

Surgical Treatment of Pectoralis Major Tendon Rupture (Outcome Assessment)

Mohammadreza Guity^{1ABCDEG}, MD; Arash Sharafat Vaziri^{1BCDEG}, MD;
Hossein Shafiei^{*2BCDEG}, MD; Amirreza Farhoud^{3BD}, MD

Authors' Affiliation:

1. Department of Orthopedic Surgery, Shariati Hospital, Tehran University of Medical Science, Tehran, Iran
2. Department of Orthopedic Surgery, Mazandaran University of Medical Sciences, Sari, Iran
3. Department of Orthopedic Surgeon, Booshehr University of Medical Sciences, Booshehr, Iran

Authors' Contribution

- A** Concept / Design
- B** Acquisition of Data
- C** Data Analysis / Interpretation
- D** Manuscript Preparation
- E** Critical Revision of the Manuscript
- F** Funds Collection
- G** Approval of the Article

* Corresponding Author;

Address: BualiSina Hospital, Saari, Mazandaran, Iran

E-mail: dr_hshafiei@yahoo.com

Received: Jun 02, 2013

Accepted: Feb 05, 2014

Available Online: Mar 03, 2014

Abstract

Purpose: Rupture of pectoralis major (PM) occurs most commonly as a result of an indirect mechanism associated with extensive tension on a maximally contracted muscle. Patients with PM tendon ruptures, classically present a history of sudden severe pain in arm and shoulder at the time of injury. Treatment options vary from conservative to operative. In cases with total or near-total injuries, surgical treatment by anatomic repair is generally advised, since conservative treatment may lead to poor results. The present paper reports 24 cases of surgically-treated ruptured PM while assessing the results.

Methods: Between 2005 and 2010, 32 cases of unilaterally distal ruptured PM were surgically treated by the same surgeon and same technique, in two teaching hospitals of Tehran University of Medical Sciences. All cases were followed postoperatively by physical examination and functional criteria.

Results: Since eight of the cases were lost from follow up, 24 cases were followed for at least one year. According to modified Kakwani system, 6 of our patients (25%) rated as excellent, 15 cases (62.5%) rated as good, 2 cases (8.33%) rated as fair and 1 case (4.1%) rated as poor.

Conclusion: In conclusion, we see that 87.5% of the patients had good to excellent results, according to modified Kakwani classification, after one year of follow up. So it seems that surgical repair of the pectoralis major ruptures will help the patients to return to their previous activities more frequently and we believe, to achieve better functional outcome. Meticulous surgical technique and attention to rehabilitation program are more important than delay in surgery.

Key Words: Pectoralis Major Rupture, Muscle Rupture, Bodybuilder, Bench Press

Asian Journal of Sports Medicine, Volume 5 (Number 2), June 2014, Pages: 129-135

INTRODUCTION

The pectoralis major muscle is a broad and triangular muscle with origins on the clavicle, sternum, ribs, and external oblique fascia that acts as an adductor, flexor, and internal rotator of the humerus [1-17]. Rupture of this muscle is an uncommon sport injury that has become considerably more prevalent in the last 30 years as the numbers of both professional and recreational athletes increase [2]. Since the first report by Patissier in 1822 [3] until 2004, fewer than 200 cases were reported in the literature, [1,18,19] and several other

reports with larger samples have been published so far.

Rupture of the pectoralis major muscle is most commonly a result of an indirect mechanism associated with extensive tension on a maximally contracted muscle. This phenomenon is best appreciated during the eccentric phase of contraction when performing a bench press because the stretched muscle fibers are unable to successfully contract under the given high loads. The muscle is at greatest risk when the shoulder is in an abducted, extended, and externally rotated position with maximal muscle tension at the bottom of a repetition after the weight is lowered to the lifter's

chest [4,17,19]. The inferior sternal head fibers are most likely to fail first and failure may then extend proximally to involve more superior fibers with increased continuous loads [4]. Therefore most total and near-total rupture injuries of pectoralis major muscle are located at the distal muscle-tendon junction area or the tendon is avulsed from the humeral bone [1,18]. Although, typically a pectoralis major rupture takes place while performing bench presses; there are also single incidents in, for example, wrestling, waterskiing, and rugby [5]. A typical patient is a muscular male between the ages of 20 and 40. No female patients have been reported.

Patients with pectoralis major tendon ruptures classically present with a history of sudden severe pain in the arm and shoulder at the time of injury, with or without a “snap”, painful limitation of motion, localized swelling and ecchymosis, and weakness [2]. Chronic cases especially bodybuilders may complain of a cosmetic problem of a defect in the course of the muscle and absence of anterior axillary fold. Physical examination shows a thin anterior axillary fold or even a sulcus at the deltopectoral groove. Contraction of the pectoralis muscle creates bulging at its origins on the chest. Muscle testing shows weakness in adduction and internal rotation of the arm [2,19].

The treatment options have varied from conservative to operative [6,7,17] and also different surgical techniques have been used for repair of ruptured pectoralis major muscle [8]. We report 32 cases of ruptured pectoralis major treated surgically and assess their subjective and objective results.

METHODS AND SUBJECTS

Thirty two cases of unilaterally distal ruptured pectoralis major in 32 patients treated surgically by the same technique and by the same surgeon (first author) in two teaching hospitals of Tehran University of Medical Sciences between 2005-2010 and were followed postoperatively by physical examination and functional criteria. All ruptures affected young men by the mean age of 26.9 (range: 22-36) years old. Other

than two cases (one open injury occurred by stone saw in workplace and other was caused during accidental traction and rotation of the upper limb), 30 cases occurred during sports activities. 25 cases happened during bench pressing of more than 140 kilogram weights, 2 during power lifting, one during wrestling, one during boxing and one during taekwondo.

Magnetic Resonance Imaging (MRI) was performed before surgery for confirmation of clinical diagnosis and estimation of extent and exact location of rupture and the extent of retraction of the ruptured head.

Surgical Technique [4]: by beach chair position using general anesthesia allowing muscle relaxation (to facilitate mobilization of the torn muscle), the deltopectoral approach was used and modified to extend the proximal portion more medial and the distal portion more lateral. The ruptured end of the muscle was mobilized and secured with stay sutures for traction and tensioning (Fig. 1). Just lateral to the bicipital groove and long head of the biceps tendon, a 3 to 5cm trough was created at the insertion site using a burr. Then by a 2mm drill bit, 3 to 5 equally spaced holes both at the bed of the trough and approximately 1 cm lateral to the trough border were created. By no. 2 or no. 5 braided non-absorbable suture and Krackow stitches in the free end of tendon. Sutures were passed



Fig. 1: The ruptured end of the muscle was mobilized and secured with stay sutures for traction and tensioning with caution to avoid aggressive dissection while mobilizing the retracted tendon to prevent injury to the medial and lateral pectoral nerves

Table 1: Modified Kakwani Classification System

Excellent	Good	Fair	Poor
Pain free	No to Mild infrequent pain	Pain on activity	Constant pain
ROM full	No to Slight reduction in ROM	Slight to moderate reduction in ROM	Restricted ROM
No cosmetic compliant	some cosmetic compliant	Poor cosmetic result	Poor cosmetic result
0-10% isokinetic strength deficit	10-20% isokinetic strength deficit	>20% isokinetic strength deficit	failure
Return to previous professional level of competitive sport	Return to same field of sport non competitive level	Impairment of function affecting Return to sport	Impairment of function affecting return to activities of daily living (ADL)

through adjacent holes and tied over the bone bridge with the arm in neutral position. The insertion site of the sternal head is located just posterior and slightly superior to the clavicular head insertion, in all of our cases both the clavicular and sternal heads were ruptured and in these situations care should be taken to reapproximate their anatomy and orientation. In this way the sternal head was secured through the most proximal and middle holes and posterior to the clavicular head which was attached through the middle and distal holes ^[4].

Postoperatively, a sling was usually used for approximately 4 to 6 weeks. Gentle range of motion and passive pendulum exercises were started early within the first week, as the patient was restricted from active abduction, forward elevation, and external rotation. Full range of motion and light isometric strengthening exercises was the goal after 6 weeks. The patients were returned to full unrestricted activity between 6 to 12 months, depending on their level of recovery and activity involvement ^[4].

Post-operative follow-up visits were on first week, 4th week, 6th week, 9th week and 12th week and then every 3 months. Up to 3 months after repair, symptoms and signs (including palpation of the site of repair) and after that range of motion and ability of the patient to meet the programmed functional criteria were re assessed. Biodex System 3 isokinetic (Biodex Medical Systems, Shirley, New York, USA) was used to evaluate muscle strength.

Kakwani introduced a system for functional result categorization ^[13], but we believe that because most of patients involved in pectoralis major tendon rupture are athletes practicing in heavy labor sports (e.g. bodybuilding and powerlifting), therefore the

definitions regarding excellent, good and fair aren't complete (especially in the "return to sport" part because we believe that in the original, items are not thorough; for example in the "fair" class the patient has slight reduction in ROM and moderate in strength (more than 20%) but in the "return to sport" part they say he or she has impairment in ADL (while we expect this condition in the "poor" class). Therefore we introduced a modification of this system that seems to have better explanation about functional recovery of these patients (table 1).

RESULTS

All of our cases had rupture at tendinous insertion of pectoralis major. Cases with presentation time shorter than 30 days (11 cases) had different degrees of tenderness, swelling and ecchymosis and no significant defect in the location of rupture could be inspected or palpated easily because of swelling (Fig. 2). The case of open injury had a 12 centimeter wound and was repaired on the day of injury. In 20 cases with presentation time equal to one month and more, weakness in adduction and internal rotation and cosmetic discomfort of a defect at the rupture site and anterior axillary fold were the main complaints (Fig. 3). Surgical repair was performed between one day to about one year after index injury (mean 3 months), on the basis of patient's presentation.

Eight of the cases were lost from follow up; therefore 24 cases were followed up to at least one year (mean: 15.5 months; range 1-2 years). Patients' data is



Fig. 2: Patients with history of injury in recent 30 days had different degrees of tenderness, swelling and ecchymosis and no significant defect in the location of rupture could be inspected or palpated



Fig. 3: Patients with history of more than 1 month from injury presented with complaint of cosmetic discomfort of a defect at the rupture site and anterior axillary fold

summarized in table 2.

Pain:

Only one patient was complaining from significant pain (the one with poor outcome).

Range of Motion (ROM):

Only three cases could not regain complete ROM of their affected shoulder 3 months after repair but two of them had functional ROM after an intensive physiotherapy program.

Cosmetic appearance:

Only eight cases complained of cosmetic loss and atrophy of anterior axillary fold (Fig. 4).

Strength:

Six of the patients had strength loss less than 10% compared to healthy arm. Fifteen of the patients had strength loss 10-20% and three patients had strength loss more than 20% compared to healthy arm.

Return to previous level of function:

Six patients could continue in their previous level of profession. Fifteen patients were unable to participate in professional competitions but continued their field nonprofessionally. Three patients completely gave up their profession.

Complications:

Two re-ruptures, (whom at last gave up their profession), occurred during the follow up, both of them were re-operated but they did not regain their full range of motion. The cause of re-rupture was performing bench-press before regaining enough strength. One patient was operated on in another center and had re-rupture after 2 weeks so we re-operated him with the same technique, he completely gave up his profession because of fear of re-rupture. A case of superficial infection, a wound dehiscence, occurred, and after wound care and antibiotic treatment, at final follow up, achieved excellent results.

According to modified Kakwani system, that we introduced, six of our patients (25%) rated as excellent, fifteen cases (62.5%) rated as good, two cases (8.33%) rated as fair and one case (4.1%) rated as poor.

DISCUSSION

Rupture of the pectoralis major muscle is most commonly a result of an indirect mechanism associated with extensive tension on a maximally contracted muscle. This phenomenon is best appreciated during the eccentric to concentric phase of contraction when

Table 2: Patients' data with unilaterally distal ruptured pectoralis major

Number of patient	Age (years)	Athletic field/Injury mechanism	Delay to surgery	Follow up duration	Functional result
1	27	Bodybuilder	1w	24m	Excellent
2	22	Power lifting	1m	18m	Excellent
3	28	Bodybuilder	2w	Lost	
4	29	Bodybuilder	1w	14m	Good
5	26	Taekwondo	2days	12m	Excellent
6	30	Bodybuilder	2m	18m	Poor
7	32	Bodybuilder	2m	21m	Excellent
8	28	Bodybuilder	3m	16m	Fair
9	30	Bodybuilder	5m	17m	Good
10	27	Boxer	5m	18m	Good
11	36	Bodybuilder	5m	Lost	
12	29	Bodybuilder	3m	Lost	
13	26	Bodybuilder	3days	15m	Good
14	28	Bodybuilder	1m	18m	Good
15	28	Bodybuilder	5m	Lost	
16	33	Bodybuilder	3w	15m	Good
17	26	Power lifting	2w	14m	Good
18	24	Bodybuilder	9m	12m	Good
19	24	Bodybuilder	5m	Lost	
20	25	Bodybuilder	2m	12m	Good
21	23	wrestler	1w	15m	Excellent
22	25	Bodybuilder	2m	14m	Good
23	26	Bodybuilder	3w	12m	Good
24	23	Stone saw	1day	Lost	
25	26	Bodybuilder	3m	15m	Excellent
26	25	Bodybuilder	5days	14m	Good
27	25	Bodybuilder	11m	Lost	
28	24	Bodybuilder	3m	12m	Good
29	25	Bodybuilder	4m	15m	Good
30	28	Bodybuilder	11m	15m	Fair
31	26	Bodybuilder	5m	20m	Good
32	26	Traction	7m	Lost	

performing a bench press as the stretched muscle fibers are unable to tolerate the given high load. We introduced a video from exact moment of pectoralis major failure during bench pressing in an Iranian power lifter that had occurred during international championship contest (video 1). All of our patients except two (case with open injury and the one with traction injury) have experienced their injuries during the mentioned mechanism whether bench pressing or other type of heavy loaded movement.

The relationship between anabolic steroid abuse in

athletes and muscle injuries is well documented in the literature [1, 2]. These drugs will cause stiffness in musculotendinous junction and this will make the muscle tendon unit prone to fail under heavy loads especially when the muscle is exhausted. All of our patients were anabolic steroid users. The interesting finding in these patients was that the pectoralis ruptures occurred during the highest dosage period of these drugs for gaining even more power or during the period of reducing fat for more muscle definition during the contests.



Fig. 4: eight cases complained of cosmetic loss and atrophy of anterior axillary fold

The treatment options have varied from conservative to operative [6,7,17]. Data concerning the management of pectoralis ruptures are very scattered, mainly consisting of reports of few cases. In cases with total or near-total injury, surgical treatment by anatomic repair is generally advised because conservative treatment may lead to loss of strength in adduction, shoulder flexion, and internal rotation. An untreated injury may also disrupt the contour of the anterior axilla, causing a poor cosmetic result. The results of the anatomic repair are generally good; however, meticulous surgical technique and thorough rehabilitation are needed to obtain the original function and strength of the upper limb [1]. Different surgical techniques have been used for repair of a ruptured pectoralis major muscle including: end to end repair along with reinforcing by anchor sutures when a segment of tendon remains attached to the humerus [8], suturing tendon by non-absorbable sutures directly to drilled holes in insertion site [6], to two rows of drill holes [9], or to trough and related holes made near it [10, 11], and using cancellous screw and washers [2] or staples [12]. Sherman in a biomechanical study showed no difference between transosseous technique, suture anchors and endosteal buttons [20]. We used osseous fixation through a bone tunnel in all the cases and achieved secure fixation during the surgery without failure during the rehabilitation period (Two patients had re-rupture because they returned to bench pressing before ending the rehabilitation program) and we

believe that in pectoralis ruptures as the patients are going to undergo heavy loads again, the osseous fixation will be more secure in respect to other techniques.

Regardless of reports in the literature claiming excellent results being achieved in patients who were operated in 2 weeks or less [4,13,15,16] from the rupture, 50% of our excellent results (three out of six patients) were achieved in patients whom were operated after 1 month, so we believe that adherence to meticulous surgical technique, secure fixation, and special attention to rehabilitation program (especially regain of ROM and strength) are more important than delay in surgery.

All of our patients were male, the same as other reports in the literature but we believe that nowadays as women are participating more in competitive sports and fitness programs it isn't so strange to hear the reports of pectoralis major ruptures in female gender.

CONCLUSION

We see that 87.5% of the patients had good to excellent results, in reference to modified Kakwani classification, after one year of follow up, so it seems that surgical repair of the pectoralis major ruptures will help the patients to return to their previous activities

more frequently, but we suggest more studies with more cases that compare different surgical techniques and different rehabilitation regimens to have better instructive results in future.

ACKNOWLEDGMENTS

We would like to thank all our subjects helping us to record patient's data.

Conflict of interests: None

REFERENCES

- [1] Aarimaa V, Rantanen J, Heikkilä J, et al. Rupture of the pectoralis major muscle. *Am J Sports Med* 2004;32:1256-62.
- [2] Quinlan JF, Molloy M, Hurson BJ. Pectoralis major tendon ruptures: when to operate. *Br J Sports Med* 2002;36:226-8
- [3] Patissier P. Maladies des bouchers. *Traité des maladies des artisans* 1822:162-5.
- [4] Pétillon J, Ellingson CI, Sekiya JK. Pectoralis Major Muscle Ruptures. *Oper Tech Sports Med* 2005;13:162-8.
- [5] Bak K, Cameron EA, Henderson IJP. Rupture of the pectoralis major: a meta-analysis of 112 cases. *Knee Surg Sports Traumatol Arthrosc* 2000;8:113-9.
- [6] Hanna CM. Pectoralis major tears: comparison of surgical and conservative treatment. *Br J Sports Med* 2001;35:202-6.
- [7] Scott BW, Wallace WA, Barton MA. Diagnosis and assessment of pectoralis major rupture by dynamometry. *Br J Sports Med* 1992; 74:111-3.
- [8] Orava S, Sorasto A, Aalto K, et al. Total rupture of pectoralis major muscle in athletes. *Int J Sports Med* 1984;5:272-4.
- [9] Kretzler HH, Richardson AB. Rupture of the pectoralis major muscle. *Am J Sports Med* 1989;17:453-8.
- [10] Schepsis AA, Grafe MW, Jones HP, et al. Rupture of the pectoralis major muscle, outcome after repair of acute and chronic injuries. *Am J Sports Med* 2000;28:9-15.
- [11] Anbari A, Kelly JD, Moyer RA. Delayed repair of a ruptured pectoralis major muscle: A case report. *Am J Sports Med* 2000;28:254-6.
- [12] Egan TM, Hall H: Avulsion of the pectoralis major tendon in a weight lifter: Repair using a barbed staple. *Can J Surg* 1987;30:434-5.
- [13] Kakwani RG, Matthews JJ, Kumar KM, et al. Rupture of the pectoralis major muscle: surgical treatment in athletes. *International orthopaedics* 2007;31:159-63.
- [14] Potter BK, Lehman RA Jr, Doukas WC. Simultaneous Bilateral Rupture of the Pectoralis Major Tendon. *J Bone Joint Surg Am* 2004;86a:1519-21.
- [15] HE Zhen-ming, AO Ying-fang, WANG Jian-quan, et al. Twelve cases of the pectoralis major muscle tendon rupture with surgical treatment—an average of 6.7-year follow-up. *Chinese Med J* 2010;123:57-60.
- [16] Merolla G, Campi F, Paladini P, et al. Surgical approach to acute pectoralis major tendon rupture. *G Chir* 2009;30:53-7.
- [17] Metzger PD, Bailey JR, Filler RD, et al. Pectoralis major muscle rupture repair: technique using unicortical buttons. *Arthrosc Tech* 2012;1:e119-25.
- [18] Fleury AM, Silva AC, de Castro Pochini A, et al. Isokinetic muscle assessment after treatment of pectoralis major muscle rupture using surgical or non-surgical procedures. *Clinics (Sao Paulo)* 2011;66:313-20.
- [19] Merolla G, Paladini P, Campi F, Porcellini G. Pectoralis major tendon rupture. Surgical procedures review. *Muscles Ligaments Tendons J* 2012;2:96-103.
- [20] Sherman SL, Lin EC, Verma NN, et al. Biomechanical analysis of the pectoralis major tendon and comparison of techniques for tendo-osseous repair. *Am J Sports Med* 2012;40:1887-94.