TECHNICAL NOTE

A Novel Surgical Technique and Narrative Review for Pectoralis Major Tendon Repair: Integration of Unicortical Button Fixation and DX Reinforcement Matrix Augmentation

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Abstract

Pectoralis major tendon (PMT) ruptures are increasingly seen in athletes, particularly weightlifters, often requiring surgical repair to restore function. Current surgical techniques may be limited by poor tendon quality or significant retraction. We present a novel approach combining unicortical button fixation with DX Reinforcement Matrix augmentation in a competitive weightlifter with a complete PMT rupture and contralateral pectoralis dysfunction. Intraoperatively, the tendon was augmented with a DX Matrix and fixed using a unicortical button to restore the anatomic footprint and reduce repair tension. The patient underwent structured rehabilitation and returned to full activity within six months. MRI at 12 months showed intact tendon healing at the anatomical footprint without graft failure or retraction. The Oxford Shoulder Score was 48 at six months, indicating high patient satisfaction. This technique is designed to provide a biomechanically robust and biologically supportive solution for complex PMT repairs and may improve outcomes, particularly in high-demand individuals. Further evaluation in larger cohorts is needed.

Level of evidence: V

Keywords: DX reinforcement matrix, Functional outcomes, Pectoralis major tendon rupture, Surgical repair, Tendon augmentation, Unicortical button fixation

Introduction

The rupture of the pectoralis major tendon (PMT) has increasingly become a common injury over the past two decades, paralleling the growing popularity of high-demand sports and activities, such as weightlifting and bench pressing.[1] First described by Pattisier in 1822, this injury predominantly affects active individuals.[2] The typical mechanism involves a sudden eccentric load applied to a maximally tensed muscle, often when the shoulder is abducted and externally rotated.[1,3] Recent studies indicate a 40% rise in PMT injuries among NFL players over the past 22 years, underscoring its increasing clinical relevance.[4]

Anatomically, the pectoralis major has two heads, the clavicular and sternal heads, which merge together to insert on the lateral lip of the bicipital groove of the humerus.[5,6] The peculiar twisting fibre arrangement around the tendon places predispositions to failure under eccentric loading; thus, most ruptures have been located at either the tendon-osseous junction-about 65%-or the musculotendinous junction, about 27%.[5,7,8] While PMT ruptures are not debilitating in most daily activities, they lead to significant deficits in adduction, internal rotation, forward flexion, and shoulder extension, thus seriously impacting patients in high-demand activities or sports.[1]

Managing PMT injuries remains particularly challenging in chronic cases involving medial retraction, scar tissue, and impaired length-tension dynamics.[4] While nonoperative treatment may be adequate for low-demand individuals

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with partial tears or underlying medical conditions, surgical repair consistently yields better results. Studies report significant advantages in strength restoration, functionality, and aesthetics following surgery.[1,5,9] For example, a meta-analysis by *Bak et al.* found excellent outcomes in 88% of surgically treated patients, compared to just 27% for conservative management.[5]

Even with the clear advantages of surgical repair, no single technique has emerged as the standard of care.[10-12] Traditional methods, including transosseous sutures, suture anchors, and cortical buttons, are often limited by biomechanical weaknesses, particularly at the suture-tendon interface.[11] Cadaveric studies consistently report failure through suture pullout rather than construct integrity, emphasising the need for improved suture fixation and tendon handling.[13,14] Furthermore, chronic injuries (38% of PMT cases) exacerbate these challenges due to tendon medial retraction and the need for augmentation to restore the anatomic enthesis.[15,16]

However, despite investigating various augmentation techniques using autografts, allografts, and dermal matrices, one method has not consistently proven to be better than another regarding clinical and biomechanical outcomes.[13,14] Similarly, ADM has been demonstrated to increase strength following repair through various mechanisms, including improved suture pullout strength and maximum load to failure in some biomechanical studies.[17,18] Current techniques for integrating ADM into PMT repair remain non-standardised and non-reproducible.

We present a novel surgical technique that combines unicortical button fixation with DX reinforcement matrix augmentation to optimise pectoralis major tendon (PMT) repair. This approach strengthens the suture-tendon interface and improves repair stability, addressing the biomechanical challenges of traditional methods.[1] Unicortical buttons ensure robust fixation and efficient force distribution at the humeral insertion, while the DX reinforcement matrix (Arthrex, Naples, FL) increases the tendon footprint and enhances load-sharing. Together, these elements enable anatomic restoration of the PMT, reduce repair tension, and create optimal conditions for biologically favourable healing. This reproducible technique improves patient outcomes by restoring functional strength and facilitating an early return to demanding activities.

Surgical Technique

Preoperative Planning

•Patient Selection

This surgical technique was performed in patients meeting specific indications. Patients with contraindications were managed non-operatively [Table 1]. This patient had a history of burn and dysfunctional contralateral pectoralis major tendon.

Table 1. Patient selection criteria for the DX Reinforcement Matrix Augmentation with Unicortical Button Fixation

Patient selection criteria	
Indications	• Acute tendon avulsion injuries in high-demand individuals (e.g., athletes, manual laborers) requiring full recovery of shoulder adduction, internal rotation, and forward flexion. • Chronic injuries with tendon retraction eligible for augmentation and persistent shoulder dysfunction or deformity (e.g., dropped nipple sign). • Partial tears causing significant functional deficits despite conservative management.
Contraindications	• Irreparable tears with extensive retraction or poor tendon quality making repair unfeasible. • Low-demand patients where pectoralis major tendon function is not critical for daily activities. • Significant medical pathologies contraindicating surgical intervention, such as severe cardiopulmonary disease or inability to tolerate general anesthesia.

• Imaging and diagnostics

Imaging plays a crucial role in preoperatively planning pectoralis major (PM) ruptures, aiding in diagnosis confirmation, injury severity assessment, and surgical planning. Radiographs are typically the first imaging modality used during the initial outpatient appointment. Following clinical and radiographic evaluation, Magnetic Resonance Imaging (MRI) is requested as the gold standard for assessing PM ruptures. In acute cases, ultrasound may occasionally be used for dynamic evaluation of PM injuries [Table 2].

Table 2. Imaging Evaluation of Pectoralis Major Ruptures

Imaging Modalities		
1. Conventional Xray	*Objective*	Exclusion of bony compromise (eg. humeral avulsions, glenohumeral dislocations, fractures of the lateral lip of the bicipital groove etc.)
	Protocol	True AP, Axial Views
	Findings	Avulsion fracture, osseous injury

Table 2. Continued

2. Magnetic Resonance Imaging	*Objective*	Confirm diagnosis (e. tear location, tendon medial retraction assessment, muscle atrophy evaluation etc.)
	Protocol	MRI of the chest (not shoulder) axial and coronal. Weighted sequences T2 (acute findings like edema, hematomas, periosteal stripping), T1 (chronic changes like fibrosis and adhesions).
	Findings	Tear localization (tendo-osseous or musculotendinous junction), retraction distance, hematomas or adhesions
3. Ultrasound	*Objective*	Dynamic evaluation or when MRI is not available.
	Protocol	Supine position with ABER arm placement. Examine both PM heads and their insertional footprint. Evaluate the deltopectoral groove and coracobrachialis for tendon retraction tendon and hematoma.
	Findings	Muscle thinning or heterogeneous echogenicity. Hypoechoic thickened tissue indicating periosteal stripping or fibrosis.

•Preoperative preparation

A standard preoperative preparation has been followed, involving patient counselling, education, fasting protocol and preoperative optimisation [Table 3]. General anaesthesia combined with an interscalene nerve block was used to ensure effective intraoperative anaesthesia and postoperative pain control.

Table 3. Preoperative Preparation

Preoperative Preparation	
1. Patient counselling	Surgical technique, expected outcomes, potential risks and complications
2. Education	Postoperative protocol, immobilization period, rehabilitation milestones
3. Fasting protocol	Preoperative timeframes for drinking and eating
4. Preoperative optimization	Anticoagulants discontinuation, management of diabetes, hypertension etc

1. Patient Positioning and Setup

The patient is in the modified beach chair position with the head elevated at 40-45 to optimize access to the axillary region and humeral insertion site. General anaesthesia combines an interscalene nerve block to achieve muscle relaxation and minimise postoperative pain. The operative arm is prepped with chlorhexidine gluconate, draped with ioban, and supported on a Trimano positioning system (Arthrex, Naples, FL) to facilitate free manipulation and stabilisation throughout the procedure. Key topographical landmarks, including the anterior axillary fold, coracoid process and the deltopectoral interval, are marked preoperatively for orientation [Figure 1].

•Key Considerations

- Ensure proper arm positioning in slight forward flexion, abduction, and internal rotation to optimise access.
- Palpate for defects in the anterior axillary fold accentuated by shoulder abduction and external rotation. Retracted tendon fibres are typically found medially on the chest wall.

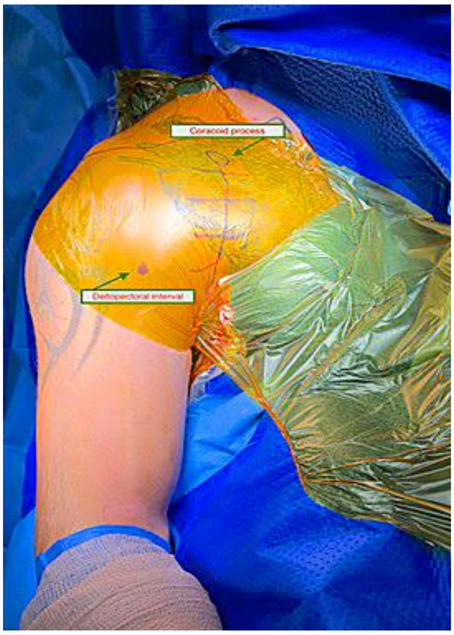

Figure 1. Patient positioning and anatomic landmarks

2. Incision and Exposure

A 4-5 cm oblique incision is made in line with the axillary crease. Dissection proceeds slightly medial to facilitate tendon retrieval through the soft tissue planes medially and laterally to expose the clavipectoral fascia, ensuring that the dissection remains lateral to the coracoid process to avoid injury to medial neurovascular structures. A Gelpi retractor is used for consistent visualisation. The clavipectoral fascia is split, revealing the clavicular head of the pectoralis major, typically preserved in isolated sternal head injuries. A hematoma often surrounds the injured tendon, aiding in identifying the tear. Suction is used to remove the hematoma, and blunt dissection releases adhesions around the superior and inferior surfaces of the tendon. When the clavicular head is also involved, it is repaired using the same principles.

•*Critical Maneuvers*

- Stay lateral to the coracoid process to avoid injury to medial neurovascular structures.
- Use a Gelpi retractor to maintain exposure and free the assistant for other tasks.

•*Landmark Identification*

- The bicipital groove and pectoralis major footprint are identified using residual tendon fibres and anatomical references such as the clavicular head.

3. Tendon Preparation and Augmentation

The macerated tendon insertion is prepared for augmentation using a DX Reinforcement Matrix (Arthrex, Naples, FL). This acellular dermal allograft provides mechanical support to the weak tendon, optimising the repair. The augment is positioned over the superior surface of the tendon [Figure 2] and sutured in place using FiberWire #2 in a Krackow whipstitch technique [Figure 3], ensuring secure fixation and uniform load distribution. The suture tails (3-4 suture tails) exit the superior surface of the tendon, facilitating subsequent approximation to the humerus. Tendon mobilisation is performed to ensure that the repaired complex can be reduced to the native footprint without tension.

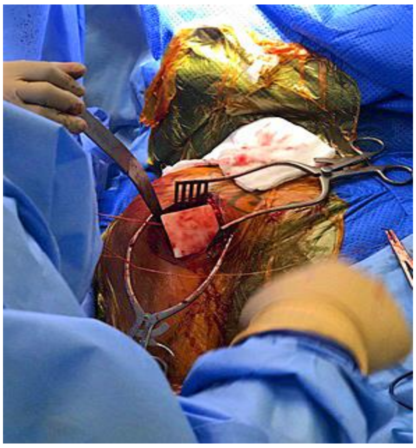

Figure 2. Allograft placement. The allograft is placed over the pectoralis tendon

Figure 3. Allograft suturing. The allograft is sutured to the tendon with Fiberwire #2

•*Critical Step*

- Mobilize the tendon sufficiently to achieve an anatomic reduction without excessive tension.

4. Humeral Preparation

The lateral aspect of the bicipital groove is exposed by retracting the deltoid laterally with a 90° Hohmann retractor. The humeral insertion site is identified and excoriated using a curette or motorised burr, creating a bleeding bone surface to promote tendon-bone integration. Three staggered unicortical holes are drilled in the humerus using a 3.7-mm spade-tip drill. The holes are spaced to distribute stress evenly, and care is taken to drill perpendicular to the cortex to allow easy flipping of the fixation buttons while preventing eccentric drilling.

•*Key Considerations*

- Avoid medial drilling into the bicipital groove to prevent biceps tendon injury.

5. Button Loading and Tendon Approximation

The tendon and augment complex is attached to 3x Pec Buttons (Arthrex, Naples, FL), each loaded with 1-2 FiberWire #2 sutures [Figure 4]. The buttons are advanced into the unicortical drill holes, flipped securely into the intramedullary canal, and the suture tails are tensioned sequentially using the tension-slide technique [Figure 5]. This manoeuvre reduces the tendon and augments the complex onto the native humeral footprint. For optimal tendon-to-bone fixation, the sutures must exit on the superior side of the graft. Once the surgeon confirms proper reduction and alignment of the tendon between the augment and the bone, the sutures are tied down securely, ensuring a robust repair.

•*Critical Maneuver*

- Ensure proper alignment of the tendon and augment to the humeral insertion and avoid suture twisting to maintain smooth tensioning.

6. Final Checks and Closure

The repair is tested by bringing the shoulder through a controlled range of motion to ensure stability and secure fixation. The incision is irrigated copiously and closed in layers: absorbable sutures for the subcutaneous tissue and interrupted sutures for the skin. Sterile dressings are applied, and the arm is immobilised in a sling for six weeks.

Figure 4. Reduction of tendon augments to natural humeral footprint. For optimal tendon-to-bone fixation, the sutures should exit on the superior side of the graft

Figure 5. Fixation of tendon augment to the humerus with unicortical Pec Buttons

- ***Postoperative Management***

Postoperative rehabilitation following pectoralis major repair with DX Reinforcement Matrix and unicortical Pec Button fixation is designed to ensure optimal tendon healing while progressively restoring range of motion (ROM) and strength [Table 4]. The arm is immobilised in a sling for 5-6 weeks to protect the repair during the initial healing phase. Scapular stabilisation exercises are initiated immediately postoperatively to maintain shoulder girdle function and minimise compensatory patterns.

The goal is to achieve a full active range of motion (ROM) by six weeks postoperatively. Patients are typically cleared of all restrictions by 12 weeks, with a return to contact sports and high-demand activities permitted at six months, provided strength, endurance, and proprioception have fully normalised. This structured rehabilitation protocol balances progressive loading with tendon protection, ensuring optimal healing and functional recovery.

Table 4: Post-operative rehabilitation program	
Phase I	
Weeks 0-3	• Passive ROM exercises are introduced, emphasizing flexion up to 90° and abduction up to 60° to avoid undue stress on the repair. • External rotation and extension beyond neutral are strictly avoided to prevent excessive tension on the repair site. • Attention is given to preventing stiffness while allowing the tendon-bone interface to heal.
Phase II	
Weeks 4-6	• Passive ROM is progressively increased to achieve full shoulder mobility by the end of this phase, with gradual increments in flexion, abduction, and external rotation within a tolerable range. • Active-assisted ROM gentle exercises are incorporated to encourage controlled functional movement. • The immobilizer is discontinued by week 6 as ROM approaches normal limits.
Phase III	
Weeks 6-12	• Active ROM is initiated once the tendon demonstrates sufficient integration with the humeral footprint. • Resistive strengthening exercises targeting the pectoralis major and shoulder stabilizers are introduced gradually using light resistance bands to ensure proper muscle activation patterns. • Strengthening programs focus on the dynamic stabilization of the shoulder girdle, avoiding eccentric loading on the pectoralis major.

Table 4: Continued	
Phase IV	
Months 3-6	• Resistance strengthening training is progressively intensified, but activities placing significant stress on the repair, such as bench pressing, are deferred until 5-6 months postoperatively to mitigate the risk of reinjury. • Advanced strengthening and functional retraining programs are tailored based on patient-specific goals, with a gradual return to athletic activities or upper-limb-dependent sports.

Results and Biomechanical Rationale

The surgical technique has been applied in the fixation of full pectoralis major rupture of a 43-year-old male weightlifter and personal trainer. The posttraumatic magnetic resonance imaging (MRI) revealed a full thickness, complete rupture of both pectoralis heads. The tendon fixation followed the above-mentioned technique, and the patient was enrolled to the prescribed postoperative rehabilitation protocol. The post-operative MRI in 12 months revealed healing of the pectoralis major tendon [Figure 6].

The patient returned to competitive sports in 6 months postoperatively. The Patient-Reported Outcomes (PROMs) for an Oxford Shoulder Score of 48.

Figure 6. MRI Axial image presenting a healed pectoralis major tendon to the humerus with the DX Reinforcement Matrix attached

Discussion

The surgical treatment of PMT ruptures remains debated, with various techniques offering distinct advantages and limitations. While conservative management may suffice for low-demand or elderly patients, it often leads to weakness, poor aesthetics, and functional deficits in active individuals, making surgery the preferred choice for better strength restoration, improved appearance, and faster return to activity.[6,19] One of the primary challenges in PMT repair is the anatomical nature of the tendon, which is often short or absent at the rupture site, necessitating direct suturing into the muscle belly.[5] This increases the risk of suture pullout and poor load distribution[20], with biomechanical studies showing higher failure rates when the remaining tendon is less than 15 mm in length.[21]

Currently, the most common PMT repair techniques include transosseous suture fixation (TOS), suture anchors, and cortical button fixation.[21] With or without a bone trough, TOS has traditionally been favoured for its strong fixation.[3] However, recent studies indicate that cortical button fixation offers superior load-to-failure strength and improved tendon-to-bone healing. Research shows that unicortical button fixation with high-strength sutures achieves higher peak failure loads than TOS with a bone trough, making it an increasingly preferred method.[22] This technique provides robust tendon fixation while minimising bone disruption, enhancing stability, and reducing cortical fracture risk.

Acellular dermal matrix (ADM) augmentation, such as the DX Reinforcement Matrix, offers a promising solution for addressing short or retracted tendons. ADM increases “functional tendon length,” enhances suture pullout strength, and is a biological scaffold for cell growth and tendon regeneration. Studies on rotator cuff and distal biceps repairs demonstrate that ADM significantly improves load-to-failure strength, reduces re-tear rates, and promotes better healing.[13,15] In PMT repair, ADM provides additional mechanical support at the muscle-tendon interface, optimising load distribution and reducing repair failure due to muscle tearing.

Our novel approach combines unicortical button fixation with DX Reinforcement Matrix augmentation to address the mechanical and biological challenges of PMT repair. The tendon scaffold allows secure suture placement within the muscle belly without excessive tension, while the unicortical button provides strong and consistent tendon reattachment to the humerus. This combination creates a sturdy repair construct suited for active individuals.

Our case study demonstrated excellent functional outcomes, with patients returning to pre-injury activity levels within six months. Twelve-month postoperative imaging confirmed successful tendon healing, with no reported complications and high patient satisfaction during the one-year follow-up.

Despite these promising results, limitations include the cost of allografts, the need for specialised surgical skills, and the lack of long-term comparative data. Future research should focus on long-term functional outcomes, biomechanical studies, and cost-effectiveness to validate this technique further.

This combined approach significantly advances PMT repair, delivering a reliable, biomechanically sound, and biologically supportive solution for challenging injuries.

Conclusion

In the presented case, this novel surgical technique combining unicortical button fixation with DX Reinforcement Matrix augmentation has demonstrated excellent clinical and functional outcome. A 12-month postoperative MRI confirmed successful tendon healing, with restoration of the anatomic footprint and no evidence of graft failure or retraction. Functional assessments showed high patient satisfaction, including an Oxford Shoulder Score of 48. The patient returned to pre-injury activity levels within six months, with no complications such as re-rupture or infection. These results highlight this technique as a potentially reliable and effective solution for acute and chronic PMT injuries, supporting early return to activity and favourable long-term outcomes.

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