soft tissue mobilization, DFM, and iontophoresis can help treat tendinopathy[1, 10]. The patient in this case report received many of these first-line treatments during the initial period of his plan of care, which led to some improvement, but did not resolve his symptoms completely. Rather, the symptoms he was experiencing seemed to become more vague and change locations and intensity. For example, he initially presented with medial elbow pain, but the pain soon crept up the arm into the anterior shoulder, then into the lateral shoulder region. Interestingly, his pain and secondary symptoms could only be reproduced with pitching, not with palpation or other forms of upper extremity exercises performed in the clinic. Although these interventions have become staple treatments for tendinopathy, tendon injuries remain a difficult diagnosis to treat for many physical therapists. This may be in part secondary to the characteristic fibroblastic response to injury, which leads to scar tissue formation in place of the collagen and other, more flexible connective tissue that would make up the tendon prior to injury[14].

Progress Examination

After the first 9 physical therapy sessions over a 4-week time period, the patient demonstrated improved arm flexibility, pain levels, and other subjective improvements when not pitching. However, his arm remained highly irritable whenever the patient attempted to pitch. Additionally, the pain he had been experiencing appeared to be changing; it was no longer in his elbow, but rather more proximal around his glenohumeral joint. Interestingly, though, the complaints became more vague, and the pain seemed to originate inconsistently from the anterior and lateral shoulder regions. The patient was improving in his arm flexibility and able to tolerate an increasingly challenging scapular and core stabilization program. However, the symptoms that occurred following pitching could not be reproduced during physical therapy visits. Due to these persistent impairments, additional testing was performed, including a throwing assessment, Roos test, first rib assessment, and neural tension testing.

Following the pitching assessment, the patient reported symptoms that had not been identified during the subjective history. The patient reported pain radiating down his entire arm, his hand began shaking, and he complained of decreased grip strength. Upon further questioning, the patient announced a history of right-sided neck pain, frequent and intense headaches, and periodic trips to the chiropractor for spinal adjustments. At this point, further testing was done to assess for cervical spine, peripheral nerve involvement, or possible thoracic outlet syndrome. Additional testing was significant for positive median, radial, and ulnar neural tension tests as well as an elevated first rib on the right, although this was reported as negative during the initial evaluation. While it would have been ideal for the patient to rest during the acute injury phase, especially since similar symptoms began during the previous baseball season, the patient returned to playing second base prior to the third physical therapy visit without discussing the possible repercussions of this activity.

Interventions

Following the throwing assessment on visit 10, many of the treatment interventions were redirected to more proximal potential sources of the pain and secondary symptoms. Stretching of the anterior chest continued but was expanded to areas such as upper trapezius, cervical paraspinals, and scalenes. Additionally, SASTM continued, but focused more on the upper trapezius and distal pectoral regions. The patient's exercise program following a scapular and core stabilization plan was progressed, and first rib mobilizations were added to the plan of care. The patient was also instructed to perform neural mobilization, a technique that helps restore the dynamic relationship between the nerve axon within its fibrous sheath[7, 20], for median, radial, and ulnar nerves as part of his home exercise program. A summary of the interventions provided from visits 10 through 14 are outlined in Table 5, below.

Table 5: Interventions

Visit #	Interventions	Outcomes
10	• Throwing assessment performed • Attempted to continue with scapular stabilization exercises but unable to perform side-lying external rotation with 4 pounds x 1 rep	• Patient threw 30 pitches in game resulting in pain through entire arm, hand shaking, decreased grip strength • Pt reports history of right-sided neck pain, frequent headaches, and periodic trips to chiropractor
11-12	• Continued SASTM • Continued SCM, scalene, pectoral stretches • Continued scapular and core stabilization exercises • Manual therapy to upper trap, cervical paraspinals • First rib mobilization • Median, radial, and ulnar nerve mobilization added to HEP	• Roos test: negative • First rib elevated R>L • Positive median, radial, ulnar neural tension • Suspected thoracic outlet involvement • Baseball season ended
13-14	• Continued SASTM • Glenohumeral posterior glides • Manual stretching into internal rotation	• Patient ceased pitching • Symptoms improved • Patient followed up with doctor who recommended discontinue PT

	• Continued scapular and core stabilization exercises • First rib mobilization	

Clinical Impression #2

The additional information regarding his history of right-sided neck pain, headaches, pain radiating down his entire arm, and decreased grip strength suggested this patient had a more proximal source of his impairments. Even though there may be multiple signs during the examination that point to a seemingly obvious diagnosis, it is imperative to perform a thorough subjective history and initial evaluation to rule out potential concomitant issues that may play a role in the overall limitations of the patient. Additionally, when working with a specialized patient population such as a throwing athlete, it is important to perform a proper throwing assessment at some point during the plan of care. The timing of the throwing assessment, however, may depend on the specific patient. If throwing is a highly aggravating activity, it may be best to avoid aggravating the tissues further and provide first-line interventions prior to the throwing assessment. However, there may also be times when the throwing assessment would be best performed at the beginning of the plan of care in order to completely assess what portion of the pitching sequence appears to be the most aggravating. Even though this patient reported that his father and his baseball coach were recording his throwing motion and had purchased a brace to correct his mechanics, there may have been a key finding during the pitching sequence that the coach or parent was not able to identify. Additionally, if the coach or parent was able to identify a flaw in the mechanics, it is possible that a physical therapist would help to explain how pitching mechanics influence the different portions of the kinetic chain and potentially lead to altered biomechanics or injury. This case report supports the approach of assessing the entire kinetic chain in a proximal to distal fashion, even when initial symptoms appear distally, such as the elbow.

Outcomes

After 14 visits, the patient was no longer having upper extremity pain or other symptoms, and subjectively reported 80% improvement since the beginning of physical therapy. Advancements in arm flexibility, strength, and endurance were also noted subjectively and anecdotally. However, the timing of the last few weeks of rehabilitation also coincided with the end of his baseball season. Results drastically improved after the conclusion of the season when he finally sustained a true rest from throwing. Unfortunately, the patient returned for a follow-up visit with his physician, and this marked an abrupt end of his physical therapy plan of care. No final measurements could be taken to help quantify the improvements he made over the course of fourteen visits. The patient met his goals of being independent with his home exercise program and decreased resting pain to 0/10. Since the patient began his episode of care with resting pain of 2/10, his pain had improved by more than the minimal clinically important difference[16]. He partially met his goal of successful return to sport, as he pitched in the last few games of the season, but his return may have been premature as he still reported significant symptoms after pitching in his last game. Again, due to his abrupt end of physical therapy, final strength testing was not performed to assess for improved triceps strength.

One limitation of this case report is a heavy reliance on subjective reports of improvement and results of special tests, and a lack of regular objective measurements to quantify changes over time. For example, grip strength is an easy, quantitative metric that can be used for patients with upper extremity pathology, and can play an important role in the ability to pitch effectively[18]. The QuickDASH outcome measure including the Sport Module would have also been a helpful objective measure to gauge progress with this patient throughout the plan of care. The QuickDash has an established sensitivity of 79% and specificity of 75%[8]. Another objective measure that could have been utilized during this case report is the Shoulder Pain and Disability Index (SPADI), which is a self-report questionnaire to assess the patient's perceived shoulder pain and disability during activities of daily

living[6]. The SPADI has an established minimal important difference of 2, and a minimal clinically important difference of 10 points[6]. Although it may have been beneficial to obtain additional objective data, it is possible that these questionnaires would have provided minimal significant information secondary to a ceiling effect of the patient's functional abilities and the symptoms which only presented following pitching.

Discussion

The purpose of this case report was to describe the continuous assessment and evolving interventions provided to an adolescent throwing athlete with complaints of unilateral arm pain. Adolescent throwing athletes are a challenging patient population to treat and are at risk of developing a wide range of injuries. These unique athletes undergo necessary tissue adaptations that occur at multiple joints, including excessive external rotation and limited internal rotation at the glenohumeral joint, and they also experience the culmination of repetitive stresses placed on the immature skeleton at vulnerable locations throughout the upper extremity. Because there is an extensive list of possible pathologies in the throwing athlete, it is even more important to perform a thorough initial evaluation, and regular re-evaluations throughout the plan of care.

Doctor James Andrews, a world-renowned orthopedic surgeon for many high-profile baseball players, believes a detailed subjective history is just as important, if not more so, than the physical examination[2]. During the initial evaluation in this case, the patient was questioned about his typical warm-up routine, history of pitching throughout the year, pitching mechanics, as well as aggravating and easing factors, which provided important information that helped guide his plan of care. However, this thorough history was unable to initially identify additional symptoms that were later revealed, suggesting cervical spine or peripheral nerve involvement.

Initial treatment was focused on SASTM, DFM, stretching, eccentric strengthening, and physical modalities. Much of the initial plan of care was shifted following the live throwing assessment that was performed during visit 10 to focus on a more proximal source of the pain and throwing impairments.

Adolescent throwing athletes are a challenging patient population to treat for many reasons. One reason this population can be challenging is the vital need to balance rest with a patient's high motivation to return to sport. Any high performance athlete needs to be able to balance work and rest, but the equilibrium changes after an injury. Although the patient took some time off from baseball after the previous season and began a throwing regimen well before this baseball season officially started, the injuries sustained during the previous season resurfaced shortly after the season began. The patient took a small amount of time off during the beginning of the season, but returned to practice and played infield after just two sessions of physical therapy. This case report strengthens the notion that a rest period during an acute, recurring injury may have been beneficial to allow the damaged tissues more time to heal and prevent further damage from occurring. However, it is important to note a rest period does not mean immobilization of the affected arm. Rather, an active rest focused on stretching, strengthening, and supporting tissue healing may lead to more rapid rehabilitation and allow the patient to successfully return to sport more quickly.

This case provides an example of an adolescent throwing athlete who presented to physical therapy with unilateral arm pain, and the evolving assessment and treatments necessary in order to provide a specific, patient-centered rehabilitation program. Although there is research regarding rehabilitation programs for overhead athletes, there is little research to support the validity and reliability of special tests that were heavily utilized in this case, such as the first rib assessment, which initially was scored as negative, but was later found to be a potential contributing factor to his upper extremity condition. Areas for further research could also include better off-season work out programs to help prepare the arm for the upcoming season while also preventing over-use injuries in the adolescent, throwing population.

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