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Pectoralis major muscle rupture treated with delayed surgery: Case report and literature review

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Abstract

Pectoralis major muscle (PMM) rupture is an injury leading to both functional and cosmetic deficiency. We are presenting a case report with a review of literature data concerning anatomy, mechanisms of the injury and surgical treatment techniques. The PMM has a sternal head and a clavicular head inserting more anterior and distal to the sternal head. Any activity in which the arm is on extension and external rotation while the tendon is under maximal contraction exposes the PMM to the risk of rupture. Physical examination of acute PM ruptures often demonstrates significant swelling and ecchymosis in the affected region. There are many anatomic classifications proposed for PMM injuries. All studies comparing non-operative with operative management strongly support surgical treatment. Repair techniques vary considerably in the literature, specifically with regard to the fixation method. Patients are immobilized in sling for 6 weeks after surgery with pendulum exercises started since the first week; the return to unrestricted activity is possible at about 6 months postoperatively.

Keywords

pectoralis major muscle; pmm rupture; classification of pmm injuries; surgical treatment of pmm tears

Introduction

Pectoralis major tendon rupture, first described by Patissier in 1822 [1], is a rare injury leading to both functional and cosmetic deficiency. In 1972 McEntire et al. [2] reviewed all 45 cases reported in the previous literature and added 11 more cases. Seven years later, Zeman et al. [3] reported 9 cases, of which five were treated surgically: those ones were able to regain their original muscular strength and return to their previous sport activities. In 1989 Kretzler et al. [4] evaluated the surgical treatment and proposed a reconstruction technique even in chronic cases. Three years later Wolfe et al. [5] concluded that the application of high external forces to the extended arm while the inferior muscle fibers are stretched can cause

a rupture. In 1993 Miller et al. [6] recommended the use of magnetic resonance imaging (MRI) for the diagnosis of suspected pectoralis major rupture. In his meta-analysis of 112 cases, Bak et al. [7] concluded that MRI does not seem to be superior to clinical or ultrasound assessment; they also confirmed that surgical treatment, preferably within the first 4–8 weeks, is associated with a better outcome than conservative management. In 2003 Joseph, Defranco and Weiker [8] reported for the first time a case of delayed repair of pectoralis major tendon rupture with the successful use of an Achilles tendon allograft to augment the repair. In 2006 Roller et al. [9] proposed a classification of PMM injuries made by three types of rupture (type 1: rupture at humeral insertion, type 2: Rupture of musculotendinous junction, type 3: rupture of muscle belly). Four years later, Hart et al. [10] compared the traditional repair technique that uses trans-osseous sutures versus anchors; they found no statistically significant differences between the two techniques. In 2013 the St. Joseph's Health Centre of Toronto established a quantifiable clinical diagnostic test for structurally significant pectoralis major injuries: the Pectoralis Major Index (PMI) [11]. Lately, new surgical techniques like the use of unicortical button fixation with suture tape [12] were proposed. Our study contains a case report with a review of literature data concerning anatomy, mechanisms of the injury and surgical treatment techniques.

Case Presentation

Patient presentation

A 49-year-old male truck-worker felt a snap in his right dominant shoulder while closing a truck back's door (the arm was in abduction and external rotation) and immediately felt a sharp pain. After having rested the arm for a few days and receiving a simple analgesic treatment (Paracetamol) he returned to work. Due to continuing pain and difficulties managing his work he sought medical advice 7 months after the injury. Clinically, there was discomfort and weakness of adduction; the patient was also unsatisfied with the deformity of the anterior axilla. Ultrasound performed prior to clinical investigation showed evidence of an avulsed PM tendon (Figure 1).

Figure 1: Loss of the anterior axillary fold with asymmetry of the chest wall

Operative technique:

The patient was placed in the supine position under general anesthesia. The surgical site was draped with povidone-iodine (Betadine®). A skin oblique incision was made in the deltopectoral groove. The retracted tendon was adherent to the chest wall; mobilization with blunt dissection was undertaken with particular care to avoid injury to lateral pectoral neurovascular bundle (Figure 2). The biceps tendon was protected by pulling it just medial to the pectoralis major insertion when beginning to drill the necessary bone tunnels in the humerus. Two rows of 4 drill holes, each 2mm in diameter, was created to reattach the pectoralis major tendon. A blue polypropylene non-absorbable suture No. 2 was passed through each of the bone tunnels. Once passed through the bone tunnel, sutures were passed through the distal pectoralis major tendon with a Mason-Allen configuration. Finally, the two limbs of the suture were tied laterally to secure the repair. Postoperatively, the affected arm was placed in a sling and immobilized for 3 weeks. Pendulum exercises were started on the second week. Immobilization was followed by passive then active range of motion exercises for 8 weeks. Next, light resistance and strengthening exercises were indicated for 4 weeks.

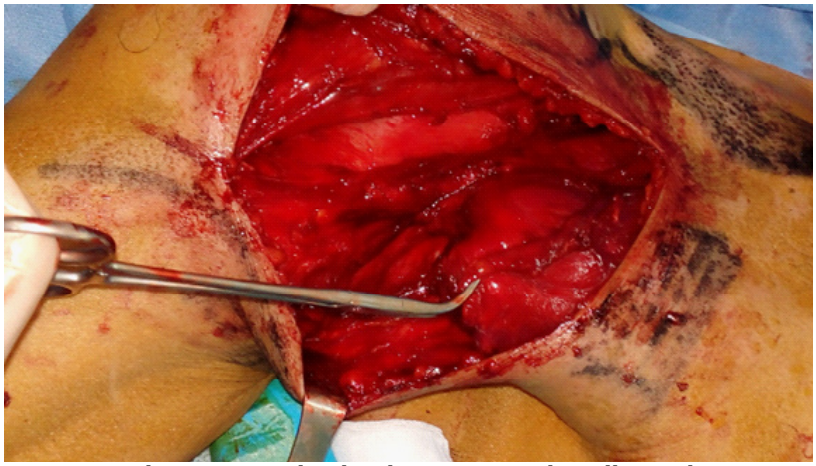

Figure 2: Intraoperative image: Pectoralis major tendon has been retrieved to allow subsequent reattachment to the humeral insertion

Discussion

Anatomy

The PMM tendon inserts into the lateral edge of the bicipital groove, beginning 4cm distal to the tip of the greater tuberosity with an insertional width of 4.8 to 7.7cm and a thickness of 1.4 to 5.6mm [13-16]. A comparison of cadaveric studies [17-21] revealed that PMM demonstrated 2 divisions: a clavicular head (CH) and a sternal head (SH); the SH can be divided along facial planes into 6 or 7 muscle segments and constitute 80% of the total PMM volume. The orientation of each muscle segment anteriorly overlaps the segment below it, similar to an Asian fan (Figure 3). A 3-dimensional digital modeling of the muscle segment conducted by Fung et al. [22] showed no flexing or twisting before humeral insertion. The PMM muscle fibers insert into a bilaminar tendon that consists of distinct anterior and posterior layers that are continuous inferiorly; these 2 tendon layers fuse laterally just before insertion of humerus. The posterior tendon layer extends about 11mm more proximally on the humerus than the anterior layer. The anterior tendon layer receives muscular contributions from the entire CH and the most superior 3 to 5 muscle

segments of the SH; the posterior tendon layer receives muscular contributions from the most inferior 2 to 3 SH segments. The PMM is innervated by 2 nerves: the medial and lateral pectoral nerves. The medial pectoral nerve (C8-T1) [the smaller of the 2 nerves] arises from the medial cord of the brachial plexus. It passes along the lower border of the pectoralis minor. It supplies the inferior portion of the PM [23-25]. The lateral pectoral nerve (C5-C7) emerges from the lateral cord of the plexus before traversing along the upper border of the pectoralis minor muscle. It supplies the upper two thirds of the PMM [26].

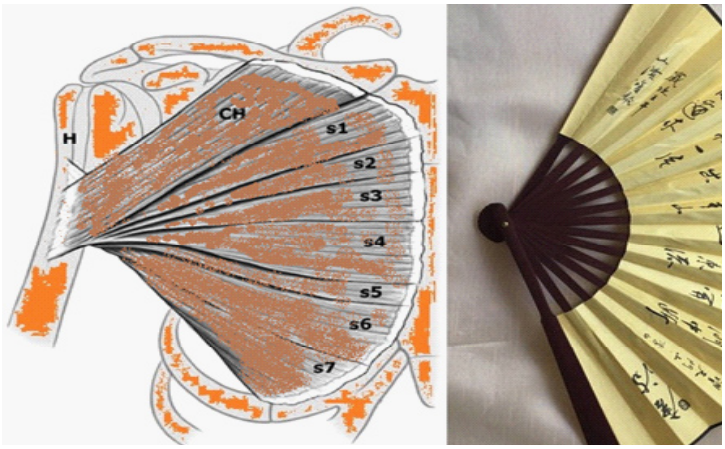

Figure 3: Orientation of muscle's segments; similar to an Asian fan

Biomechanics

The PMM is a broad muscle responsible for adduction, internal rotation and flexion of the humerus as well as dynamic stabilization of the shoulder [2,27,28]; it is also a contributor of the aesthetic appearance of the chest wall. The PMM has significant variation of fiber lengths across segments [5,13,29]. The last two SH segments average about 1 to 2cm less than the SH segments above them [5,22]. The shorter length of the inferior SH segments makes this region of the PMM more susceptible to injuries when the muscle is eccentrically contracted [22].

Patient presentation

Any activity in which the arm is on extension and external rotation while the tendon is under maximal contraction exposes the PMM to the risk of rupture [5,30]. This injury is followed by immediate pain [6, 31-41] and an audible pop [38,42-45] with a tearing sensation [46-48]. The bench press exercises is by far the most common activity that causes PMM ruptures [25]. Some other activities leads to rupture including power lifting [37,49] parallel bar dips [32,38] wrestling [48,50-53] boxing [3] football [3,6,37,45,47,50] rugby [28,37,54] skiing [28,34,50,54,55] sailboarding [5] and parachuting [35,56]. However, some rare cases of rupture at work, just like our case, were reported [2,36,49,50,57,58,54,59,60]. The rupture is almost exclusively found in men between the ages of 20-40 years [49]; women are less predisposed because of the less energetic injuries, the greater muscular elasticity and the larger tendon-to-muscle diameter [25,49].

Classification

In 1980 Tietjen [61] proposed an anatomic classification for PM injuries; it divides PM injuries into 3 principal categories ranging from a contusion through partial to complete tears (Table 1). A more

contemporaneous classification has been proposed by Elmaraghy et al. in 2012 [29]; it takes note of the tear's chronicity, its location, its thickness and width (Table 2). Even with this comprehensive classification, there is a perceptible deficit in quantitative description of the width of injuries, which are defined only by a qualitative "complete" or "incomplete."

Table 1: Tietjen's classification of pectoralis major injuries [61]

Type	Injury pattern
I	Contusion or sprain
II	Partial tear
III	Complete tear :
III-A	Muscle origin
III-B	Muscle belly
III-C	Musculotendinous junction
III-D	Tendinous insertion

Table 2: ElMaraghy's classification of pectoralis major injuries [29]

Timing :	Acute vs Chronic
Location :	1 – Muscle origin or Muscle belly
	2 – At or between the musculotendinous junction and tendinous insertion
	3 – Bony avulsion fracture
Extent (thickness) :	1 – Partial anterior 2 – Full 3 – Partial posterior
Extent (width) :	Incomplete
	Complete

Diagnosis

Physical examination of acute PM ruptures often demonstrates significant swelling and ecchymosis in the affected region [6,7,21,30,33,34,39,45,46,56,59,62-67]. Pain with palpation [6,36,39,51,67] and pain with arm movement [7,63,65] are also common findings. A specific sign of PMM rupture in both acute and chronic stages is loss or thinning of the anterior axillary fold on the side of injury [3,20,42,46,28,31,32,35,36,41,47,48,51,56,59,63,64,67,68] which can be more easily recognized by looking for asymmetry compared with the non-affected side. In chronic cases cicatricial fibrosis, prominent skin fold, webbing, pectoralis atrophy and prominence of the distal deltoid insertion have all been described [5,69]. Finally, with forward elevation, lateral inspection may demonstrate the "S" sign: it's a visible retracted stump within the anterior axillary fold [69]. The efficacy of plain radiographs as a diagnostic tool is limited but should be performed to rule out additional abnormality and assess for the rare bony avulsion injury that occurs 2% to 5% of cases [7,29]; they may also be useful in the skeletally immature patient, which increases the likelihood of ossification and periosteal elevation [40]. Ultrasound has proven to be an effective and relatively inexpensive way to identify and even locate a pectoralis major rupture [21,41,56,62,70-72]. An uninjured pectoralis major can be identified as a hypoechoic region, representing the muscle surrounded by parallel echogenic lines, which represent the perimysium. The epimysium is seen as a dense echoic portion

anterior to the muscle [25]. MRI remains the method of choice to identify partial and complete tears [73,74] and to assess the amount of muscle retraction; for a better study including the tendon insertion a dedicated sequence is required with axial slices extending superiorly from the quadrilateral space and inferiorly to the deltoid tuberosity along with coronal oblique cuts [26]. In the case of tear the normally low signal intensity tendon is absent from a point 1 to 1.5 cm inferior to the quadrilateral space and 1cm superior to the origin of the lateral head triceps [14]. T1-weighted images are more helpful in identification of chronic tears [14,53]. However, it is not clearly shown that MRI is a 100% accurate tool for confirmation of a tear [6,14,50,57].

Treatment Options

Non-operative treatment: Non-operative management of PM ruptures is generally recommended for the lower demand and elderly subgroup of patients, sedentary individuals or those not wishing to undergo surgery [5,21,68]. It may also be appropriated to treat contusions, suspected partial tears or muscle belly ruptures [2,7,75]. Regardless of treatment desired, initial non-operative treatment involves rest, cold compression, control of hematoma, analgesics, and sling immobilization in the adducted and internally rotated position [3,7,21,25,56,73,76]. Passive exercises can begin immediately as tolerated, followed by active exercises with a gradual increase to full motion over the next 6 weeks [73,75]. Heat and ultrasound may also be used [75]. After this, resistance therapy can be implemented and unrestricted activity allowed at 2 to 3 months [23,25]. Return to contact sports should be delayed for 5 to 6 months until full motion and strength return [30]. If non-operative treatment fails to produce desired results over the first 3 or 4 months, surgical repair remains an option [68,70,77].

Operative management: In spite of the fact that the PMM is not required for most activities of daily living [3,21,32,48] it is generally known that surgery is indicated in all young, active patients [3,7,49,75]. It provides the best outcomes in satisfaction, strength, cosmetics, and return to sport for athletes [2-5,7,28,36,37,45,54,70, 78,79]. To effectively repair a PMM rupture both the beach chair [28,45] and supine [26,49] positions through a deltopectoral [4-6,8,28,30,34,40-42,46,49,63,66,68] or anterior axillary [36,45] approach can be employed. Repair techniques vary considerably in the literature, specifically with regard to the fixation method. All techniques require meticulous attention to protect the long head of biceps just medial to the pectoralis tendon insertion.

The suture anchor technique includes removing soft tissue and lightly bradding the footprint. Three rotator cuff–sized suture anchors with high-strength non-absorbable sutures are placed in the footprint. One limb of each suture is passed in a locking fashion in the tendon and tied to its free limb [18].

The bone trough technique requires creating a 5cm trough over the footprint just lateral to the biceps tendon at PMM insertion site. Three or four 2mm holes are made 1cm lateral to the trough. Three high-strength non-absorbable sutures are placed in the tendon in a locking configuration. Sutures are passed into the trough and tied over the bone bridge [45].

The cortical button technique involves the same footprint preparation as for the suture anchor technique. Three No. 2 polyblend sutures (Fiberwire; Arthrex Inc) are passed in a Krackow fashion for a total of 6 suture limbs across the repair site. Three cortical buttons (Titanium Pec Button; Arthrex Inc) are used to secure the tendon to its anatomic footprint. After all of the buttons are placed, one limb from each suture is placed through

the tendon and tied to its free limb, similar to the suture anchor technique [80].

Sherman et al. [81] compared several techniques and concluded that there is no significant difference between fixation devices with regard to cyclic loading or load to failure properties. In his recent biomechanical analysis of modern repair configurations versus traditional repair configuration, Edgar [82] concluded that repair constructs with larger caliber suture offered a significant improvement in construct strength versus traditional PM repair techniques.

The definition of a chronic tear varies in the literature [45,49,83]. Repair strategy may be affected by the chronicity of a rupture; however good outcomes still achievable and chronicity should not be an obstacle to surgical treatment [23,25,29,45,49]. Medial fascial release can be performed in the same approach or through a separate incision to mobilize the myotendinous unit sufficiently [42]. A reconstruction may be more appropriate than repair if sufficient mobilization of the tendon is not possible. When primary repair is not possible there are some alternative techniques like autograft reconstruction (using hamstring, fascia lata, bone patellar tendon) or allograft reconstruction (using Achilles tendon) that have been described to manage chronic cases; they had excellent loading characteristics, favorable physical dimensions and good reported outcomes [26].

Rehabilitation

Patients are immobilized in sling for 6 weeks after surgery with pendulum exercises started since the first week. Abduction and external rotation are avoided [25,30,45], most authors prefer internal rotation [5,41,42,66,70] and adduction [30,36,41,43]. After 6 weeks passive motion can begin in all planes of motion [44]. At 12 weeks the patient can begin light resistance exercises [25,44,55] with return to unrestricted activity at about 6 months postoperatively. High-weight exercises that involve the PM should be avoided permanently [44].

Outcomes - Complications

All studies comparing non-operative with operative management strongly support surgical treatment [2-5,45,54,69,78]. Bak et al. [7] performed a study which concluded that 88% of surgically treated patients experienced excellent results versus 27% of those treated non-surgically, they suggested there was a trivial advantage in operating the rupture if the injury was less than 8 weeks old and while some authors agree [2,8,31,84-86] others confirmed that chronicity does not affect surgical outcome [28,45,54]. One of the most concerning issues after PMM surgery is postoperative infection [33,44,60,76,87]. Hypertrophic scar, stiffness and rupture are other complications reported with operative treatment [4,5,87]. Persistent weakness is the most common complaint with non-operative treatment [3,4,7,45,54,69]. Hematoma, abscess formation, myositis ossificans are other complications described with non-operative treatment [44,45,54,69].

Conclusion

PMM rupture can result from activities in which the arm is maximally contracted in extension with external rotation. It most commonly occurs in young athletic male. Patients typically present with pain, deformity, swelling, ecchymosis and weakness with adduction and internal rotation. Ultrasound and MRI can be helpful in identifying the location of injury. Non-operative treatment can be proposed for partial tears or tears in sedentary

patients. In the young active athlete, surgical treatment is recommended to return the patient to full strength and function.

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