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Surgical repair of chronic pectoralis major rupture with peroneus long autograft: A case report

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Abstract
Background and Aim: Pectoralis Major (PM) ruptures are relatively rare injuries occurring mostly in men, 20 to 40 years of age. Weightlifting or bench pressing is the most common mechanism of injury. Although an uncommon injury, a high degree of clinical suspicion should be maintained since early surgical treatment has been shown to be beneficial.
Discussion and Conclusion: We present a case of a 35-year-old male with no known past medical history, who had sudden onset left chest and shoulder pain after bench pressing 2 months back. Pain aggravated on movement and relieved on rest. He was admitted to NSSH for further management. In our case, we provide practical evidence that the rupture of the tendinous insertion of the pectoralis major can be surgically reconnected by inserting anchors/buttons into the Humerus and duplicating the suturing layers in three directions in the muscular belly crossing the rupture's lips. Graft reconstruction (autograft or allograft) is a viable option in chronically torn pectoralis major tendons.

Keywords: Pectoralis, graft, rupture, suture, orthopedic surgeons

Introduction
Pectoralis major (PM) ruptures are uncommon injuries (1). PM provides arm adduction and internal rotation, while it also provides some flexion (2-4). Injuries of the PM mostly occur in young males during weightlifting or bench pressing in gym enthusiasts (1-3). Literature supports that surgical treatment is advantageous for young, physically active patients (1, 5). Acute repair of PM rupture yielded better outcomes as compared to non-operative treatment in active individuals who wish to return to their sports or physically demanding lifestyles(8). Although the condition is well known among orthopedic surgeons, due to its rarity, a high degree of clinical suspicion is required for the diagnosis not to be missed.

Case Presentation
A 35-year-old male presented with sudden pain in his left chest, accompanied by a tearing sensation while bench pressing, which occurred 2 weeks prior to presentation. He had visited a local medical practitioner and then an orthopaedic surgeon. However, the diagnosis was missed in both instances.
He used to exercise with a lot of weight training and denied any steroid use. His past medical history was unremarkable, and he was a non-smoker.
On examination, he had evidence of PM rupture with ecchymosis and loss of shoulder contour, as well as bulking over the left chest. The shoulder range of movement was preserved, although decreased muscle power in arm adduction and internal rotation was noticed. The patient had a Medical Research Council (MRC) scale of 3 out of 5 in shoulder adduction (Active movement against gravity) and an MRC scale of 4 out of 5 in shoulder internal rotation (Active movement against resistance), non-pain related. He was otherwise neurovascular intact throughout his left upper limb. Plain radiographs of the left shoulder showed no fracture, dislocation, or other bony abnormality.
Two weeks after magnetic resonance imaging (MRI) scan was performed, which also missed the tear as the MRI was not done in the area of interest. A later MRI revealed a PM rupture with retraction and the patient underwent left PM tendon repair 2 months after the injury.

Discussion

Epidemiology

The vast majority of the cases occur in young men between 20 and 40 years (1-3). Rupture occurs mainly during bench pressing (2, 5) and weight-lifting accounts for nearly 50% of the cases (3). However, other activities such as rugby or boxing have been identified (2). The presented case was within the expected age range, but PM should also be considered in older individuals presenting with a consistent mechanism of injury.

Anatomy/Classification

PM is composed of two heads: The clavicular head originates from the medial half of the clavicle and it is shorter. The sternal head originates from the second to sixth ribs, the costal margin of the sternum, and the aponeurosis of the external oblique. The two parts of the muscle converge laterally and are inserted on the lateral lip of the bicipital groove over an area of 5 cm (3). The fibers of the sterno-costal head pass underneath the clavicular head fibers forming the deeper posterior lamina of the tendon, which rotates 180 degrees so that the inferior-most fibers are inserted at the highest or most proximal point of the Humerus. As a result of the anatomy, the fibers of the sternocostal head are maximally stretched during activities when the arm is abducted, externally rotated, and extended such as during a bench press. This predisposes the inferior portion of the tendon to fail first (13). Although most cases are undoubtedly partial, most reported injuries have been complete ruptures, predominantly affecting the distal musculotendinous junction or insertion of the tendon (8). PM's main functions are adduction and internal rotation of the arm while providing some flexion (2, 3, 4).

The traditional classification of Tietjen divides PM injuries into three groups: contusion, partial tear, and complete tear (2-4). Furthermore, each injury is subdivided by anatomical location to the muscle belly, the musculotendinous junction (24%-29%), and tendinous insertion (59%-65%) (2, 3).

Table 1: Tietjen's classification of pectoralis major injuries

Type	Injury pattern
I	Contusion or Spain
II	Partial Tear
III	Complete Tear
III-A	Muscle Origin
III-B	Muscle Belly
III-C	Musculotendinous Junction
III-D	Tendinous Insertion

The tear in our case was at the tendinous insertion, suggestive of type III-D.

Pathogenesis/etiology

PM tears occur during excessive tension or, less commonly, after a direct trauma (6). Specifically, rupture occurs when tension is applied to an eccentrically contracting muscle (3, 4). This is the case of maximal contraction when the arm is externally rotated, extended, and abducted (4). Less commonly, rupture may result from a direct blow (4, 6). Muscle structure allows for maximum muscle power production but has also as a consequence disproportionately high fiber excursion in the inferior sternocostal head. This phenomenon is believed to be the explanation behind PM rupture during mechanical stress in the disadvantageous position (e.g., bench press) (3), which was also the mechanism of PM rupture in the presented case.

Presentation

- Classic history includes sudden onset of pain, accompanied by a "pop" sensation (2, 7).
- On examination, there is usually bruising and swelling of the affected anterolateral chest wall (2, 3). Tenderness over the humeral insertion is common (3, 7). Loss of the axillary fold can be seen, although this finding may be obscured by the tissue swelling (2, 3, 7).
- Resisted adduction is helpful in testing strength as muscle power may be decreased (2, 7).
- Full-thickness tears have a characteristic "gap." However, the axillary fold and not the fascial sheath should be palpated (3).
- On examination, our patient had evidence of PM rupture with ecchymosis over the left shoulder area and loss of shoulder contour, as well as bulking over the left chest.

Muscle power in arm adduction and internal rotation was significantly decreased (MRC scale 3 out of 5 in shoulder adduction and 4 out of 5 in shoulder internal rotation).

Clinical Examination

Fig 1: Loss of the axillary fold can be seen

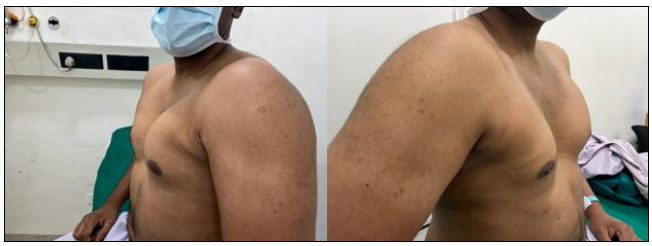

Fig 2: Loss of shoulder contour, as well as bulking over the left chest

Diagnosis

- Initial imaging investigation should include plain radiographs to exclude concomitant bone injuries (4, 8). Plain radiographs may be useful only in rare cases of bone avulsion (2-4). This occurs in 2%-5% of the cases (3, 8).
- U/S is an adjunct when MRI cannot be performed (2). Its usefulness relies on the fact that it is a low-cost and available imaging modality (9). However, U/S is an operator-dependent modality and is shown to produce false negative results (3, 9).
- MRI is the investigation of choice (2, 10). It can distinguish between partial and full-thickness tears (10) thus helping with surgical planning (2, 10).
- In our case, the first MRI had missed the pectoralis rupture as it is an uncommon injury and the area of interest wasn't included.
- Thus high clinical suspicion along with clinical examination findings help in reaching the diagnosis. One must talk with the radiologist or mention in the form the suspicion of PM rupture.

MRI

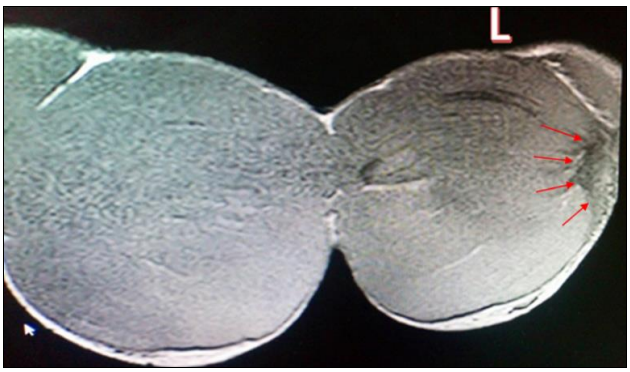

Fig 3: Coronal MRI T_1 shows a clear tear in the tendinous insertion of the sternocostal part of the left. Pectoralis Major Muscle in comparison to the right one (red arrows)

Coronal MRI T_1 shows a clear tear in the tendinous insertion of the sternocostal part of the left. Pectoralis Major Muscle in comparison to the right one (red arrows).

Fig 4: Transversal MRI T_2 shows a clear tear in the tendinous insertion of the left Pectoralis Major muscle in comparison to the right one (see the rounded ruptured ends with the red arrows)

Transversal MRI T_2 shows a clear tear in the tendinous insertion of the left Pectoralis Major muscle in comparison to the right one (see the rounded ruptured ends with the red arrows).

Treatment

Literature supports by far surgical management in physically active patients (2, 5). Repair techniques vary considerably but usually consist of transosseous fixation, suture fixation, anchor fixation, and cortical button fixation. For chronic ruptures, reconstruction with the use of allografts is described (2, 3, 11), although not much literature about chronic repair has been mentioned. Specific repair technique depends on the site of rupture: Musculotendinous junction injuries are repaired by direct suturing, while avulsion injuries are anatomically reduced and internally fixated (4). Although no guidelines regarding optimal surgical timing exist, literature generally shows that acute repairs are easier and lead to improved results (3, 12). In chronic settings, adhesions between ruptured muscle and chest wall may complicate the procedure (4). Conservative management is reserved for the elderly population or individuals who do not wish or are not medically fit for surgery (2, 3). The protocol involves sling immobilization with immediate passive exercises and unrestrictive activity allowed after two to three months (2, 3). Contact sports should only be initiated after 5-6 months (3). However, recent studies show that the power of adduction and internal rotation is permanently diminished when conservative management is chosen (4, 13). In our case, the patient underwent right PM tendon repair 2 months after the injury. On follow-up in the second and sixth post-operative week, no postoperative complication was evident, and the patient was referred for physiotherapy. Currently, the patient demonstrates almost normal muscle power (MRC scale 5 out of 5) in all shoulder movements.

Surgical Procedure

- General anesthesia was used to allow complete muscle relaxation and mobilization of the torn pectoralis major tendon. The patient was placed in a beach chair position with the body elevated 30°.
- A small roll of sheets was placed under the patient's scapula to allow optimal shoulder motion during the repair.
- The arm, shoulder, and chest were prepped and draped free to allow intraoperative manipulation.
- A deltopectoral approach was used, with the proximal extent of the incision placed slightly medial to allow easier access to the retracted tendon, while the distal aspect was placed slightly lateral for better exposure of the pectoralis insertion.

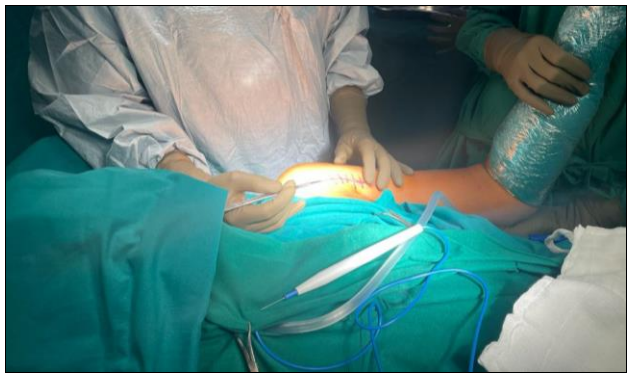

Fig 5: Patient position, draping, and Incision

The pectoralis was not easily identified medial to the cephalic vein so anterior chest wall dissection was done.

- As the torn tendon was identified, several #2 traction sutures (Fiber Wire; Arthrex) were placed through it, and a combination of sharp and blunt dissection was used to free the muscle and tendon from the chest wall and subcutaneous tissue. Care was taken to avoid extensive deep dissection under the muscle belly, to avoid injury of the medial and lateral pectoral nerves. A distinction could be made between the sternal and clavicular heads and each one was carefully dissected and mobilized separately.
- Since the muscle end was not able to reach the insertion site, we decided to take the Peroneus Longus graft.
- Peroneus Longus was chosen as it can be easily folded and flattened, thus making it morphologically similar to the pectoralis tendon.
- Peroneus graft harvested via direct lateral incision on Left leg behind the lateral malleolus.

Peroneus graft stitched over Pectoralis tendon with 4 whip stitches running through the graft and tendon simultaneously, one in the superior end, one in the inferior end, and 2 in the middle with 8 tail strands leaving the tendon with 5 cm overlap between the tendon and graft.

Fig 6: Use of peroneus longus auto graft for chronic pectoralis major tear

Once the tendons were sufficiently mobilized to enable adequate reduction to their footprint, the footprint area was prepared using a motorized burr to create an area of bleeding bone. Care was taken not to over-decorticate, which would weaken the site of anchor insertion.

- When the clavicular head is intact, it can be used to help identify the sternal head footprint on the humerus just posterior and slightly proximal to it. In cases where both heads are ruptured, the superior insertion of the latissimus dorsi can be used as a marker for the distal border of the footprint. The average dimensions of the footprint are 50 mm in length and 3 mm in width, along the lateral border of the bicipital groove.

Two Pushbuttons were placed in a square configuration, with 3–3.5 cm between each set, and passed intra-medullary. Two limbs of each suture from the tendon's whip stitch from superior as well as inferior margins were passed through it. The 4 middle tail strands were passed in a swivel lock which was placed between the 2 pec buttons.

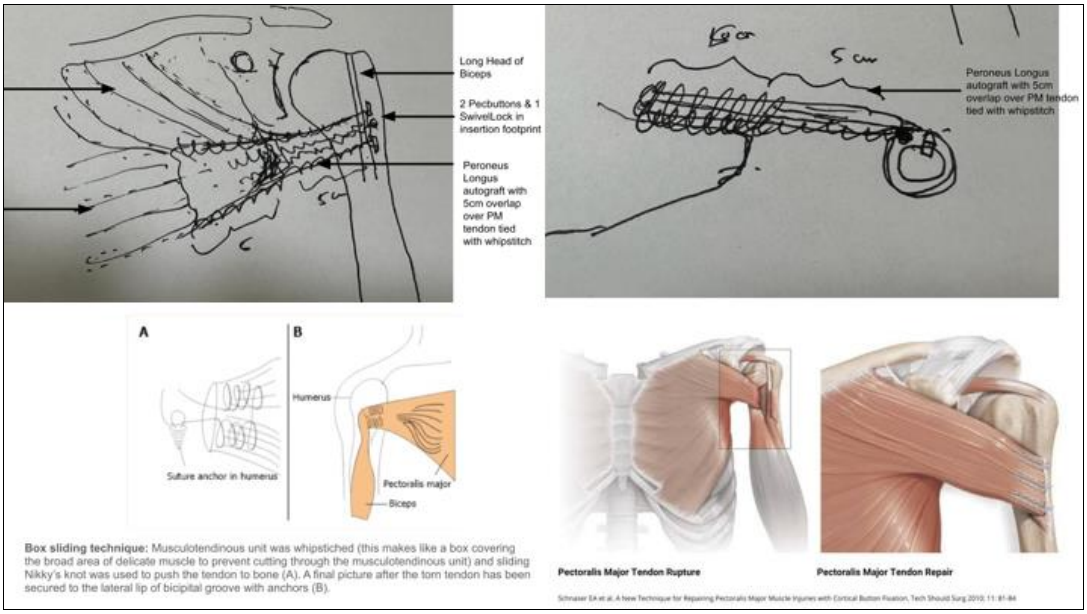

Fig 7: Diagrammatic representation of the planning of repair using Peroneus Longus auto graft

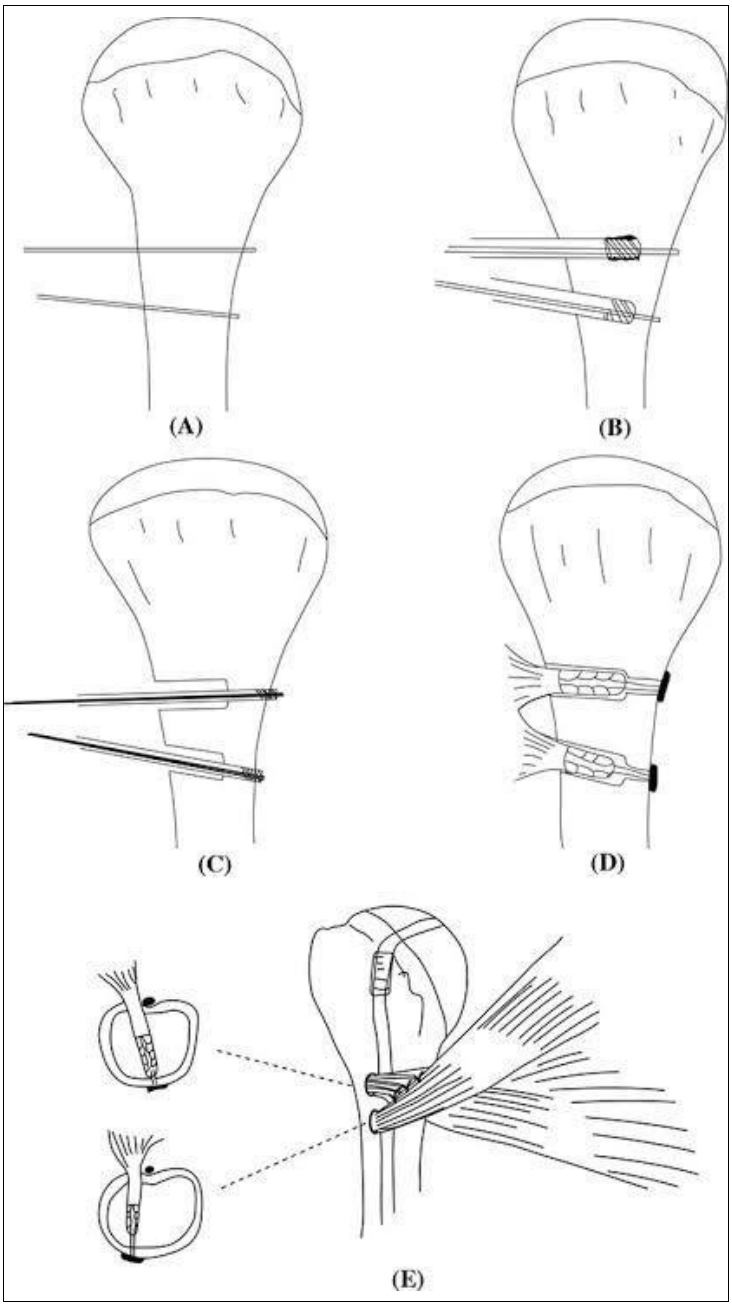

Fig 8: Diagrammatic representation of the fixation of the reconstructed Pectoralis Major tendon

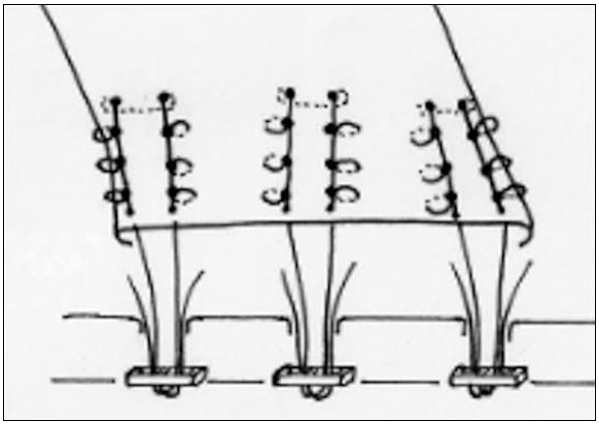

Fig 9: Diagrammatic representation of the fixation of the reconstructed Pectoralis Major tendon with pec buttons

The arm was positioned in neutral rotation and abduction and slight forward flexion to minimize the tension on the tendons during fixation.

- Pulling the post reduced the tendon tightly to the footprint as the suture slid through the Pec buttons and Swivel Lock. This was followed by alternating half hitches, completing the repair. In cases of relatively low tissue quality, we used more sutures for tendon fixation.
- The logic was to reduce the tension on each suture.
- The repair was inspected and palpated while the arm was gently internally and externally rotated to ensure a tight, stable repair.

Immediate post-op

Fig 10: Immediate post op Xrays- AP and Lateral

Post-op Rehabilitation

After surgery, the accelerated rehabilitation protocol

involved:

1. Elbow, wrist, hand, and neck exercises from day 1.
2. Isometric rotator cuff and pectoralis major strengthening were permitted with the shoulder in neutral rotation at 2 weeks along with passive external rotation within the documented 'safe arc'.
3. Progressive physiotherapy included a range of motion, strengthening, and endurance exercises. Regular follow-ups were arranged to evaluate shoulder function. Gradually, progressed movements started to get a full range of motion (ROM), and the patient returned to his favorite sport (bodybuilding) after 10 weeks.

3 Months post-op

Fig 11: 3 Month post op reappearance of shoulder contour, as well as bulking over the left chest

3 Months post-op

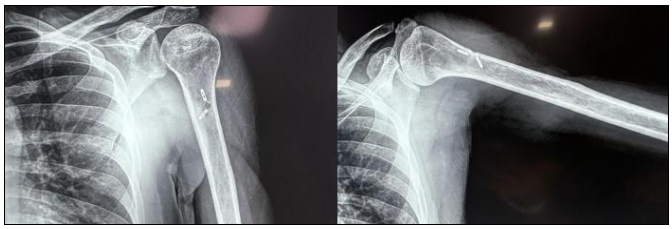

Fig 12: 3 month post op Xray- AP and Lateral

Result

No range of motion loss was noted in the patient in forward elevation, external rotation, or internal rotation. Manual muscle testing using Medical Research Council (MRC) grading revealed an increase in internal rotation muscle power from 4 pre-operatively to 5 post-operatively. The VAS score improved from 7 pre-operatively to 0 post-operatively. The SANE score improved from 42 pre-operatively to 94 post-operatively. The Quick DASH score improved from 55 pre-operatively to 7 post-operatively. The ASES score improved from 48 pre-operatively to 94 post-operatively. The patient was satisfied with the cosmetic outcome of the pectoralis major repair as well as the functional outcome. Complications such as the development of a keloid scar that is tender to direct pressure can be present post-operatively in some patients but were not seen, and the patient returned to their preoperative level of recreational and job activity.

Discussion

Here, we presented a rare case of musculotendinous junction rupture of the PM. As we usually meet tears or avulsions in the tendon's stump insertion into the humeral bone, many techniques were described for these cases (tendon's tears or avulsions), but we did not find a clear explanation or technique for musculotendinous junction rupture. Therefore, we decided to mix two techniques; the primer is; inserting anchors/buttons into the bone to start firmly from the force-affecting point in the humerus (as the stump reinserting technique), and the last is; duplicating the suturing layers in multiple directions to distribute the forces that may separate the rupture point's lips (as in the case of the muscular belly's rupture). By doing that, we got a firm and strong way to collect the contraction forces from the sternocostal parts (superior, middle, and inferior) and transport their effects into the anchors' sites in the humeral bone through the sutures, letting the rupture site to heal well by muscular-fibrotic integrating. The good results were clear after 10 weeks as the patient got a full ROM in the affected shoulder and started his favorite sport (bodybuilding) and weight lifting.

Conclusion

Rupture of the musculotendinous junction of the pectoralis major should be suspected in any case of absent adduction and internal rotation of the shoulder joint after heavy weight lifting, and careful reading of MRI especially coronal and transverse sections is the cornerstone in the diagnosis of these ruptures. In medical practice, orthopedists tend to deal with ruptures of the tendon of this muscle or avulsions of its insertion into the humerus by using anchors into the bone or drilling holes in it to reattach the tendon. In our case, we provide practical evidence that the rupture of the tendinous insertion of the pectoralis major can be surgically reconnected by inserting anchors/buttons into the humerus and duplicating the suturing layers in three directions in the muscular belly crossing the rupture's lips.

Graft reconstruction (autograft or allograft) is a viable option in chronically torn pectoralis major tendons. However, there are issues to consider with this reconstructive approach, such as donor site morbidity associated with autograft procurement and factors associated with the use of allograft tissue (e.g. cost, infection, healing). Given the consistent and reliable outcomes of direct repair including biologic healing of native tissue, we suggest that graft reconstruction be considered only in cases where the muscle-tendon unit cannot be adequately mobilized or the repairable tissue is not of sufficient quality to ensure secure repair.

Due to the site of the rupture, the surgeon may tend to make direct suturing between the belly and the tendon only, so, the rupture site will tolerate the direct effect of the contraction forces directed from the belly into the humerus, which in turn cause may re-rupture of the musculotendinous junction. Therefore, the successful transporting of the forces' affecting points from the contracting belly into the bone -by using anchors and shippable sutures- put the rupture lips out of the distracting effect, so it healed by fibro-muscular integrating, and after a few weeks, it became firm, strong and powerful enough to let our patient return gradually to his powerful sport.

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