Case Reports

Clinical Diagnosis of Scapular Dyskinesis in a Youth Softball Pitcher: A Case Report

Connor Skoumal[a], Matt Dewald

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Introduction

Effective rehabilitation strategies for upper extremity injuries in softball pitchers are scarce in current literature, especially among youth athletes. Additionally, there continues to be ambiguity regarding the interpretation and clinical practicality when treating an overhead athlete with scapular dyskinesis. The purpose of this case report is to highlight the examination and treatment of a youth softball pitcher referred to physical therapy with the diagnosis of scapular dyskinesis.

Case Description

This case report presents data and outcomes for a 14-year-old female who experienced chronic right shoulder discomfort related to performing the windmill softball pitch (WSP). The subject was clinically diagnosed with scapular dyskinesis by her referring physician and demonstrated abnormal scapular movement when elevating and lowering her upper extremity. Internal and external rotator isokinetic strength testing and the Athletic Shoulder Test (ASH) were used as primary objective measures. Both were performed six days after the initial evaluation and again six weeks later. Initial testing demonstrated decreased peak torque and total work. Initial treatment involved periscapular and shoulder strengthening with progression to overhead loading. Later rehabilitation strategies focused on neuromuscular control, functional training, and sport-specific activities.

Outcomes

The subject initially demonstrated improved peak torque and total work of the shoulder with isokinetic strength testing but continued to have symptoms with pitching, even though the Scapular Dyskinesis Test had become negative. After changing the focus to neuromuscular and functional training the subject had fewer symptoms and became comfortable with self-management.

Discussion

This case matches previous research that endorses scapular dyskinesis being a normal finding in overhead athletes with and without shoulder pain. Neuromuscular control and functional training after a period of scapular strengthening were beneficial in improving symptoms in this athlete.

Level of Evidence

5

a Corresponding author:
Connor Skoumal, PT, DPT
Email: Connorskoumal@gmail.com

INTRODUCTION

There is a paucity of literature on the biomechanics of the windmill softball pitch (WSP) and their impact on the upper extremity in comparison to overhead baseball pitching (OBP).[1] It is believed that because during the WSP the ball is released below the shoulder, it is considerably safer than the OBP. However, the WSP has been shown to have injury rates comparable to baseball, particularly when considering overuse shoulder injuries.[2] Significant acceleration occurs during the delivery of the WSP, which puts large amounts of stress on the upper extremity. A study by Barrentine et al[3] comparing kinematics and kinetics for the WSP and the OBP of collegiate pitchers showed similar joint speeds and loads at both the shoulder and elbow but occuring at different phases of the pitch delivery. The only critical difference was during the WSP, forces to resist distraction at the shoulder and elbow were the greatest during acceleration, whereas during the OBP, forces were greatest during deceleration. However, biomechanical evidence indicates relatively similar distraction forces at the shoulder for both the WSP and OBP.[4]

There are even fewer studies on youth softball pitchers, with a recent prospective study finding that 23% of youth fastpitch softball players had shoulder injuries sustained while pitching during a single season.[5] With the popularity of softball rising and WSP injuries frequently resulting in a significant decrease in quality of life, there is a need for more research on WSP.[5-7]

Scapular dyskinesis has been associated with most shoulder pathologies.[8-10] However, the clinical relevance of scapular dyskinesis has recently been challenged, as nearly half of asymptomatic people have scapular dyskinesis and there are few prospective studies to establish causality.[11] Additionally, there have been inconsistent definitions of what is actually considered scapular dyskinesis. When compared to controls, some authors describe decreased scapular upward rotation as scapular dyskinesis while others have defined it as a loss of scapular downward rotation.[3] In light of these conflicting views on classifications, there is also evidence supporting scapular dyskinesis as being a normal finding in both symptomatic and asymptomatic overhead athletes or even that it may be a beneficial adaptation to increase velocity through force coupling and/or length-tension relationships for force generating muscles with overhead hitting or throwing.[11,12]

The purpose of this case report is to highlight the examination and treatment of a youth softball pitcher referred to physical therapy with the diagnosis of scapular dyskinesis. Key components of the examination, including WSP pathomechanics, will be presented and discussed; along with the relevance of scapular dyskinesis in this case.

CASE DESCRIPTION

The subject was a right hand dominant 14-year-old female with right shoulder pain that began six months prior to her evaluation. She participated as a pitcher in softball, a thrower in track and field, a middle hitter in volleyball, and as a basketball athlete. The subject does not recall a distinct mechanism of injury but noticed her pain after pitching one day. At rest her pain is 0/10, however, she reports achiness with symptoms at 4/10 after pitching, with symptoms lasting for the rest of the day and returning to baseline in the following day. She is unable to point to a specific point of pain but feels it in her shoulder when pitching, typically when the shoulder is in the 12 o'clock position. Currently, her symptoms are alleviated with rest and exacerbated with activity, reporting "feeling tired" with activity. The subject had radiographs taken by her orthopedist without any significant findings. She was referred to physical therapy with a clinical diagnosis of "scapular dyskinesis".

EXAMINATION

At the initial examination no atrophy was noted and there was no tenderness to palpation in the glenohumeral or periscapular region, and no obvious scapular malpositioning was noted in a resting posture. Active range of motion was normal bilaterally with passive internal rotation being limited on the right, with a glenohumeral internal rotation deficit (GIRD) presentation. Right shoulder passive internal rotation was 45 degrees with 154 degrees of a total arc of motion, while the left shoulder passive internal rotation was 75 degrees with 185 degrees of a total arc of motion. The subject had slight hypermobility (grade four glenohumeral mobility) in the posterior and inferior directions of the right glenohumeral joint, which was assessed through a standard joint play assessment.

Manual muscle testing was performed at the initial evaluation, as well as isokinetic testing of the external rotators (ER's) and internal rotators (IR's) and the Athletic Shoulder Test (ASH) testing occurring at the next visit six days later. Table 1 presents manual muscle testing outcomes, performed in standard positioning. Table 2 presents isokinetic testing data at 90 and 270 degrees per second and shows decreases in strength of the right IR's and ER's at 270 deg/sec. ASH testing indicated equal and good strength without any significant deficits.[13] The subject reported pain with strength testing.

Upon visual assessment of scapulohumeral rhythm via the Scapular Dyskinesis Test, the subject demonstrated reduced upward rotation of the scapula with increased anterior tilt on the right during active flexion and abduction.[14] Pitching was pain-free at lower intensities, with symptoms present at about 50% throwing intensity. Special testing was negative for the scapular assist test and the Biceps Load II test. The hospital-specific outcome measure used was Focus on Therapeutic Outcomes (FOTO) and the subject scored 64/100, which indicates moderate dysfunction in the subject's physical functional status. FOTO was used because it captures the breadth of health concerns associated with a subject's perception of their functional status. The report also helps determine the subject's individual preferences, needs, and values to help ensure that these values guide clinical treatment decisions.

A throwing assessment was performed three weeks after the subject's initial evaluation. An iPhone with slow-motion camera mode was used to assess the subject's pitching

Table 1. Manual muscle testing at evaluation

	Right	Left
Shoulder flexion	4/5	4+/5
Shoulder abduction	4/5	4+/5
Shoulder ER at 0 degrees	4/5	4/5
Shoulder IR at 0 degrees	4-/5	4-/5
Serratus Anterior	4-/5	5/5
Middle Trapezius	4-/5	4/5
Lower Trapezius	4-/5	4/5
Latissimus Dorsi	4/5	4+/5
Rhomboids	4/5	4/5
Biceps	5/5	5/5

Abbreviations: ER, external rotation; IR, internal rotation

Table 2. Isokinetic testing at the first follow-up visit

Peak Torque			
	Right (ft-lbs)	Left (ft-lbs)	Deficit
ER at 90 degrees of abduction (90 degrees per second)	20.7	19.4	None
IR at 90 degrees of abduction (90 degrees per second)	28.2	29.7	None
ER at 90 degrees of abduction (270 degrees per second)	7.4	10.8	31.5%
IR at 90 degrees of abduction (270 degrees per second)	14.3	17.1	16.4%
Total Work			
	Right (ft-lbs)	Left (ft-lbs)	Deficit
ER at 90 degrees of abduction (90 degrees per second)	77.3	59.1	None
IR at 90 degrees of abduction (90 degrees per second)	143.4	111.1	None
ER at 90 degrees of abduction (270 degrees per second)	3.7	6.4	42%
IR at 90 degrees of abduction (270 degrees per second)	46.5	118.9	60.9%

Abbreviations: ft-lbs, foot-pounds; ER, external rotation; IR, internal rotation

mechanics. There are multiple biomechanical risk factors documented in the literature that put softball pitchers at increased risk for upper extremity injury: greater shoulder horizontal abduction at foot contact, less trunk lateral flexion towards the throwing side, increased stride length, increased trunk rotation away from the throwing side, and increased center of mass posteriorly.[1] None of the following were demonstrated during the throwing assessment. Figures 1 and 2 show images of the subject's pitching mechanics during initial foot contact from posterior and lateral views, respectively.

CLINICAL IMPRESSION #1

This case is particularly unique because of the discrepancy in the literature and the novelty of upper extremity injuries in youth softball. Differential diagnoses following the initial evaluation included scapular dyskinesis, labral pathology, multidirectional instability, rotator cuff pathology, cervical pathology, and thoracic outlet syndrome. The initial working diagnosis was multidirectional instability and scapular dyskinesis based on initial findings. Since there were deficits in the subject's peak torque of the internal and external rotators along with scapular dyskinesis, the first objective was to improve the subject's impairments of the muscle groups associated with her altered scapular movements including the middle trapezius, lower trapezius, serratus anterior and address rotator cuff strength deficits.

OUTCOMES

Following seven weeks of physical therapy the subject reported feeling better noting reduced pain with pitching. Her isokinetic measures were significantly improved, see Table 4 for details. The subject also tested as "normal" for the Scapular Dyskinesis Test. However, she was still having discomfort with pitching, therefore she had magnetic resonance arthrogram (MRA). The report from the MRA was negative for any pathologies including normal findings for the rotator cuff, labrum, and articular cartilage. Following the MRA results, the subject was nearing the end of the calendar year, in which her insurance benefits followed, and a conversation ensued with her mother regarding continuing

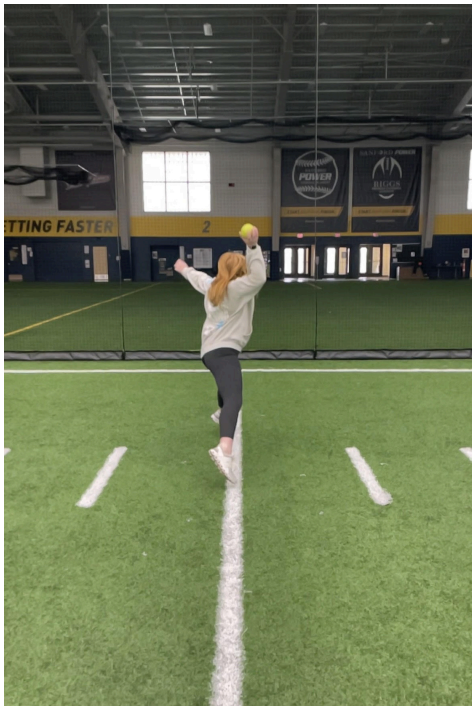

Figure 1. Initial contact during the WSP, from a posterior view

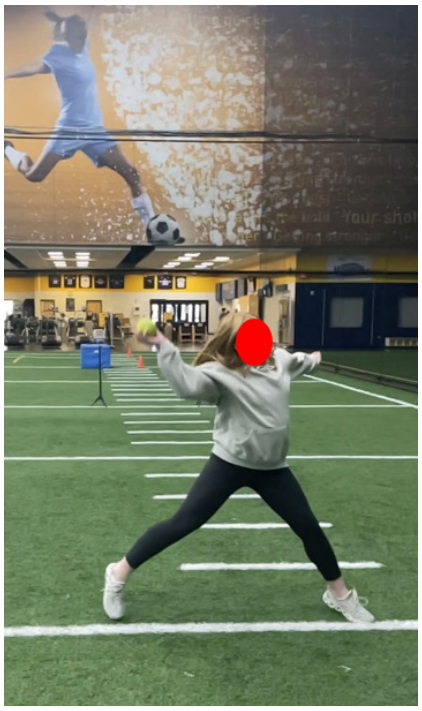

Figure 2. Initial contact during the WSP, from a lateral view

a self-management home exercise program with a conservative progression back into pitching.

CLINICAL IMPRESSION #2

This case report has demonstrated the complexity of both the examination and treatment of a youth softball pitcher with a shoulder injury related to WSP. The initial impression was that the subject's scapular dyskinesis was the origin of her shoulder dysfunction. After addressing the subject's scapular deficits with approximately two months of treatment focusing on improving peak torque, total work, and neuromuscular control of the involved side, she continued to have pain and the inability to fully return to pitching without reproduction of her symptoms. Due to a lack of progress regarding pain with pitching, the plan was to focus primarily on neuromuscular control and softball pitching specific functional training to improve the subject's glenohumeral and scapular control during activity rather than focus on isolated strengthening. The subject was contacted roughly five months later for consent for publication of this case report and reported no pain with pitching following continued adherence to her home exercise program and progressive return to pitching with the return to pitching program.

DISCUSSION

Despite there being a lot of research related to overhead injuries in baseball pitchers, there continues to be a significant deficit in research studying overhead injuries in softball players. The scapula has long been demonstrated to be important in the performance of overhead athletes, as it serves as the link that transfers energy from the trunk and lower extremities to the glenohumeral joint and elbow. Scapular dyskinesis has been classified in multiple ways without consensus on a gold standard definition.[11]

In this case report, the authors attempted to isolate the scapular stabilizers to address scapular dyskinesis and address the subject's shoulder pain because of the importance of the scapula when transferring kinetic energy. Although the subject had significant improvements in her peak torque with overhead internal and external rotation along with improvements in total work of the shoulder, she continued to be symptomatic during her full-intensity softball pitch. Following improvement in the subject's shoulder peak torque, increased focus was placed on neuromuscular training in more functional overhead patterns including the use of proprioceptive neuromuscular facilitation (PNF). Because maximal scapular muscular activation occurs during functional movement patterns rather than isolated scapular strengthening,[3] strengthening in sport-specific movement patterns should be considered during exercise selection.

But what about other considerations in the kinetic chain? An additional variable that could have been considered in this case report was lower extremity strength. During phase three of the WSP, also known as the acceleration phase, high gluteus maximus activity creates the energy needed to move the shoulder from the 3 o'clock position to the 12 o'clock position.[15] Without sufficient gluteal strength, it is hypothesized that an athlete will instead rely on the shoulder complex to create more energy to maintain pitch velocity. When studying single-leg squat mechanics, youth and high school softball pitchers demonstrated increased trunk rotation and trunk flexion at peak depth. Those that demonstrated these altered mechanics during

Table 3. Treatment Interventions and rationale

	Interventions	Rationale
Weeks 1-2	Rotator cuff isometrics (starting with short lever arms and progressing to longer lever arms); pec minor stretching; prone I, Y, and T; Grade I and II posterior GH joint mobilizations; side-lying ER strengthening	Decrease pain, increase load capacity, improve neuromuscular control, address posterior capsule, improve muscular endurance
Weeks 3-4	Planks with scapular protection; overhead medicine ball rolls with perturbations; 90/90 ER/IR with TheraBand resistance; progression to holds with perturbations	Increase lever arms, increase overhead load capacity, increase functional neuromuscular control
Weeks 5-6	Shoulder-controlled articular rotations; body blade variations; overhead KB carries; CKC plank ½ bosu walkovers; landmine pressing; introduction to pitching variations including T's and K's	Increase strength, continue the progression of overhead loading
Weeks 7-8	PNF diagonal patterns with resistance and alternating intensities; a continuation of body blade progression' overhead KB press walking with perturbations; full pitching progression	Neuromuscular control and sport-specific functional training

Abbreviations: GH, glenohumeral; ER, external rotation; IR, internal rotation; KB, kettlebell; CKC, closed kinetic chain; PNF, Proprioceptive Neuromuscular Facilitation

Table 4. Isokinetic testing at seven weeks

Peak Torque				
	Right (ft-lbs)	Left (ft-lbs)	Deficit	Improvement
ER at 90 degrees of abduction (90 degrees per second)	22.2	21.2	None	7.2%
IR at 90 degrees of abduction (90 degrees per second)	32.0	32.3	None	13.5%
ER at 90 degrees of abduction (270 degrees per second)	10.6	6.7	None	43.2%
IR at 90 degrees of abduction (270 degrees per second)	17.7	22.2	20.3%	23.8%
Total Work				
	Right (ft-lbs)	Left (ft-lbs)	Deficit	Improvement
ER at 90 degrees of abduction (90 degrees per second)	70.2	70.0	None	-9.2% (decreased)
IR at 90 degrees of abduction (90 degrees per second)	145.6	142.7	None	1.5%
ER at 90 degrees of abduction (270 degrees per second)	15.3	7.8	None	34.3%
IR at 90 degrees of abduction (270 degrees per second)	136.7	95.5	None	193.7%

Abbreviations: ft-lbs, foot-pounds; ER, external rotation; IR, internal rotation

a single leg squat also demonstrated increased knee valgus and trunk flexion during initial contact when pitching, which may also be associated with greater risk for upper extremity injury.[16]

An additional parameter that could account for increased risk for upper extremity injury in softball pitchers is high pitch counts. Currently, the Amateur Softball Association, which is the national governing body for softball in the United States, has no rules that limit the number of innings or pitches at any level of play.[17] Within professional softball, injuries for pitchers increase by 5% for every additional 100 pitches thrown in a season.[18] The athlete in this case report may have increased her risk for shoulder pathology because of high pitch counts and/or her participation in overhead sports year-round, however, pitch count was not assessed herein.

Other considerations for this case report would be using a validated outcome measure such as the Shoulder Pain and Disability Index (SPADI) or Quick Disabilities of the Arm, Shoulder and Hand (QuickDASH) which could have been utilized to more accurately track the athlete's subjective progress over time. Additional performance testing such as the Closed Kinetic Chain Upper Extremity Stability Test (CKCUEST) could also have been used to more objectively track the athlete's upper extremity stability. A focus on endurance testing could also have been beneficial in guiding treatment.[19]

CONCLUSION

The results of this case report demonstrate successful interventions that allowed an adolescent pitcher to return to sport. Further research is recommended to address any potential relationships between lower extremity strength and scapular dyskinesis in overhead athletes. It is also recommended that further research explore the differences between neuromuscular training strategies in overhead athletes with and without scapular dyskinesis, especially within a youth population. Lastly, pitch counts may assist in protecting some youth athletes from similar injuries.

CONFLICTS OF INTEREST

The authors report no conflicts of interest.

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