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INJURIES IN OVERHEAD ATHLETES (J DINES AND C CAMP, SECTION EDITORS)

Approach to Latissimus Dorsi and Teres Minor Injuries in the Baseball Pitcher

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Abstract

Purpose of Review Tears of the latissimus dorsi and teres major are uncommon but significant injuries, most frequently seen in high-level, overhead throwing athletes. Diagnosis can be challenging, as there are no pathognomonic signs, symptoms, or physical exam findings associated with latissimus dorsi/teres major tears, and the clinician must have a high suspicion for this injury. While many of these tears can be treated non-operatively, a subset of these benefits from surgical intervention. Rehabilitation following operative and non-operative treatments of these injuries is extensive, and timing of return to sport can be variable from 3 to 12 months.

Recent Findings The literature surrounding latissimus dorsi/teres major injuries is sparse. Several small studies have shown good results in patients with mild to moderate tears that were treated non-operatively. Recent evidence has shown good results following operative repair of larger tears, with excellent return to sport rates. Furthermore, focused rehabilitation is imperative when treating patients with latissimus dorsi/teres major injuries to allow these athletes to return to sport.

Summary Latissimus dorsi/teres major tears are uncommon but significant injuries in the throwing athlete. Prompt diagnosis, proper treatment, and focused rehabilitation will allow these patients to return to sport in a safe and efficient manner.

Keywords Latissimus dorsi · Teres major · Baseball · Pitcher · Surgery · Shoulder

Introduction

There has been a significant increase in the number of shoulder and elbow injuries in baseball pitchers over the past 15 years [1, 2••, 3, 4]. While most of the literature has focused on ulnar collateral ligament (UCL), superior labrum, rotator cuff, and biceps tendon injuries in baseball pitchers, there are other, less common, but still very significant causes of shoulder dysfunction in baseball pitchers [5–10, 11••]. One such problem is an injury to the latissimus dorsi (LD) and teres major (TM) [11••, 12–14]. Although tears of the LD/TM are uncommon injuries in the majority of athletes, baseball pitchers are the cohort of athletes who are at highest risk for sustaining a LD/TM tear. Although rare, LD/TM injuries have also been reported in water-skiers, wakeboarders, tennis players, and those who participate in rock climbing [15–17].

Anatomy and Function

The LD originates from the spinous processes of the lower 6 thoracic vertebrae, lower ribs, and iliac crest and inserts on the floor of the intertubercular groove of the humerus after externally rotating 90° before insertion [18, 19]. The TM, which runs deep and superior to the LD and can converge with the LD at their insertion onto the humerus, originates on the dorsal surface of the inferior angle of the scapula [20, 21]. Both the LD and TM function as strong internal rotators, extenders, and adductors of the humerus, making them vital to the overhead pitching motion. As one of their main functions is internal rotation, the LD/TM are most active during the late cocking and acceleration phases of the pitching cycle, although they do

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show some activation in the deceleration phase as well [12, 22, 23]. In the late cocking phase, the LD/TM eccentrically contract to decelerate the arm and halt shoulder external rotation, thereby preventing excessive stretch on the anterior capsule of the shoulder. The LD/TM then concentrically contract during the acceleration phase to aid in humeral internal rotation. Finally, the LD/TM play a role in decelerating the arm in the deceleration/follow-through phase. Hence, when a baseball pitcher sustains an injury involving the LD TM, they often cannot continue to compete at a high level without some form of treatment.

History and physical exam

LD/TM tears can be extremely difficult to diagnose. As such, a thorough history and physical exam is crucial to aiding the clinician in making the correct diagnosis. The pitcher should be asked about their level of competition as well as their goals moving forward (returning to the same or higher level of play, possible retirement, etc.). They should also describe the nature of the pain, and at what point during the pitching cycle the pain comes on (wind up, early cocking, late cocking, acceleration, deceleration, follow-through). Baseball pitchers are often very in-tune with their bodies and can usually articulate where their pain is with reasonable reliability when they sustain an injury. Unfortunately, unlike a UCL tear that presents with medial elbow pain, tears of the LD/TM do not present with specific, pathognomonic symptoms. Many pitchers who sustain LD/TM injuries will complain of loss of pitching velocity and accuracy, and may or may not recall a specific pitch where they felt a pop accompanied by an acute onset of pain in their arm [12]. Unlike UCL tears which are often attritional, LD/TM injuries can often be truly acute [12]. Pitchers will commonly complain of pain that begins in the late cocking/early acceleration phases of the pitching cycle and continues throughout the rest of the pitch, as this is when the LD/TM is most active. As with any new injury in an athlete, it is important to obtain a complete history regarding prior injuries and/or surgeries, treatments (including various injections) that have been attempted up to this point, and whether or not they have been shut down for any extended period of time (and if so, for what duration).

Physical exam of a baseball pitcher with a suspected injury to the LD/TM begins by adequately exposing the patient's shoulder and scapula and beginning the exam by standing behind the pitcher to view the scapula/posterior humerus. The examiner should look for any signs of bruising, specifically in the posteromedial arm, and any side to side asymmetry, especially as it pertains to the posterior axillary fold. If the LD/TM tear is retracted, there can be loss of the posterior axillary fold and bruising in this area. The entire course of the LD/TM from origin to insertion should be palpated for tenderness and evaluated for any side to side differences in muscle bulk, tension, etc. A complete shoulder exam is then performed including range of motion (ROM) and strength testing. While ROM should be normal in pitchers with a LD/TM tear, there may be weakness in shoulder adduction and extension and, to a lesser degree, in internal rotation. Furthermore, resisted shoulder extension and adduction may cause pain in some of these pitchers. A complete neurovascular exam should also be performed to document the status of the radial nerve, as this runs in close proximity to the LD/TM and can be injured in traumatic LD/TM injuries, and to rule out other uncommon neurologic causes of upper extremity dysfunction in a pitcher. Other advanced imaging such as an ultrasound may aid in diagnosis, but because of the variability of this test and how operator dependent it is, the authors do not routinely obtain an ultrasound.

Imaging

Any pitcher who presents with shoulder/arm pain should obtain a complete shoulder X-ray series including anteroposterior (AP), axillary, scapular Y, and Grashey views. While these radiographs are commonly normal, they are useful to rule out other causes of shoulder pain including a Bennett lesion. Advanced imaging should be obtained for any patient in whom a LD/TM tear is suspected. Magnetic resonance imaging (MRI) is the advanced imaging of choice to diagnose a LD/TM tear as this can provide detail of the entire course of the LD/TM and can demonstrate fluid surrounding/tracking along the LD/TM when an acute injury has occurred (Fig. 1). When ordering a MRI to diagnose a LD/TM tear, the clinician should not order an MRI of the shoulder in isolation as this sequence often does not go distal enough, and sometimes is not cut in the proper plane to diagnose a LD/TM injury. To properly diagnose a tear of the LD/TM, a MRI of the chest wall should be ordered along with an MRI of the shoulder. This allows the clinician to evaluate the shoulder as well as the LD/TM. If the clinician cannot obtain an MRI of the chest wall, it is necessary to specify to the radiology technician performing the shoulder MRI that the area of concern is the LD/TM and to please expand the field of view to encompass the LD/TM insertion onto the humerus. The course of the LD/TM on the MRI should be critically evaluated, with special attention paid to the insertion of the LD/TM onto the humerus. Although injuries to the LD/TM can occur at the musculotendinous junction, the majority of these injuries occur with the LD/TM torn off the humerus. It is important to determine if the tear is partial thickness or full thickness, as this has implications for treatment. The amount of retraction of the LD/TM should also be measured, as tears with greater amounts of retraction are less likely to heal reliably and afford the pitcher an excellent outcome.

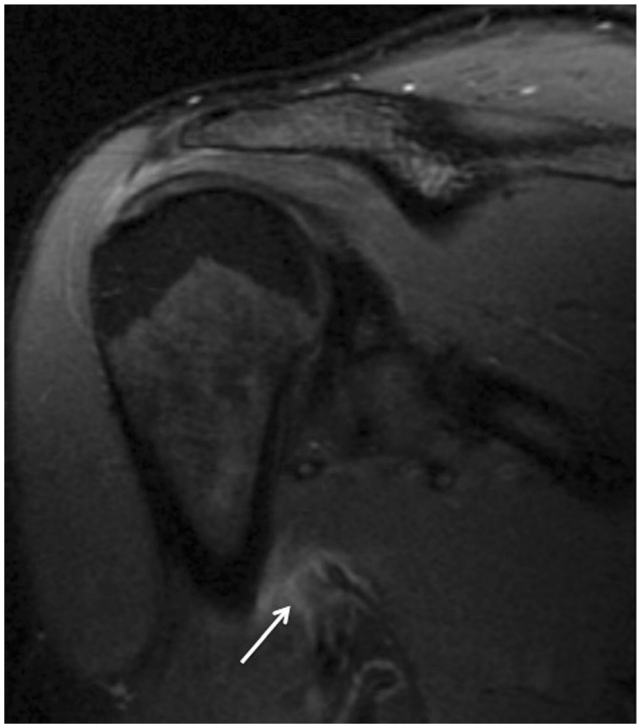

Fig. 1 Coronal fat sat inversion recovery magnetic resonance image demonstrating a tear of the latissimus dorsi and teres major at the tendinous level as they insert onto the humerus with retraction (arrow)

Treatment Options

The most difficult part of treating a LD/TM tear is making the diagnosis. Once the diagnosis is established, the treatment options can be broken down into non-operative and operative methods. While there are no hard and fast rules for treating LD/TM injuries, the authors feel that full-thickness LD/TM tears should be treated operatively with LD/TM repair while partial-thickness tears or strains of the LD/TM deserve an attempt at non-operative management.

Non-operative Management

Conservative treatment options for LD/TM tears include rest, anti-inflammatory medications, cryotherapy, laser therapy and other modalities, and rehabilitation with or without an injection. There have been no studies to date that have valuated the effectiveness of any type of injection (steroid, platelet-rich plasma (PRP), etc.) in treating LD/TM injuries, and as such, the authors cannot recommend for or against these. Most LD/TM injuries are muscle strains or partial-thickness tears that can be managed without surgery. Once the diagnosis is confirmed with MRI, the pitcher should be shut down from throwing until they are completely asymptomatic. During this time, they can work on core strengthening to help mitigate the force on the LD/TM during the pitching motion. Once they are asymptomatic, they begin a shoulder ROM program to ensure they regain all of their preinjury ROM. The therapist should focus on their total shoulder ROM, including both internal and external rotation, as well as hip ROM, as shoulder and hip motion has been shown to be a risk factor for shoulder injury in pitchers [2••, 24, 25].

Once the pitcher regains their ROM, a strengthening program is initiated with specific attention paid to scapular stabilization exercises. This phase is followed by a return to throwing program. The throwing program begins with lofted long toss and is followed by long toss on a rope, flat ground throwing, and, finally, throwing from the mound. Only at the completion of a return to throwing program is a pitcher allowed to return to sport (RTS). The timing of RTS from the date of injury is often variable, especially since it may take weeks or months to properly diagnose this injury in pitchers who are not under the care of physicians used to treating baseball players. However, studies have reported the average time to RTS following a LD/TM to be 3–4 months under ideal circumstances [12, 13].

Operative Management

Pitchers with full-thickness tears of the LD/TM, or those who fail conservative management, are indicated for a LD/TM repair. This is not a trivial surgery and should be performed by a surgeon who has experience with this injury pattern, as there are several pitfalls that must be avoided. A complete understanding of the position of the radial nerve, axillary nerve, and posterior brachial cutaneous nerve is paramount to avoid neurovascular complications during this procedure. The surgical options for a LD/TM tear are a single-incision approach performed in the lateral decubitus position via a posterior axillary incision, or a two-incision approach performed in the beach chair position. The two-incision technique is performed through a standard deltopectoral approach where the footprint of the LD/TM on the humerus is exposed. A second, posterior axillary incision is used to expose and free up the retracted LD/TM tendon stump. Regardless of the technique, once the tendon is retrieved and mobilized, it should be anatomically restored to the humeral footprint with either the use of cortical buttons loaded with high-strength suture/suture tape or high-strength suture anchors. The single incision technique is preferred by the authors. Briefly, a skin incision is made and dissection is taken down to the fascia overlying the LD/TM (Fig. 2). The two tendons may be confluent or separate depending on where along their course they are isolated. Surgeons should take their time dissecting out these tendons and understanding the tear pattern (isolated LD, LD+TM, etc.) (Fig. 3). Once the tear pattern is defined and the radial nerve is located, the LD/TM footprint on the humerus is exposed by placing retractors around the humerus. Great care is taken to protect the axillary nerve. Once the footprint is exposed, the bone is decorticated using a high-speed burr followed by a

Fig. 2 Patients positioned in the lateral decubitus position with the posterior axillary incision marked out for the LD/TM repair

Fig. 3 Following careful dissection, the LD/TM tendons are mobilized out of the incision to ensure there is enough length to reach their insertion on the humerus

rasp, and three fixation devices (unicortical buttons, suture anchors, etc.) are placed in a stop light configuration at the insertion of the LD/TM. Sutures are placed through the tendon stump after removal of any diseased tendon tissue, and the LD/TM are fixed securely to the humerus (Fig. 4). The wound is copiously irrigated and closed in a layered fashion.

Following surgery, patients are immobilized in a sling with a 4-in. abduction pillow (used to place the shoulder in internal rotation and slight abduction) for 6 weeks. The sling is used to prevent the athlete from stressing the repair and specifically limits resisted adduction or excessive abduction. Patients are allowed to perform gentle shoulder pendulum exercises and elbow/hand/ wrist ROM once or twice per day. Passive ROM exercises of the shoulder begin at 2 weeks, and passive exercises, followed by active ROM exercises, are continued until full ROM of the shoulder is achieved. This can take anywhere from 8 to 12 weeks after surgery. Once the patient is pain free and has regained their strength and ROM, a throwing program is initiated between 12 and 16 weeks. The progression of the pitcher through each phase of the throwing program is dictated by the individual athlete's response to activity. RTS is not permitted until at least 6 months, although this may be longer in pitchers with poor tissue quality. Pitchers often notice that, although they may be cleared to RTS at 6 months, they still make gains and are not completely recovered until 9–12 months.

Results

As tears of the LD/TM are uncommon, there are only a few studies in the literature that have reported results following treatment of these injuries. Schickendantz et al. reported on 10 professional baseball pitchers (aged 21–38 years) who had sustained either a latissimus dorsi (LD) and/or teres major

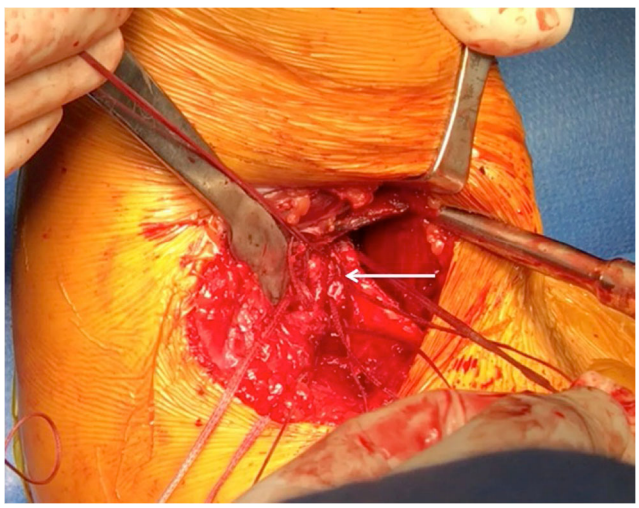

Fig. 4 Reattachment of the LD/TM (white arrow) to the proximal humerus using high-tensile sutures and unicortical buttons

(TM) tear at the humeral insertion diagnosed by MRI and were treated conservatively [12]. Of the 10 injuries, 1 injured both tendons, 5 had isolated LD tears, and 4 had isolated TM tears. Initial treatment consisted of rest, modalities, and cryotherapy followed by restoration of shoulder ROM to preinjury levels. Shoulder strengthening was begun once ROM was nearly normal. The strengthening started with isometric latissimus dorsi and teres major exercises and continued with progressive resistance exercises. Abdominal core exercises, lower body strengthening, and cardiovascular conditioning were performed over the course of the rehabilitation period. Once the player regained full preinjury ROM and strength and was pain-free with provocative testing of the LD/TM, they began a structured return to throwing program (a 4-week long-toss program followed by 2 weeks of throwing off the mound). Pitchers returned to competition once the throwing program was complete. The average time to return to competition was 4.1 months. One player's injury recurred, one never fully recovered, one was released by his team, and one player failed to regain his full velocity.

Similarly, Nagda et al. performed a retrospective review of 16 professional baseball players diagnosed by MRI with a LD/TM tear between 2002 and 2008 that was treated non-operatively [13]. Ten of these pitchers played in the majors while 6 pitched in the minors. Their average age was 28.1 years. Six pitchers had tendon avulsions (2 of the LD, 3 of the TM, and 1 combined). The other 10 had intramuscular strains of the LD/TM. All pitchers discontinued pitching immediately and started a program to decrease inflammation after the diagnosis was made. All were started on a shoulder rehabilitation program when symptoms allowed (regaining ROM and strengthening), which began, on average, 9 days (range 1–28) after injury. Players were allowed to throw when manual muscle testing and active ROM was back to preinjury levels, and they were asymptomatic. They threw off a mound only after they finished the throwing program and were asymptomatic. Players were able to begin throwing at an average of 35.6 days after injury (range, 4–120 days), although those with an avulsion averaged 65.5 days before throwing. Nine of the 16 injuries were season ending. The average time lost for those injuries that were not season ending was 12 weeks or 82.4 days (range, 49–118 days). Fifteen of the 16 athletes (94%) returned to the same or higher level of competition, but the authors did not comment on specific performance metrics. LD/TM injuries recurred in 2 patients.

Erickson et al. performed a retrospective review of 11 male patients (73% ($n = 8$) of whom were baseball pitchers) with an average age of 29.9 years who underwent surgical repair for a LD/TM tear [11••]. Surgery was indicated if conservative treatment had failed, patients had a history, and physical examination findings consistent with a LD/TM tear (loss of accuracy and velocity, pain during the late cocking and/or early acceleration phases, palpable defects, and tenderness over the LD or TM), as well as MRI findings consistent with an LD and/or TM tear. Surgery occurred within 6 weeks of injury in 36% of cases and more than 6 weeks after injury in 64% of cases. The average time from injury to repair was 389 ± 789 days (range, 8–2555 days). Of the pitchers, 1 played major league baseball, 6 played minor league, and 1 played collegiate. All players saw significant improvements in clinical outcome scores. The professional (major and minor league) pitchers had a mean total time participating in professional baseball of 6.6 years, with 3.9 years before surgery and 2.7 years after surgery. No significant difference in performance was seen when comparing pre-op to post-op performance metrics. No pitcher had a recurrent injury.

Complications

Just as LD/TM injures in general are uncommon, complications following non-operative and operative treatment of these injuries are rare. The most common complication following non-operative management of LD/TM tears is a reinjury/restrain of the muscles that requires either a second round of non-operative treatment or an operative repair [12, 13]. There is risk of injury to several nerves during operative repair, specifically the radial nerve and axillary nerve, although no reports of permanent injuries to these nerves have been published to date.

Conclusion

Tears of the latissimus dorsi and teres major are uncommon but significant causes of dysfunction in baseball pitchers. These injuries can be difficult to diagnose and must be considered when pitchers present with shoulder/arm pain. Non-operative management is the mainstay of treatment when there is a signal along the LD/TM or a partial-thickness tear is present. When pitchers present with a full-thickness tear, with or without retraction, consideration should be given to early operative management. With proper management, pitchers who sustain a LD/TM injury are often able to RTS at a high level.

Compliance with Ethical Standards

Conflict of Interest Brandon J. Erickson and Nina Petronico declare no conflict of interest.

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