

Pectoralis Major Muscle Belly Rupture: A Narrative Review

Francesco Oliva^a, Francesco Cuozzo^b, Valeria De Cesare^b, Giuliano Sammaria^b,
Roberta Danieli^a, Nicola Maffulli^{c,d,e}

^aDepartment of Human Science and Promotion of Quality of Life,
San Raffaele Open University of Rome, 00166 Rome, Italy

^bDepartment of Musculoskeletal Disorders, Faculty of Medicine and Surgery,
University of Salerno, 84084 Baronissi, Italy

^cFaculty of Medicine and Psychology, University Hospital Sant' Andrea,
University La Sapienza, 00185 Rome, Italy

^dSchool of Pharmacy and Bioengineering, Faculty of Medicine, Keele University, Stoke On Trent ST4 7QB, UK

^eBarts and the London School of Medicine and Dentistry, Centre for Sports and Exercise Medicine, Queen
Mary University of London, Mile End Hospital, London E1 4DG, UK

Purpose: Tears of the pectoralis major (PM) rupture are uncommon and are associated with sport. Early diagnosis is essential to obtain a satisfactory functional outcome. Ruptures can be full or partial and can present as acute or chronic injuries. Most commonly, ruptures are located at the level of the humeral insertion of the PM, followed by ruptures at the musculotendinous junction. Muscle belly ruptures are rare.

Methods: We review the literature, and we add our personal case about a 53-year-old male bodybuilder with an intramuscular rupture of the PM managed conservatively.

Results: The management of pectoralis muscle belly rupture should be discussed on a case-by-case basis, according to the patient, and their functional demands and expectations. The fact that these injuries are at best uncommon makes it difficult to plan and execute randomised controlled trials to gain level I evidence for their management.

Conclusions: Intramuscular tears of the pectoralis major are rare and the best treatment for these injuries remains unclear.

Keywords: Muscle belly ruptures, pectoralis major, muscle tears, pectoralis, muscle.

Level of evidence: IV

Introduction

The triangular pectoralis major muscle is located within the upper thoracic wall, and is generally described as having two heads¹. The clavicular head originates from the medial one half to two thirds of the clavicle, while the sternocostal head can be divided into an upper segment, the manubrial portion, and a lower segment, the abdominal one². The manubrial portion of the sternal head arises from the midportion of the sternum and the costal cartilage of ribs 1 through 5; the abdominal portion originates from the distal sternum, ribs 5 and 6 and the fascia of the external oblique and transversalis muscles³. All the fibers coalesce into a single tendon which inserts on the intertubercular groove of the humerus, just lateral to the the LHB (long head of the biceps tendon)^{3,4} (Figure 1). The pectoralis major muscle acts as an adductor, internal rotator and flexor of the humerus⁵. Injuries to the pectoralis major are uncommon, and result in immediate pain and/or weakness with swelling and bruising in the anterior axillary region, which may extend along the lateral chest wall and the proximal arm¹. The lesion is almost exclusively found in men between in the third and fourth decades. It has been postulated that women have a larger tendon-to-muscle diameter and greater muscle compliance, and this would explain the male predisposition¹. Recent studies have shown a high prevalence of anabolic steroid use associated

with PM tears⁶. Castro Pochini et al. conducted a prospective randomized study in which 58 of 60 patients with ruptures of the PM were using anabolic steroids⁷. Injury can result from direct trauma, often associated with contact sports, or indirect trauma, typically associated with weight training⁸. Most injuries result from maximal eccentric contraction of the muscle while holding the arm in an abducted, extended position⁹, and most reported pectoralis major ruptures occur while bench pressing⁹. Ruptures can be full or partial, can present as acute or chronic, and, depending on their location, can involve the origin of the muscle or the muscle belly, the musculotendinous junction, or the tendinous insertion on the humerus, with or without bony avulsion¹⁰. Most tears are located at the humeral insertion, followed by the musculotendinous junction. Muscle belly ruptures are rare¹¹. The speed of the force that causes the rupture can affect the location of the rupture. Low energy forces, such as the ones produced during training, result in ruptures at the insertion site, while ruptures at the musculotendinous junction are caused by high-energy forces, such as contact sports like in wrestling and martial arts¹².

Classification of PM Muscle Injury

Dating back to 1980, the classification system for pectoralis major injuries developed by Tietjen¹², was later modified by Bak et al¹³. However, these classifications were not consistently applied in most PM injury reports because their ability to

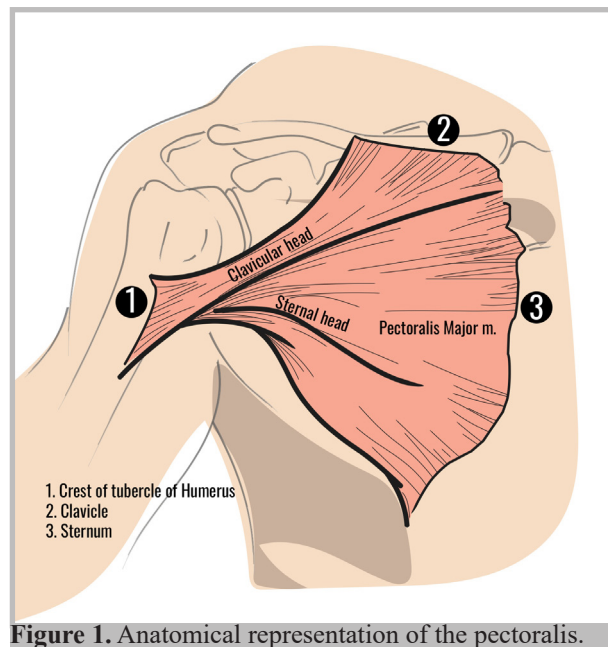


Figure 1. Anatomical representation of the pectoralis.

understand the location and extent of tear patterns appears to be insufficient. Tietjen's classification lacks several descriptive elements essential to guide management recommendations and surgical planning, including comprehensive recognition of injury locations, whether the injury is acute or chronic. Both lack standardized terminology to address the extent of the tears. El Maraghy et al, proposed a further classification system that incorporates these elements¹⁰.

The literature provides different systems to classify muscle injuries. A comprehensive system should allow to classify muscle injuries based on the exact anatomical site involved, and severity at imaging assessment. Chan et al defined site-specific muscle lesions as proximal, medial and distal; according to the various anatomical muscle structures involved, intramuscular, myofascial, myofascial/perifascial and musculotendinous lesions are listed¹⁴. Muscle injuries can be distinguished based on the trauma mechanism as direct (contusion and laceration) or indirect¹⁵. Indirect injuries account for 70% of all muscle injuries in sport, are classified as non-structural, when the muscle fibers don't show an evident anatomical lesion (type 1 and 2), and structural, with an anatomical lesion (type 3 and 4)¹⁶ (Table 1).

Material and Methods

Search strategy

The literature search of the present review was conducted according to this protocol:

- Pectoralis major muscle belly ruptures
- Classification system of muscle injury
- Conservative treatment and surgery

Literature search

From February to October 2024, the PubMed, Embase, Scopus, Web of Science, Google Scholar databases were accessed. The following keywords were used by two authors (V.D.C. and G.S.) independently: pectoralis major, pectoralis major muscle belly ruptures, pectoralis major injury, muscles classification system, muscle injury. If title and abstract matched the topic, the full text was accessed. The bibliographies of the full-text articles were also screened for inclusion. Disagreements were solved by a third author (F.O.). All the articles that investigated muscle classification system, pectoralis major injuries, surgery and conservative treatment of pectoralis major injuries were

considered. According to the authors language capabilities, articles in English, French, German, Italian, and Spanish were considered.

Discussion

Muscle injuries are often managed conservatively with excellent outcomes, and surgical repair is preferred for larger tears/lacerations, with the aim to restore function. Because of its unique characteristics, the repair of muscle belly injury is technically demanding. First, is more difficult to suture because of the low resistance of the traumatized fibers, which results in a high rate of failure and stitch pull-outs. Muscle fibers are the weakest part of the suture, as showed in biomechanical studies on animals¹⁷. Moreover, the suture is more vulnerable to failure because the vector through which force is applied is parallel to the muscle fibers¹⁸. For this reason, it is still unclear which the best surgical procedure is. If the injury involves the tendon, this can be solved with different suture techniques that lead to high pullout resistance; but if the muscle belly or musculotendinous junction are injured, the tear is more difficult to repair because of the lack of robust suture methods¹⁰. Suturing the muscle fibers together with the epimysium significantly improved the biomechanical properties of sutured muscle bellies when compared with repairs with perimysium alone^{18 19}.

Muscle injuries can be sutured using various methods: horizontal mattress and figure eight stitches, Kessler stitches, and some others. Modified Mason-Allen suture or Modified Kessler suture and combination stitch and muscle suture with augmentation seems to belong to the second group. However, even for these injuries the best suturing technique is yet not known²⁰. Conservative treatment for type 1, 2 and 3 injuries (according to I.S.Mu.L.T.¹⁵) presents excellent results, while conservative management does not always produce the desired outcomes for type 4 injuries, especially in high level athletes. Surgical suture for type 4 muscle injuries generally results in good outcomes, with a high rate of return to sports activities and a reduction in complications and recurrence rates. A torn muscle can heal, but this process leads to replacement of muscle tissue with non-contractile fibrous tissue which has poor mechanical properties. Moreover, as the healing of massive muscle tears is slow and incomplete, leaving a mass of scarred and immature tissue can easily lead to re-injuries. Thus, the right choice for a

Table 1. I.S.Mu.L.T. classification of muscle injuries¹⁷

INJURY	TYPE	
DIRECT	Contusion	Mild >1/2 ROM Moderate <1/2 e >1/3 ROM Severe <1/3 ROM
INDIRECT	Laceration	
Nonstructural injuries	1A: Fatigue injury 1B: DOMS (Delayed Onset Muscle Soreness) 2: injury related to neuromuscular disorder	
Structural injuries	3A: minor partial injury, involving one or more primary fascicles within a secondary bundle 3B: partial injury involving at least one secondary bundle, but less than 50% of the cross section of the muscle belly 4: subtotal or total tear, involving more than the 50% of the cross section or the entire muscle fibers, at the MTJ (Muscle tendon junction) or muscle belly	

type 4 injury may be a surgical treatment¹⁸.

History of Pectoralis major muscle belly rupture

Pectoralis major tendon ruptures are well documented, but it seems unusual in literature a full thickness closed intramuscular rupture of the muscle belly, with only 10 other patients reported to date. Eight of those 10 patients underwent surgical repair. In the meta-analysis by Bak et al., of 112 PM ruptures, the ones described were not analysed separately from the tendon or musculotendinous injuries, and the outcomes after surgical repair were not reported¹³. Pochini et al. reported 60 patients with complete PM rupture, including 2 muscle belly lesions. One was repaired surgically and resulted in an excellent outcome based on Bak's criteria, while the other was treated conservatively and did not achieve an excellent outcome⁷. After surgical repair of the PM muscle belly rupture in a competitive skateboarder, dynamometer-measured adduction power increased from -26% to -10%, according to a case report. Preoperative MRI was presented but the postoperative MRI was not recorded to document muscle healing after surgical repair²¹. A patient with a PM muscle belly rupture following

blunt thoracic trauma was reported by Foroulis et al ²². The patient underwent surgery within the 24 hours, and the rupture was repaired perfectly with full-thickness absorbable sutures; however, MRI and functional outcomes were not reported ²³ . Green et al reported a PM muscle belly rupture in a male soldier injuries while performing high-intensity burpee exercises ²⁴. The PM rupture underwent a successful subacute surgical repair with a modified Kessler technique following failed conservative treatment ²⁴. Another case of a healthy 17-year-old female softball player with a subacute full-thickness intramuscular tear of the pectoralis major (PM) muscle was reported by Kuechly et al and a successful muscle repair was obtained using a modified Kessler technique^{25,26}. In conclusion, we present our personal case about a 53-year-old right-handed male body builder, who developed sudden left chest wall pain while bench pressing 145 kg. The patient reported chronic anabolic steroids and organic supplements use. At the first clinical examination, four days after the index injury, the patient presented a hematoma with acute and sharp pain, especially when adducting the left (non-dominant) arm (Figure 2 and 3). Palpation evoked pain over the pectoralis

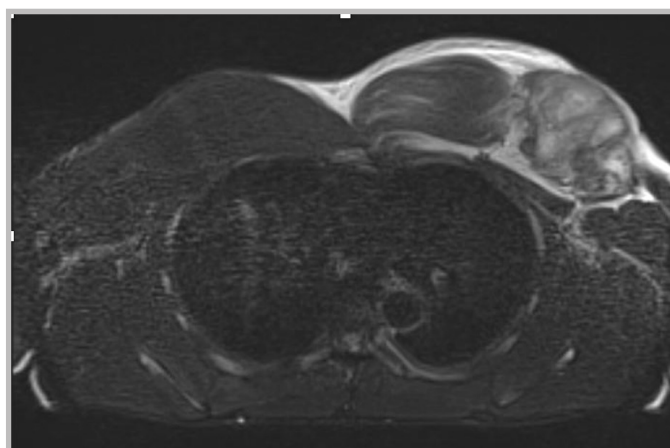


Figure 2. Four days after the trauma (frontal view).



Figure 3. Four days after the trauma (lateral view).

major muscle, and a craniocaudal defect was appreciable along the whole pectoralis major. Contraction of the pectoralis major muscle against resistance was impossible because of pain. The MRI demonstrated a full thickness tear in the sternocostal

head of his left PM measuring 95 mm in a craniocaudal direction, with muscle end retraction of 75mm. Hemorrhagic extravasation between the two muscle ends was clearly visible (Figure 4). Based on the I.S.Mu.L.T. and Munich system classifications^{17,18},



Figure 4. Muscle belly mri.

the injury was a 3B, with the clavicular head of PM intact. The patient was informed that there were no indications for surgery for his kind of injury and about the difficulty suturing injured muscles, and the risk of a disfiguring scar. The lesion was managed non operatively, and the patient underwent three weekly sessions

of physiotherapy based on core and proprioception exercises, shoulder and elbow mobilization without resistance, gradually introducing exercises with an elastic band over the course of six weeks. In addition, the patient underwent two sessions of laser and ultrasound therapy twice a week for four weeks, then



Figure 5. Four months after the trauma.

Table 2. Muscle belly in literature search

Authors	Patients (n)	Age (yr)	Sex	Mechanism Of Injury	Location Of Injury	Treatment	Outcome
Bak et al., 1999 ¹³	2				Muscle belly	Surgical repair	
Pochini et al., 2013 ⁷	1				Muscle belly	Surgical repair	Excellent*
	1				Muscle belly	Conservative	Not excellent*
Pochini et al., 2015 ²¹	1	32	Male	Skateboarding	Muscle belly	Surgical repair	Excellent*
Foroulis et al., 2004 ²²	1	28	Male	Blunt thoracic trauma	Muscle belly	Full-thickness absorbable Sutures	Successfully
Green et al., 2019 ²⁴	1	34	Male	Burpee exercises	Sterncostal head	Modified Kessler technique	Good*
Kuechly et al., 2023 ²⁵	1	17	Female	Softball	Muscle belly	Modified Kessler technique	Successfully
Harvey et al., 2008 ²⁶	1	34	Male	Seat belt trauma	Muscle belly	Delayed repair using mesh	Successfully
Oliva et al., 2014 ¹⁰	1	53	Male	Bench press	Muscle belly	Conservative	Excellent*

Note: The outcome (*) of management is based on the Bak Criteria.

supplemented with Tecar therapy.

After two months, the patient gradually returned to free weight training. Four months after the injury, he is able to bench press 85 kg. The patient reports no pain, no symptoms, no cosmetic modifications, normal range of motion of the shoulder and no adduction weakness of the left arm (Figure 5). The overall outcome of the patient is rated as “excellent” based on the Bak Criteria¹³. The patient agreed to be part of the clinical study, and moreover the research was conducted ethically according to international standards¹¹.

The cases mentioned above are reported in Table 2.

The outcome (*) of management in Table 2 is based on the Bak Criteria ¹³:

- Excellent: no symptoms, normal range of motion, no cosmetic modifications, no adduction weakness, and able to return to sports activities.
- Good: subnormal range of motion, no cosmetic modifications, and 20% isokinetic peak torque.
- Fair: limited range of motion, unable to return to sports activities, and poor cosmetic state.
- Poor: continuous pain and in need of surgical revision.

Practical applications

Further studies are needed to clarify the management of traumatic pectoralis mayor muscle belly rupture.

Conclusion

Full-thickness ruptures of the PM muscle belly are rare, and the best management for these injuries remains unclear: data concerning the management of pectoralis major ruptures are scarce, the outcome measures vary between studies and are incompletely documented. Consequently, the indication should

be discussed patient by patient basis, according to the patient and their functional demands, considering that PM muscle belly ruptures are different from tendon ruptures. There are no high level of evidence studies supporting surgical or conservative management of PM muscle belly ruptures, and these injuries may respond well to conservative management.

Ethical Committee approval

Not request, narrative review.

Informed Consent Statement

Not request, narrative review.

Topic

Muscle belly traumatic rupture.

Conflicts of interest

The authors have no conflicts of interest to declare.

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Author-s contribution

FO and VdC reviewed the literature and wrote the manuscript, Vdc and GS reviewed the literature and collected the articles, FC, RD made a critical revision of the manuscript, MN reviewed the manuscript, and all the authors gave their final approval to publication.

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Corresponding information:

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Correspondence to: Dr. Francesco Cuzzo M.D.

University: Department of Musculoskeletal disorders, school of medicine and surgery, University of Salerno, Via Salvador Allende, 84081 Salerno, Italy

E-mail: fra.cuoz@gmail.com