

Case Reports

The Immediate Effects on Shoulder Internal Rotation Motion and External Rotation Strength Following a Muscle Energy Technique in a Young Overhead Thrower: A Case Report

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INTRODUCTION

Glenohumeral internal rotation deficit (GIRD), total rotational motion (TRM) deficit, and weakness of the rotator cuff have been determined to be potential risk factors for the development of shoulder and elbow injuries in the overhead thrower. The causes for these deficiencies are multifactorial and the ability to identify and correct those deficits could decrease the potential for injury. Therefore, the purpose of this case report was to investigate the immediate effects of a muscle energy technique (MET) on shoulder internal rotation ROM and external rotation strength in the throwing shoulder of an overhead thrower.

CASE DESCRIPTION

The subject of this case report was a 20-year-old collegiate baseball pitcher without any reported previous injury that presented with a loss of passive shoulder internal rotation at 90 degrees of abduction, a deficit in TRM, and weakness of the external rotators as determined by handheld dynamometry. The athlete was identified during a pre-sport screening for overhead throwers. Following the assessment, a MET was performed for shoulder internal rotation in a side-lying position.

OUTCOME

The athlete demonstrated an immediate 38-degree improvement in shoulder internal rotation motion, reduction in TRM deficit from 42 degrees to 4 degrees, and 7.8% increase in shoulder external rotation strength.

DISCUSSION

It is not uncommon for symptomatic and asymptomatic overhead throwers to present with GIRD, TRM deficit, and rotator cuff weakness. The ability to improve these deficits following the application of a MET could imply that the deficits are linked. Previous studies have identified different methods that improve internal rotation ROM but have not documented possible related outcomes in external rotation strength. Future research should examine the potential mechanism for such a response to the MET, and if these changes have a lasting effect, as only short-term effects were examined.

Level of Evidence

4

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INTRODUCTION

There have been numerous risk factors associated with the development of shoulder and elbow pain in the throwing athlete. Extrinsic factors include innings pitched per game, innings pitched per season, pitching more than eight months per year, mechanical deficiencies, and lifting weights during the season.^{1,2} Additionally, shoulder range of motion (ROM) deficits, specifically internal rotation (IR) and external rotation (ER) at 90 degrees of abduction, have been correlated with elbow and shoulder injuries in pitchers.^{3,4} Professional pitchers with a glenohumeral internal rotation deficit (GIRD) of greater than 20 degrees compared to the non-dominant shoulder were found to be twice as likely to be injured.⁴ It appears that GIRD of greater than 20 degrees may not be a risk factor in isolation. Wilk et al⁴ also measured total rotational motion (TRM) (ER + IR) and found that pitchers with a TRM deficit of greater than 5 degrees had a higher rate of injury. Garrison³ found similar findings in high school and collegiate baseball players that sustained an ulnar collateral ligament (UCL) tear.

Sufficient rotator cuff and scapular stabilizer strength are also imperative to limit the possibility of upper extremity injury in the thrower. In a study assessing risk factors in adolescent baseball pitchers, Olsen and colleagues² reported a 36 times increased risk for injury when throwing with arm fatigue. In another study involving adolescent pitchers with and without prior throwing-related pain, Trakis et al⁵ reported that those with previous pain complaints presented with weakness of the posterior shoulder musculature. The infraspinatus and teres minor are most active in the late cocking phase during pitching⁶ where they work to compress the glenohumeral joint to maintain stability of the shoulder. Weakness of these muscles can lead to compensatory changes throughout the kinetic chain during the act of throwing. Additionally, the infraspinatus may be more susceptible to inhibition during fatigue than other muscles.⁷ Gandhi et al⁸ found a decrease in external rotation strength and a statistically and clinically significant decrease in voluntary muscle activation of the infraspinatus immediately following pitching in a simulated game. Neuromuscular inhibition appeared to be the mechanism of the subsequent weakness.

In a prospective study of high school pitchers, Tyler et al⁹ found that preseason supraspinatus weakness was significantly associated with an increase in shoulder and elbow injury risk. Interestingly in both studies, Tyler⁹ and Trakis⁵ noted no significant weakness in the external rotators, but they assessed shoulder ER strength at 90 degrees of abduction and ER. Reinold and colleagues,¹⁰ in an EMG analysis of the rotator cuff, found that both the teres minor and infraspinatus had the highest percentage of maximum voluntary isometric contraction during side-lying external rotation at 0 degrees of abduction, showing significantly less middle and posterior deltoid activity than when performed at 90 degrees of abduction. Therefore, a more appropriate assessment of isolated rotator cuff external rotation strength appears to be at 0 degrees of abduction.

Though the cause of GIRD remains a topic of debate, the appearance of GIRD in symptomatic throwers has been attributed to posterior capsule tightness,¹¹ osseous adaptations,¹² and soft tissue restrictions of the posterior cuff and deltoid.¹³ Passive stretching^{13,14} and joint mobilizations¹⁵ have been found effective in improving IR motion. In addition, Moore et al¹⁶ found an immediate improvement in horizontal adduction and IR ROM following the application of a contract-relax muscle energy technique. It should be noted that Muraki¹⁷ found that the greatest strain of the inferior fibers of the infraspinatus occurred at 90 degrees of shoulder elevation with IR. This suggests that the infraspinatus can be a significant contributor to GIRD. Though not assessed for strain levels in that study, based on its origin and insertion, the teres minor is also stretched in that position of IR and abduction and therefore may also have a role in GIRD.

The combination of loss of IR motion and weakness of the external rotators might be explained by the concept of "tightness weakness" as described by Janda.¹⁸ As already noted, the posterior rotator cuff demonstrates large EMG activity during the act of throwing. Overused muscle shortens over time, changing the muscle length-tension properties and becoming more readily active and weaker after time.¹⁸ It is important to distinguish between neuro-reflexive and structural weakness. Stackhouse and colleagues noted in two studies on infraspinatus activation and inhibition in fatigued and non-fatigued states that subsequent development of weakness could result from incomplete motor unit recruitment or from suboptimal motor unit firing rates due to a lack of central drive.^{7,19}

A muscle energy technique (MET) for the shoulder horizontal abductors¹⁶ has effectively been utilized in improving shoulder IR range of motion, but there have been no reported studies that indicate if the utilization of a MET could restore both the IR range of motion loss and ER weakness that symptomatic and asymptomatic throwers typically present with. Osama²⁰ found that the application of a MET increased the isometric neck strength in patients with mechanical neck pain. He noted that as resting tone of a muscle increases, more sarcomeres form cross bridges which maintain the increased active tone and less sarcomeres would be available for voluntary contraction. MET by either autogenic or reflexive inhibition could make more sarcomeres available for contraction, allowing for an immediate increase in isometric strength. Therefore, the purpose of this case report was to investigate the immediate effects of a MET on shoulder IR ROM and external rotation strength in the throwing shoulder of an overhead thrower.

CASE DESCRIPTION

A screening was performed on 17 Division III baseball pitchers which included assessments of shoulder rotational ROM at 90 degrees of abduction and external rotation strength at 90 degrees and 0 degrees of abduction. The first athlete that met the criteria of GIRD greater than 20 degrees, TRM deficit greater than 5 degrees, and weakness of the external rotators at 0 degrees of abduction relative to

the non-throwing side was included as the subject of this case report. The athlete was a 6'2", 195-pound, 20-year-old, left-handed pitcher, who did not present with any of the established exclusion criteria which included previous shoulder or elbow surgery on the throwing arm, currently in the post-operative phase of a shoulder or elbow surgery on the throwing arm, currently participating in a rehabilitation program for shoulder or elbow pain, and currently not able to throw due to shoulder or elbow pain. This case report study protocol was approved by the Institutional Review Board at Sacred Heart University (IRB-FY2025-98). Prior to enrollment in the study, the participant was informed that data collected during the study would be submitted for publication and informed consent was obtained.

RANGE OF MOTION MEASUREMENTS

Passive glenohumeral IR ROM at 90 degrees of abduction was measured bilaterally as outlined by Wilk et al²¹ which was shown to have the highest intra-rater reliability of the three methods investigated. The athlete was positioned in supine with his arm placed in 90 degrees of shoulder abduction and a small towel roll under the distal humerus to place the humerus in 10 degrees of horizontal adduction ([Figure 1](#)). The examiner utilized gentle pressure on the coracoid process with his thumb, while placing pressure on the spine of the scapula with his fingers, thereby stabilizing the scapula. He then placed his other hand under the elbow with his thumb on the forearm. A second examiner aligned a goniometer with a bubble level attachment to obtain the measurement. The center of the goniometer was placed over the tip of the olecranon process while one arm was placed along the length of the ulna aligned with the ulnar styloid process. The other arm was aimed inferiorly, perpendicular to the floor, utilizing the bubble level to assure proper alignment. The first examiner internally rotated the humerus by applying pressure on the forearm. During IR, the scapula will tilt anteriorly. The first examiner discontinued pressure into IR once the scapula could no longer be stabilized. The second examiner then read and documented the measurement of IR ROM in degrees.

Passive glenohumeral ER ROM at 90 degrees of abduction was also assessed bilaterally in a similar fashion. The athlete was supine and his arm was placed in 90 degrees of shoulder abduction with a small towel roll under the distal humerus. The goniometer was aligned as described for IR. The first examiner externally rotated the shoulder until there was a capsular or bony end feel. The second examiner then read and documented the measurement of ER ROM in degrees.

STRENGTH MEASUREMENTS

Shoulder ER strength was then assessed using a handheld dynamometer (HHD). The use of a HHD has been shown to be a reliable method for assessing shoulder ER strength.²²⁻²⁴ Holt et al²³ reported high intra- and inter-rater reliability in its use as well as superior reliability with a smaller minimal detectable change (MDC) when compared to an externally fixated dynamometer. Both Holt et



Figure 1: Assessment of shoulder IR passive range of motion at 90 degrees of shoulder abduction and 10 degrees of horizontal adduction with stabilization of the scapula.

al²³ and Chamorro et al²⁴ found a high correlation with HHD shoulder rotator torque assessment and isokinetic dynamometry. The participant was positioned supine with the test arm abducted to 0 degrees (arm at the side of the body) with a small towel roll placed between the body and distal humerus ([Figure 2a](#)). Forbush et al²⁵ noted an improvement in infraspinatus recruitment while inhibiting the deltoid when the subject actively adducted the shoulder into a towel roll while performing ER. External rotation strength was also tested with the participant in supine and the test arm abducted to 90 degrees, with the distal humerus supported again by a towel roll and the elbow maintained at 90 degrees ([Figure 2b](#)). The HHD (MicroFET2, Hoggan Scientific, Salt Lake City, Utah) was placed at the same location on the distal aspect of the participant's forearm for each test. The athlete was instructed to perform a make test by pushing into the dynamometer with gradually increasing force to maximum over a period of three to five seconds. During this contraction, the athlete was cued to maintain adduction into the towel roll.

INTERVENTION

After the initial assessments were completed, the MET was applied to the athlete. The MET involved having the athlete in a side-lying position on his non-throwing side ([Figure 3](#)). The athlete then placed his throwing arm in a "lift-off position," with the arm in an internally rotated position and elbow in 90 degrees flexion. The examiner placed one arm under the athlete's humerus and his hand on the athlete's ilium. The athlete was instructed to let his humerus



Figure 2a: Assessment of shoulder ER strength in supine at 0 degrees of shoulder abduction with a towel roll between the trunk and medial humerus.



Figure 3: Muscle energy technique (MET) consisting of manually resisted internal rotation with the patient positioned in side-lying.



Figure 2b: Assessment of shoulder ER strength in supine at 90 degrees of shoulder abduction.

“rest” on the examiner’s arm. The examiner then placed his other open hand in contact with the distal radius and ulna. The athlete was instructed to “push into my hand.” An isometric contraction of IR was performed for five seconds. The athlete performed three sets of three repetitions of this five-second contraction with a five-second rest period be-

tween sets, for a total treatment time of approximately two minutes.

OUTCOME

Immediately following the MET intervention, shoulder rotation passive ROM at 90 degrees of abduction and ER strength at 90 degrees of abduction and 0 degrees of abduction were reassessed for the throwing arm. Internal rotation passive ROM improved from 38 degrees to 76 degrees, leading to an improvement in TRM from 153 to 191 degrees and reducing the TRM deficit from 42 degrees to 4 degrees. External rotation strength at 0 degrees of abduction improved from 23.0 to 24.8 lb (7.8% increase). External rotation strength at 90 degrees of abduction remained essentially unchanged from 38.0 to 38.1 lbs ([Table 1](#)). The athlete tolerated the intervention without incident.

DISCUSSION

The clinical finding of GIRD and rotator cuff weakness is common in the symptomatic overhead thrower, and these findings have also been identified as potential risk factors for injury in the asymptomatic thrower. Screening for these and other factors that have been associated with risk of injury should be performed in the overhead throwing athlete. GIRD, TRM deficit, and ER weakness are common deficits noted in the throwing athlete and seem to be consistently found in tandem. The authors have found that the use of a specific MET not only decreases the deficits of GIRD and TRM but also improves ER strength. During a recent

Table 1: Pre-treatment and post-treatment measures of shoulder rotational ROM and ER strength

	Baseline Measures (Pre-MET) Non-Throwing Arm	Baseline Measures (Pre-MET) Throwing Arm	Reassessment Measures (Post-MET) Throwing Arm
Shoulder IR ROM at 90° abduction	80°	38°	76°
Shoulder ER ROM at 90° abduction	115°	115°	115°
Total Rotational Motion (deficit)	195°	153° (42°)	191° (4°)
Shoulder peak ER force at 0° abduction	27.3 lb	23.0 lb	24.8 lb
Shoulder peak ER force at 90° abduction	41.2 lb	38.0 lb	38.1 lb

screening of 17 collegiate baseball pitchers, four players were identified that exhibited deficits in IR ROM and ER strength. The MET was applied on the first athlete identified during the screening with this presentation and improvements were observed in both measures. Following the MET, shoulder IR ROM improved from 38 to 76 degrees (4 degrees less than the non-throwing shoulder). The gain in IR motion for the athlete in this case report improved the TRM deficit from 42 degrees to 4 degrees. A TRM deficit of greater than 5 degrees has been associated with a higher risk of injury in throwers.^{3,4}

Moore and colleagues¹⁶ noted that following a single application of MET for the horizontal abductors, IR improved 4.2 degrees. McClure et al¹⁵ instructed asymptomatic subjects with GIRD of greater than 10 degrees to perform either daily cross-body stretches, or the sleeper stretch for four weeks. Those in the cross-body stretch group increased shoulder IR ROM by 12.9 degrees, and the sleeper stretch group demonstrated a gain of 10 degrees (insignificant compared to a control group). Sehgal et al²⁶ reported gains in IR ROM in subjects that received interventions of MET and passive stretching of the external rotators delivered three times per week over a duration of two weeks.

After a single application of the MET used with this athlete, ER strength at 0 degrees of abduction increased by 7.8%. That change can be considered clinically impactful as a systematic review with meta-analysis investigating the reliability and validity of HHD reported a minimal detectable change (MDC) of 3.29% (95% CI: -2.69 - 9.27) for shoulder external rotators.²⁴ External rotation strength at 90 degrees of abduction remained essentially unchanged (0.26% increase). The difference observed in ER strength gains in these positions is not surprising based on the work by Reinold et al¹⁰ that noted EMG activity of the infraspinatus and teres minor was higher at 0 degrees of abduction than 90 degrees of abduction.

Safford et al²⁷ recently compared ER strength gains of an eight-week, low-load exercise program that included side-lying ER and standing scaption in subjects with and without Blood Flow Restriction Training (BFRT). The BFRT group demonstrated an 8.5% gain in ER strength and those without BFRT demonstrated a 10% gain. In a study implementing a dry-land strengthening program in competitive ado-

lescent swimmers consisting of band exercises for shoulder flexion, extension, abduction, IR and ER, no significant strength gains of ER were noted at six weeks, though there was a 23% gain after 12 weeks.²⁸ Though significant gains were reported, both studies involved rather lengthy treatment durations while the intervention in this study resulted in an immediate improvement without performing any strengthening exercises.

The ability to improve both IR motion and ER strength with a single application of a MET may indicate that the two entities are linked. The concept of “tightness weakness” whereby there is a change in muscle-length tension properties provides a possible explanation for this relationship. Osama²⁰ noted that the application of a MET resulted in an immediate increase in isometric neck strength in patients with mechanical neck pain. The mechanism of such an improvement was attributed to a decrease in active tone by either autogenic or reciprocal inhibition. The exact mechanism of ROM and strength gains following repeated isometric contractions of the internal rotators in this case cannot be definitively determined. It is plausible that the loss of IR ROM at 90 degrees of abduction was due to tightness of the teres minor and/or infraspinatus. Following the concept proposed by Janda,¹⁸ overused muscle shortens over time leading to changes in the muscle-length properties and subsequent weakness. Isometric contractions of the internal rotators could have caused a restoration of length to the external rotators via reciprocal inhibition and hence an improvement in their strength.

The presentation of GIRD and rotator cuff weakness typically occur in tandem and a question therefore arises if these are linked, and if they might actually occur in response to the act of throwing. A subsequent loss of IR ROM and weakness of ER has been noted immediately following pitching. Reinold et al²⁹ found a significant loss of passive shoulder IR in asymptomatic professional pitchers immediately following pitching that was also evident 24 hours after throwing. They purported that the altered ROM may be related to acute musculotendinous adaptations in response to the eccentric muscle activity of the external rotators during the throwing motion. It could be reasoned that for an immediate decrease in shoulder IR ROM to occur following one pitching session, a neural component cannot be ruled

out as a precipitating factor. Gandhi et al⁸ found a decrease in ER strength and a statistically and clinically significant decrease in voluntary muscle activation of the infraspinatus immediately following pitching in a simulated game. Their reasoning was that the weakness was due to incomplete neuromuscular recruitment. The immediate change in shoulder ROM and strength observed in this athlete following the application of the MET may suggest a neuromuscular component, perhaps with origin or contribution from the cervical spine.

Based on what is known about throwing mechanics and what research has indicated as a possible neural component to the loss of IR ROM and ER strength, it is important to include a thorough assessment of the cervical spine when evaluating the throwing athlete. Screening procedures should include assessing cervical ROM and performing palpation of the cervical spine. During the screening performed for this study, the athlete presented with tenderness to palpation over the C4 transverse process and an increase in tone of the paraspinals in that area. Dilozenzo et al³⁰ noted a similar finding in a case study of a professional baseball pitcher with medial elbow pain and reported dysfunction of the cervical spine as a common finding in symptomatic overhead athletes. In a case series of two athletes with functional shoulder impingement, Pheasant³¹ noted that performance of cervical retraction with extension improved shoulder ER and abduction strength, while resolving a painful arc and a positive empty can test. Range of motion of the involved shoulder was assessed visually and not reassessed following the intervention. He noted that the movement of cervical retraction with extension was shown to increase the dimensions of the C4-C5 intervertebral foramen, allowing reduction of a potentially mildly compressed nerve root and promoting improved neuromuscular recruitment for the shoulder muscles.

As typical with a case report, there is no way to discern if the intervention alone resulted in the change due to the lack of a control group. Further limitations of this case report include that only an immediate response to the intervention was assessed on an asymptomatic athlete. However, it has been the experience of the authors that when the intervention has been applied in the clinic and followed with issuance of a home exercise program to maintain IR ROM (i.e., sleeper stretch, etc.) and rotator cuff strength, the improvements persist.

CONCLUSION

It has been established that both a decrease in rotator cuff strength and GIRD are potential risk factors for injury in the overhead thrower. The results of this case report indicate that utilization of a MET was able to improve passive shoulder IR motion at 90 degrees of abduction, total rotational motion, and ER strength at 0 degrees of abduction in an asymptomatic 20-year-old baseball player. The immediate response and improvement of both entities with the application of a MET may indicate a neuro-reflexive component. Future research would benefit from assessing the long-term effects of this MET intervention, the mechanism for explanation of such a response, the effect of improving shoulder IR motion on rotator cuff strength, and conversely the effect of improving rotator cuff strength on shoulder IR ROM.

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