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Acute Pectoralis Major Rupture Repair at the Myotendinous Junction with Dermal Allograft Augmentation: A Surgical Technique and Review of the Current Literature

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Abstract

The pectoralis major (PM) tendon plays a critical role in upper body strength and shoulder function, particularly in physically active individuals. Unlike chronic tears, which usually require more technical demand, acute tears of the PM can be primarily repaired in the right tear pattern identified in a timely manner. We describe a surgical technique for primary repair with dermal allograft augmentation of a PM tear at the myotendinous junction (MTJ) in a young law enforcement officer and review the available relevant literature. We aim to contribute to the growing body of evidence supporting the utility of dermal allograft augmentation in acute PM tear repair.

Keywords: Pectoralis tear; Myotendinous junction; Surgical technique; Dermal allograft; Upper extremity

Introduction

Acute PM ruptures typically occur during eccentric contraction under heavy load and are usually treated with primary tendon repair. Risk factors include anabolic steroid use (reported in 94.5% of cases in the current literature), nicotine, and fluoroquinolone antibiotics [1]. MRI remains the gold standard for diagnosis, though its accuracy decreases in partial or MTJ tears due to complex anatomy [2]. Most acute tears (<6 weeks) are avulsions from the humerus and amenable to direct repair. MTJ tears, seen in 24–29% of cases, may require modified fixation due to limited tendon length [3]. Chronic or massive subacute tears often necessitate reconstruction with graft augmentation to bridge retracted defects and reduce repair tension [4–7].

Various grafts have been described, including semitendinosus, Achilles, tensor fascia lata, patellar tendon and dermal allograft (acellular dermal matrix, ADM) [7–16]. ADM use is uncommon in acute repairs. In a series of 104 cases, Kowalczuk et al. reported only four augmented repairs, all of which were chronic [17]. Still, ADM augmentation may be beneficial in acute cases with short or poor-quality tendon (e.g., MTJ tears), enhancing repair strength and reducing tension [18]. Mirzayan et al. showed that ADM significantly increased (35%) ultimate load to failure in a cadaveric PM repair model [19]. We present a case of an acute PM tear in a young law enforcement officer, detailing surgical technique, rationale for ADM augmentation, and review the relevant available literature.

Case Presentation

History and Exam

Our patient was a 26-year-old right-hand dominant male law enforcement officer who works in the K9 division. Before his injury, he was experiencing anterior shoulder discomfort and pain when handling the police dogs on leashes. On the day of injury, he participated in a jujitsu session in the morning, and after work, he was attempting a bench press personal best of 515 pounds when he heard a pop in his right shoulder, followed by immediate pain. After two referrals, one from a non-surgical sports medicine physician and another from an orthopaedic surgery generalist, he was seen in our office approximately three weeks after his injury.

Notable findings on the initial physical exam included limited shoulder range of motion (ROM) due to pain, loss of the axillary contour and reduced shoulder adduction strength (4/5). Clinically, there was also a noticeable difference in the contour of his pectoralis muscle with asymmetry of the nipple line (Figure 1). This has been historically referred to as the dropped nipple sign [20]. A preoperative MRI was obtained for surgical planning (Figure 2). This revealed an acute full-thickness tear of the sternocalvular head of the pectoralis major with its distal tendon remaining attached to the lateral bicipital groove. The tear was noted to be approximately 8.2 cm medial to its insertion on the humerus. There was also edema noted of the lateral muscle fibers indicating prior muscle-tendon unit strain. At this time, he was scheduled (33 days after the initial injury) for primary PM repair with dermal allograft augmentation. The patient signed informed consent for external release of his surgical records and clinical pictures. IRB approval was not required.

Our rationale for the augmented repair was the idea that repairing tendon (laterally) to muscle (medially) would not be as strong as a tendon-to-tendon or tendon-to-bone repair. With these grafts advertised to improve the tensile strength of repairs and offer a scaffold for host tissue integration, we believed dermal allograft augmentation would be well-suited and diminish our risk for repair failure in this young, active law enforcement officer who was regularly bench pressing over 300 pounds.

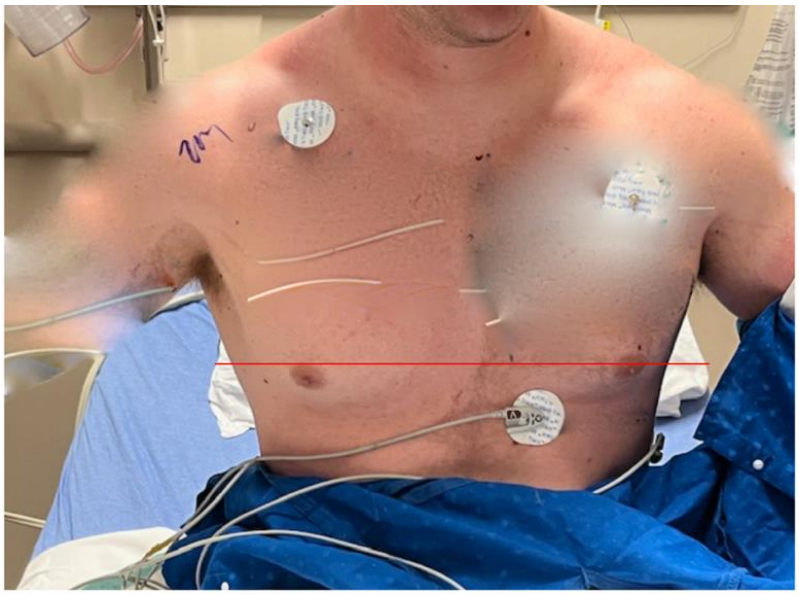

Figure 1: Pre-operative clinical photograph showing asymmetric nipple line ("dropped nipple sign") . Muscle retraction due to tearing causes the ipsilateral side to droop.

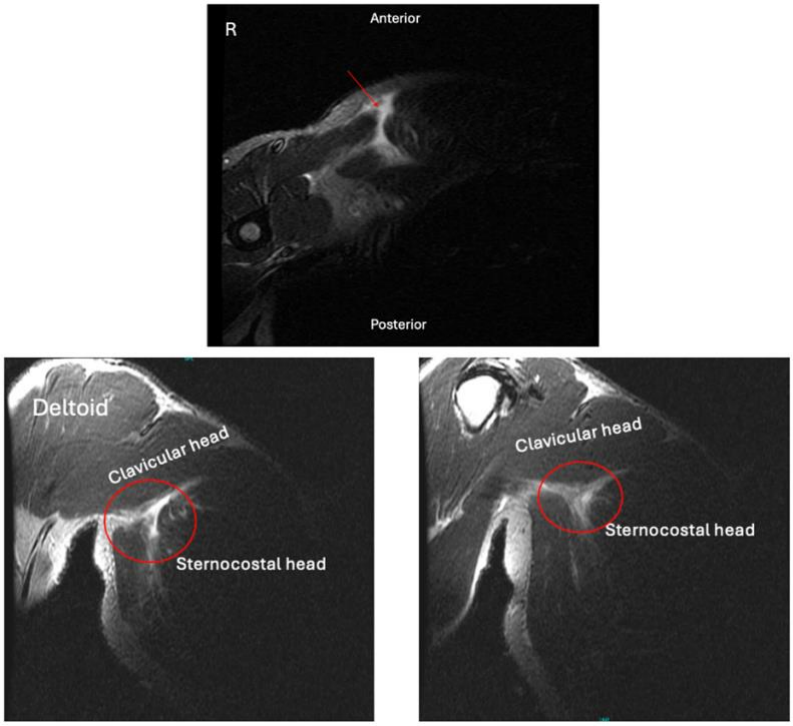

Figure 2: Preoperative axial (top) and coronal (bottom) STIR sequence MRI images demonstrating tear with surrounding edema of the pectoralis major at the myotendinous junction. Tear location was measured at 8.2 cm medial to its insertion on the humerus.

Surgical Technique

After informed consent was signed and the patient's right shoulder was marked, the patient was brought to the operating room. The patient's right upper extremity was prepped and draped in sterile fashion in the supine, partial reverse trendelenburg position on the operating table. A modified deltopectoral incision was made slightly medial over the PM, extending laterally towards its insertion. Sharp dissection through the skin and blunt dissection through subcutaneous tissue was performed. We identified the seroma near the MTJ which was used to accurately identify the tear. Palpation of the bicipital groove and biceps tendon (long head), between the PM (lateral) and latissimus dorsi (medial) insertions, was performed to confirm both the integrity of the muscle's insertion and the location of the lateral segment of our musculotendinous unit.

We then localized and isolated the medial portion of the pectoralis major tear (Figure 3). This was mobilized and pulled laterally to assess excursion and feasibility of primary repair to the lateral portion of the tear. Once adequate approximation of the two segments was confirmed, we primarily repaired the medial and lateral portions of the PM tendon using figure-of-8 interrupted sutures with #2 fibertape. This was facilitated by a very small segment of tendon still attached to the lateral portion of the tear, allowing partial tendon-to-tendon suturing. We then overlayed our dermal allograft patch (4x7 cm, 2mm thick) and sutured it onto our primary repair using #2 fibertape in a locking Krackow fasion for added reinforcement to our repair (Figure 4). Finally, the primary repair and dermal allograft construct was sutured into the intact superior clavicular head using #2 fibertape in a running locking fashion (Figure 5). We noted good clinical contour of the pectoralis major at this point. Abduction of the patient's right arm to approximately 45 degrees was achieved intraoperatively without excessive straining of the repair.

Copious irrigation and layered closure of the surgical wound was performed. After interrupted subcutaneous closure with 2-0 vicryl suture, the skin layer was closed with 3-0 monocryl in a running subcuticular fashion. The patient's right shoulder was placed in a sling and swathe. He was allowed no active or passive ROM immobilized in the sling postoperatively for one month.

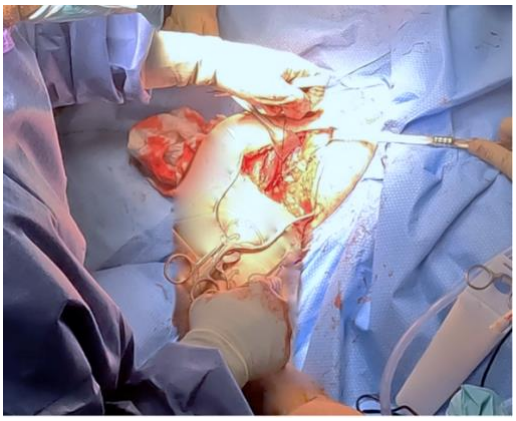

Figure 3: Modified deltopectoral incision centered medially over the pectoralis major, extending laterally toward the muscle's insertion on the humerus.

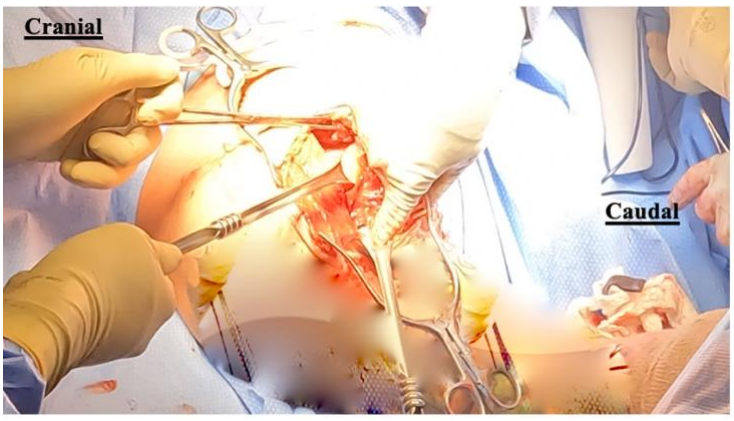

Figure 4: Intraoparative palpation of the bicipital groove and biceps tendon (long head). This was performed to confirm the integrity of the insertion of the pectoralis major just lateral to the bicipital groove and to localize the lateral portion of the musculotendinous unit of the pectoralis major insertion.

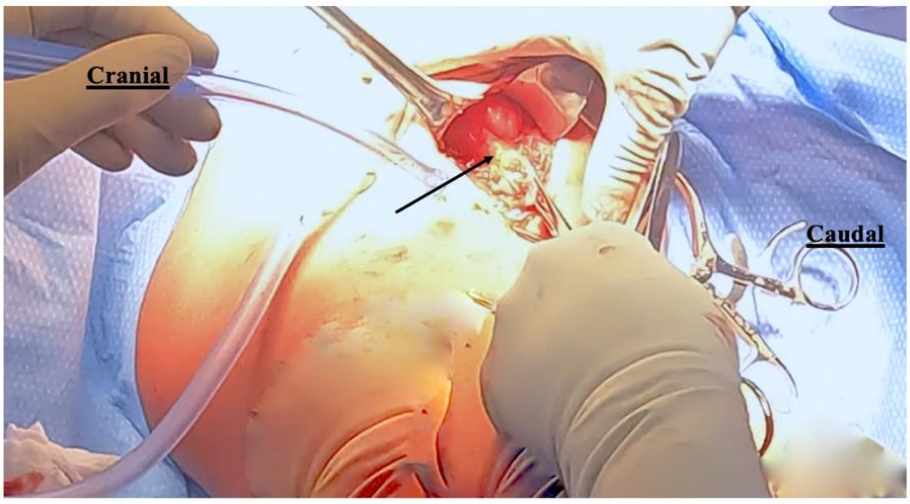

Figure 5: Intraoperative identification and isolation of the medial portion of the pectoralis major tendon tear.

Postoperative Course

At his first postoperative visit one month after surgery, the patient's pain was well controlled and there was maintenance of adequate cosmetic contour of the PM (Figure 6). He did demonstrate tightness with passive shoulder forward flexion (FF) and abduction beyond 90-100 degrees. At this point his sling was discontinued and he was allowed to perform AROM exercises in front of the body only without any resistance or external rotation (ER). Physical therapy (PT) was begun for ROM only. At his 2.5 month postop visit, the patient did demonstrate some residual scar tightness and we recommended continued stretching with PT. We allowed him to begin gentle strengthening exercises of the right shoulder focusing on low weight, high repetitions. He was released back to work two weeks later.

4.5 months postoperatively he endorsed no pain, had full ROM of the right shoulder and was back to bench pressing up to 200 pounds. At this time, he was back at work on full duty. He was allowed to increase his weightlifting load as tolerated, but we recommended he be cautious and avoid one repetition max lifts if possible. Seven months after surgery, he was back to full duty at work without any issues. At this time, he stated he was bench pressing up to 265 pounds for a couple of reps and had just recently resumed jiu-jitsu. His only concern was the slight apprehension about re-injuring himself and a feeling of mild stiffness in the shoulder with full abduction of the shoulder. Since the injury, he has given up powerlifting and does not plan to perform another 1-repetition max bench press. At this seven-month postoperative timepoint, he had an ASES score of 97/100 and a Constant shoulder score of 97/100.

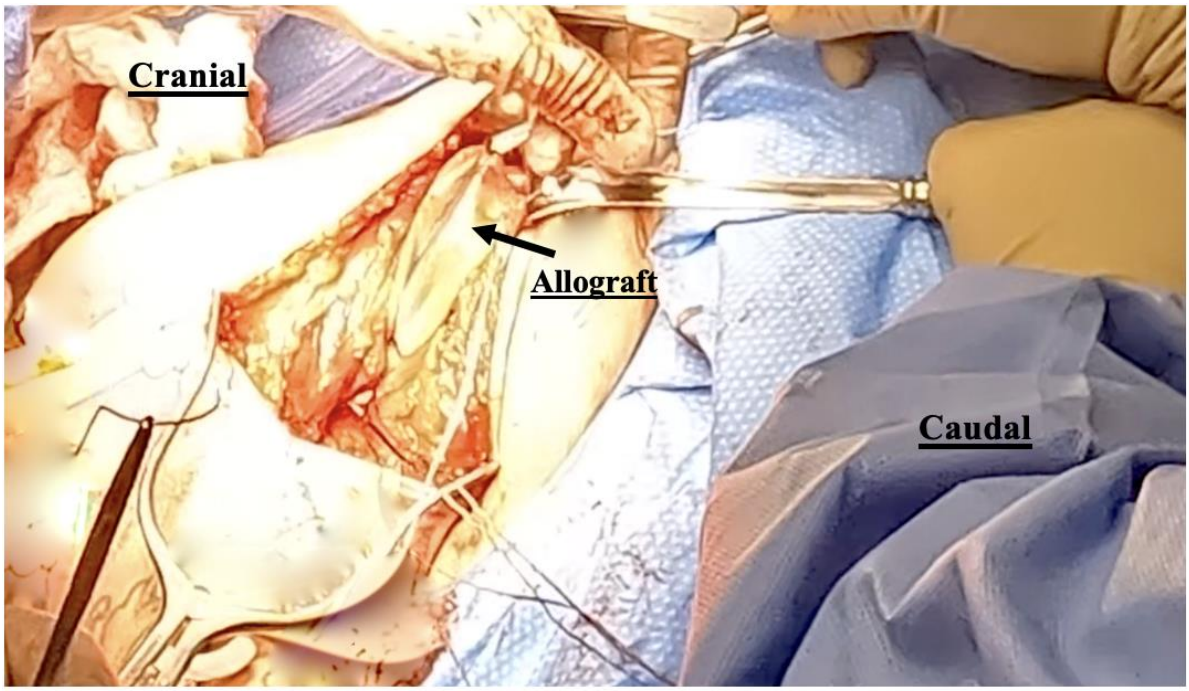

Figure 6: Onlay of our dermal allograft patch onto the underlying primary pectoralis major repair for added reinforcement.

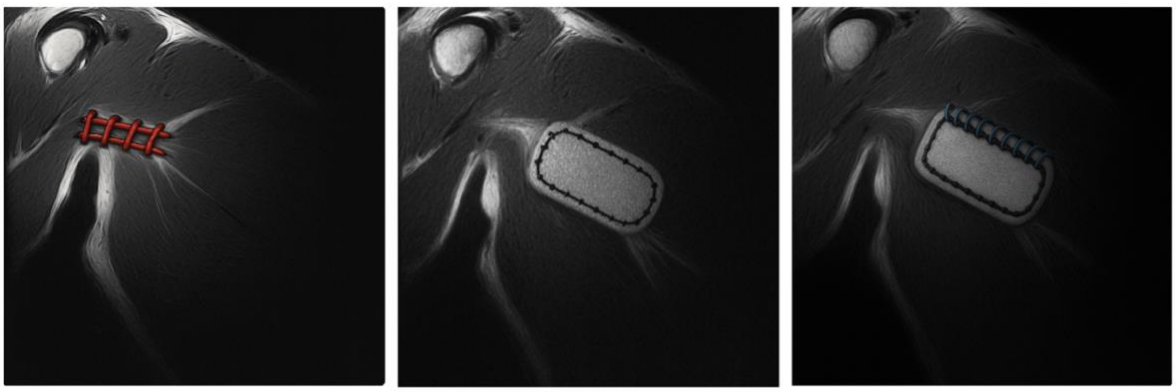

Figure 7: Graphical representation of repair technique. Primary repair of the rupture where feasible was first performed (left). The dermal allograft was then onlayed to the primary repair and sutured in place with a krackow technique (middle). The repair was further reinforced by suturing our graft repair to the intact clavicular head in a running-locking fashion (right).

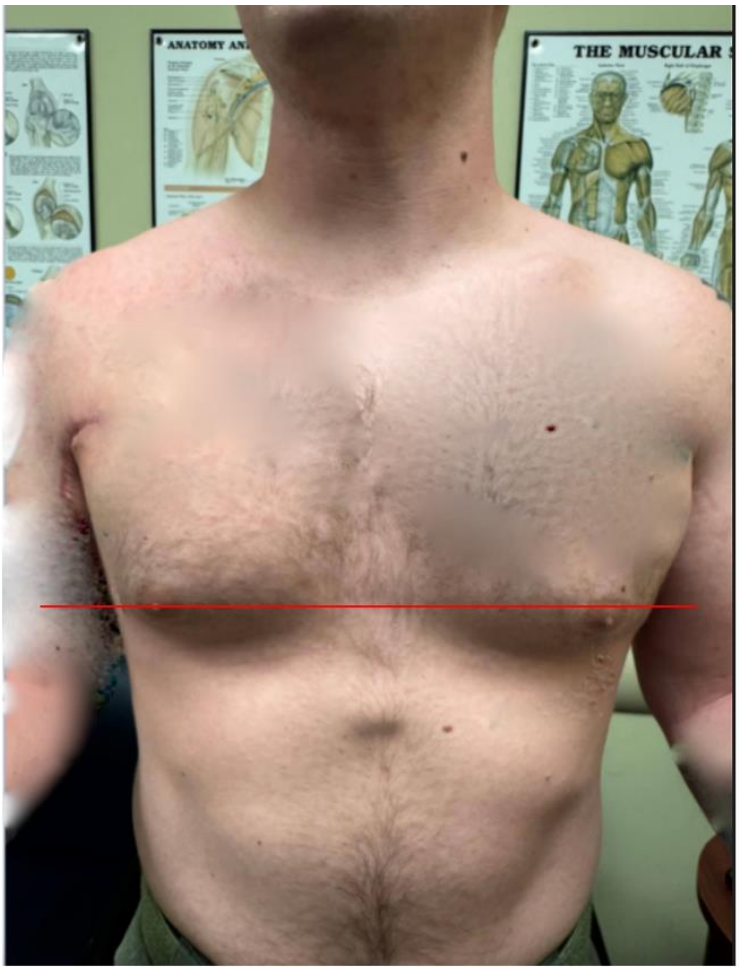

Figure 8: Postoperative clinical picture demonstrating resolution of the "dropped nipple sign" on the right side. Compared to preoperatively, there is more cosmetic symmetry of the pec contours.

Discussion

PM tears most commonly occur in young, athletic males in their 20s to 40s, often during high-intensity exercise such as bench pressing [8,17,21-24]. Injury typically results from eccentric contraction under excessive load with the shoulder abducted and externally rotated—the position most prone to failure [25]. The most frequent tear location is the tendinous insertion on the humerus (59–75%), followed by the MTJ (17–27%), with intramuscular tears being exceedingly rare [24,25]. Although MTJ injuries are increasingly reported, insertional avulsions remain more common in younger individuals [2]. However, there are recent reports of midsubstance PM tears occurring in the mid-teenage athletic population [26,27]. Complete tears are more prevalent than partial, and the sternal head is more often involved than the clavicular head [1]. In the case of PM tear repair, the overall rerupture rate has been reported to be from 2.9-5.4% [28,29]. One of the theoretical advantages of using dermal allograft is to reduce the re-rupture rate during the initial tendon healing phase.

Treatment should be individualized based on patient age, activity level, chronicity, tear location and return-to-sport goals. That said, data are extremely limited on acute tear dermal allograft augmentation. Most patients with acute PM ruptures do well with standard repair alone, so augmented repairs are typically reserved for unusual acute scenarios (e.g., MTJ tears or tears with poor-quality tissue). The theoretical benefits include a stronger repair and reduced risk of failure. The biomechanical advantage of ADM augmentation (higher failure loads) supports this benefit [19]. From a clinical perspective, authors like Cooper and Mirzayan have noted that using a dermal patch gave them "more confidence" in the repair and allowed early motion protocols [18].

In the case of an acute MTJ tear, dermal allograft augmentation can help extend and fortify the MTJ. This helps achieve a tension-free repair in acute cases with short tendon stumps, potentially reducing the risk of suture pull-through. The limited cases of dermal allograft augmentation in the acute setting demonstrate good to excellent functional outcomes, with patients returning to pre-injury activities and no significant strength deficits [22]. Early mobilization has been possible without compromise of the repair in the reported cases.

Operative vs Nonoperative Treatment of PM Tears

Surgical repair is widely considered the preferred treatment for complete PM ruptures in active individuals, with studies reporting excellent or good outcomes in over 90% of cases [24,30]. Nonoperative management is associated with lower return-to-sport rates and greater strength deficits [3,18,24,25,31]. Acute repair within six weeks yields superior functional and cosmetic outcomes compared to delayed repair, though the latter can still be effective when augmented in cases with tendon retraction [22,32].

Various surgical techniques—transosseous tunnels, suture anchors, and cortical buttons—offer comparable biomechanical strength and clinical outcomes. In a systematic review of 384 PM injuries, Bodendorfer et al. found that acute repair significantly improved function and cosmetic satisfaction, with a trend toward more pain-free recoveries [28]. In a separate meta-analysis of 664 PM tears, they also reported that operative treatment led to better functional outcomes (23.3%), isometric (77%) and isokinetic (29%) strength, and cosmetic satisfaction (14%) compared to nonoperative treatment, along with near-universal improvement in resting deformity [22].

Although shoulder ROM often normalizes after nonoperative treatment and ADLs may be pain-free, residual deformity and reduced strength are common. Hanna et al. reported that 33% of patients managed nonoperatively were unable to return to work or sport [30]. Overall, surgical repair is recommended for full-thickness PM tears in active patients, with nonoperative treatment reserved for those who are poor surgical candidates or sedentary [3,18,24,25,30,33].

Return to Work/Sport

Return to work and sport is a critical outcome following PM tears, especially in military and high-level athlete populations. In a cohort of 257 active-duty servicemen (72% treated surgically within 3 months), Nute et al. reported a 94% return to full duty at preinjury function levels [29]. Similarly, Balazs et al. found that 95.3% of 291 servicemen treated surgically at a median of 27 days post-injury returned to full duty [34].

Yu et al. conducted a 2018 systematic review of 149 PM repairs and reported a 90% return to sport at a mean of 6 months post-op, with 74% resuming preinjury performance levels [35]. In a prospective series of 44 patients, Liu et al. found that while 97.7% returned to sport, only 50% did so at the same or greater intensity. Significant declines were noted in 1-rep and 5-rep max bench press, dumbbell press and fly, and push-up capacity. Prior contralateral shoulder surgery was linked to decreased return at previous intensity (OR 0.60), whereas sports-related injury was a positive predictor (OR 2.2) [36].

Cordasco et al. reported on 40 male athletes (mean age 34) with acute PM repairs—60% involving the MTJ—and found 100% returned to sport by 5.5 months, with >80% achieving good or excellent outcomes. Cosmetic concerns were the main limiting factor in perceived recovery [23].

Dermal Allograft Augmentation in PM Repairs

As stated previously, there is limited existing data on the utility of dermal allograft augmentation in acute PM repair, specifically in tears at the MTJ. Cooper et al. described a technique of suturing the allograft patch to the torn tendon/muscle and subsequently anchoring this unit to the humeral insertion along with the native tendon [18]. They note that PM tears often leave a short stump requiring suturing into muscle which has reduced pull-out strength compared to tendon-to-tendon or tendon-to-bone repairs. In chronic, subacute or massive tears there is usually a large soft tissue void that does not permit feasible primary repair. The use of dermal allograft to bridge this defect and strengthen the repair has been frequently utilized in this situation [7,37]. Its use for tendon reconstruction has also shown good results for “irreparable” tears in the military population [38].

In a recent case series of nine military personnel with chronic PM injuries with significant retraction, Nute et al. showed that despite delayed repair (average 14.5 months post-injury), significant improvements (4.5 year follow-up) in shoulder strength were achieved along with high rates of return to duty after PM reconstruction with dermal allograft augmentation [39]. In a study of 19 chronic PM tears repaired with dermal allograft augmentation, Neumann et al. demonstrated promising outcomes, where they observed significant improvements in DASH and VAS scores [11].

Complications of Dermal Allograft Augmentation

In general, biologic graft use in PM repairs has shown a low complication rate [22]. In their case series of 9 PM reconstructions with allograft augmentation, Nute et al. reported one re-rupture (11%) and two cases of persistent pain (22%) [39]. However, in a systematic review of 603 PM repairs, 42 of which were chronic or subacute with significant retraction and thus augmented with grafts, Bodendorfer et al. reported no graft-related complications at an average follow-up of 37 months [22].

In their retrospective review of 19 chronic PM repairs with dermal allograft augmentation, Neumann et al. demonstrated that increased age was associated with worse pain scores and less FF and ER. In addition, worker’s compensation patients demonstrated worse SANE, Constant and ASES scores [11]. Further, a 2-head tendon tear and use of more than one graft was associated with decreased postoperative abduction, likely due to an excessive amount of tension on the repair.

Conclusion

We believe that prior PM strain at the myotendinous junction in our patient, demonstrated by his antecedent anterior shoulder pain at work, likely predisposed the MTJ to fail before the tendon at the humeral insertion. This phenomenon has been reported in the past [40]. With an ever-increasing competitiveness and full-year participation being seen in sports, PM tears at the MTJ are likely to become more and more prevalent. Timely diagnosis and repair have been shown to lead to better outcomes and allows a more straightforward repair in most cases. We believe that our technique may have efficacy in the armamentarium of surgeons treating PM tears, especially for tears at the MTJ in patients putting exceedingly high stresses on the shoulder and PM.

Augmentation in tendon and ligament repair is becoming more common, as surgeons and researchers seek ways to improve healing, strengthen repairs and minimize graft morbidity [41]. There has been a robust pipeline in new biologic, synthetic and hybrid scaffolds entering the market, evidenced by the development of ten new devices in just the last decade and a half [42]. There has also been a simultaneous uptick in publications and clinical trials focusing on technique refinement and clinical outcomes of augmented repair. Augmentation strategies have transitioned from niche applications to mainstream consideration in managing large, chronic, or complex tendon injuries—supported by evolving evidence and commercial innovation.

Ongoing clinical experience and future studies (perhaps comparing augmented vs. non-augmented acute repairs) will better clarify the role of dermal allografts in acute PM injuries. Our case and the limited available evidence indicate that dermal allograft augmentation is a safe and effective option to reinforce acute PM tendon repairs when direct repair alone is insufficient [19].

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