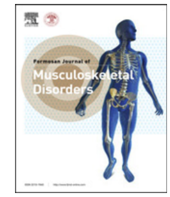
Formosan Journal of Musculoskeletal Disorders 3 (2012) 137–143

Contents lists available at SciVerse ScienceDirect

Formosan Journal of Musculoskeletal Disorders

journal homepage: www.e-fjmd.com



Case Report

Latissimus dorsi tendon transfer for treatment of irreparable superior–posterior rotator cuff tears and evaluation by isokinetic dynamometer

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A R T I C L E I N F O

Article history:
Received 11 June 2012
Received in revised form
2 July 2012
Accepted 14 August 2012
Available online 7 November 2012

Keywords:
isokinetic dynometer
latissimus dorsi tendon
rotator cuff tears
tendon transfer

A B S T R A C T

Restoring shoulder function in patients with irreparable rotator cuff tears (RCTs) is difficult. We performed a latissimus dorsi tendon transfer in a patient with massive RCTs to improve his shoulder function using a technique described by Gerber et al in 1988. After 1 year, his shoulder function was evaluated with an isokinetic dynamometer, and the results suggested better improvements in external rotation than abduction. Overall, the pain associated with daily activities was also reduced. The latissimus dorsi tendon transfer technique appears to be a good therapeutic choice for young and active patients with irreparable RCTs.

1. Introduction

Rotator cuff tears (RCTs) are commonly encountered in clinical practice, and the majority of RCTs can be surgically repaired via reattachment at the bony insertion. Massive RCT (i.e., >5 cm) present a significant challenge even with vigorous mobilization of the remaining soft tissues. In 1988, Gerber et al[1] first introduced the latissimus dorsi tendon transfer technique to manage massive RCTs. The literature suggested encouraging results and indicated improvement in some patients.[2–6] In 2007, Gerber et al[7] advocated using this technique to facilitate forward flexion and external rotation following reverse total shoulder arthroplasty. An isokinetic dynamometer (Biodex Medical Systems Inc, Shirley, NY, USA) was used to evaluate our patient with a primary, irreparable superior–posterior RCT who underwent latissimus dorsi tendon transfer.

2. Case report

On November 8, 2005, a 57-year-old, right-handed male barber visited our outpatient clinic due to a painful right shoulder sustained in a falling accident 2 or 3 months prior to presentation. The plain radiographs of his right shoulder showed a loss of the normal contour of the greater tuberosity (Fig. 1). Physical examination revealed pseudoparesis with abduction, forward flexion, and external rotation of the right shoulder. RCTs were suspected, and magnetic resonance imaging (MRI) revealed a loose bone fragment in the shoulder joint (Fig. 2A and B). During operation, we found that this bone fragment was avulsed with greater tuberosity. Therefore, open reduction and internal fixation with a 3.5 Arbeitgemeinschaft für Osteosynthesefragen (AO) countered buttress plate and reinforced by heavy suture of rotator cuff to the plate was performed on November 15th, 2005 to repair the avulsion fracture off the greater tuberosity of the proximal humerus (Fig. 3). Acromioplasty was performed to avoid impingement of the implant. The shoulder was then immobilized with a sling, and no active range of motion (ROM) was allowed for 6 weeks. After 6 weeks, the patient was allowed to use the arm as tolerated in his daily activities.

The patient returned with the same right shoulder complaints on April 24, 2006, which had persisted for 1 month. Radiographs of the right shoulder showed the implants had been removed at other hospital, and the humeral head had proximally migrated (Fig. 4). The MRI identified massive RCTs (Fig. 5A and B), and the patient was admitted for rotator cuff repair on April 29, 2006. The University of California, Los Angeles (UCLA) shoulder score was 5 points prior to surgical intervention. The visual analog scale (VAS) score of pain was 7–8 points. At the time of the surgery, the RCTs were noted to be too large to repair; however, the previous fracture had healed, so we only performed cuff debridement. After operation, he still could not regain his right shoulder function in spite of vigorous

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http://dx.doi.org/10.1016/j.fjmd.2012.09.006

Fig. 1. Initial radiograph taken at the first evaluation.

Fig. 3. A 3.5 AO buttress plate is used to fix this fragment.

rehabilitation for about 2 months. Therefore, the patient agreed to a follow-up reconstructive surgery using latissimus dorsi tendon transfer to improve his overall shoulder function. On July 1, 2006, this procedure was performed as Gerber et al[1] originally described. During the procedure, we found massive tears of the supraspinatus, infraspinatus, and teres minor, but the subscapularis and long head biceps were intact (Fig. 6). The operative time was approximately 8 hours, and the blood loss was approximately 200 mL. The only problem encountered was the inadequate length of the latissimus dorsi tendon to the insertion site on the humeral head that resulted in increased tension (Figs. 7 and 8). Immobilization with a sling and swath for was prescribed for 2 weeks, followed by a hanging-sling for another 4 weeks. No active use of the right shoulder was permitted; however, passive-assisted ROM was performed to avoid shoulder joint stiffness postoperatively. He was regularly followed up in our outpatient clinic for 3 months and returned to his job as a barber. Evaluation of his right shoulder function was done one year later included an MRI and an isokinetic dynamometer test. This test was performed by a rehabilitation physician. The patient was tested in a seated position with stabilization straps across the hips and upper body. The ROM was also checked by him. Internal and external rotations were tested with 90° of abduction in the scapular

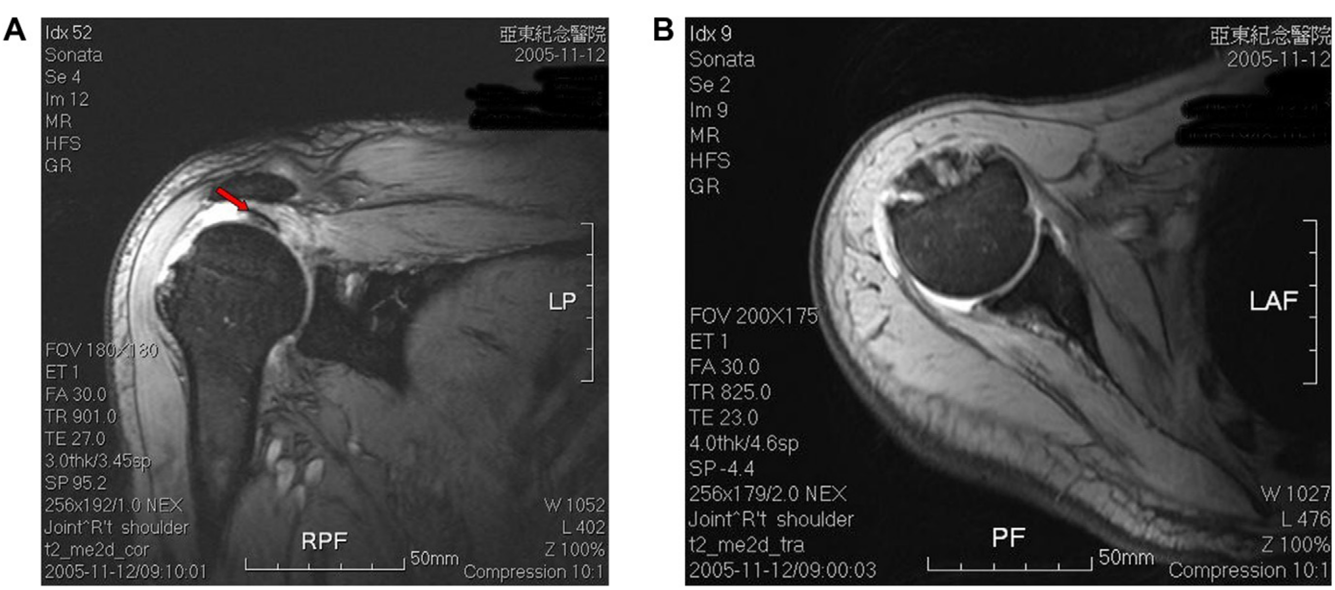


Fig. 2. Sagittal view on the initial magnetic resonance imaging showed a bony fragment (arrow) entrapped in the shoulder joint.

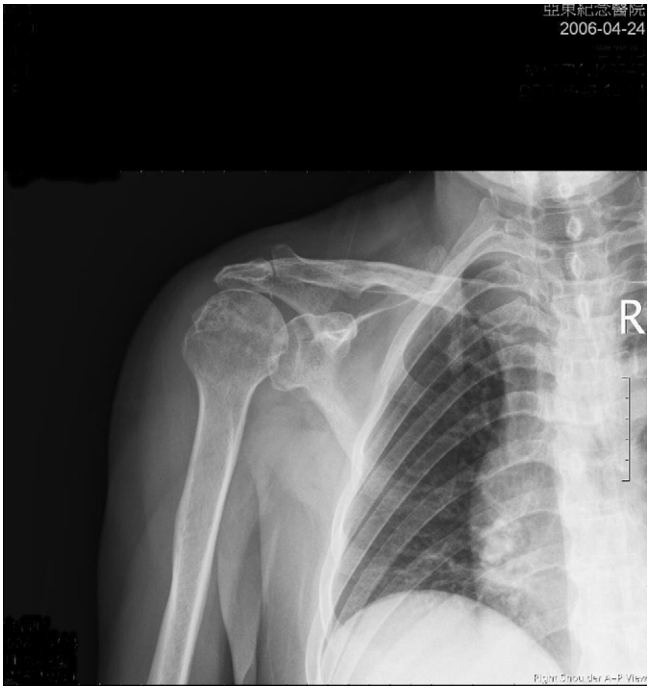


Fig. 4. The implant had been removed, and the greater tuberosity avulsion fracture had healed. The humeral head has proximally migrated.

plane. Abduction and adduction were recorded with the arm in the frontal plane. The ROM for internal and external rotation was 86.9° on the affected side and 126.2° on the contralateral side. ROM for abduction and adduction was approximately 65° on the affected side and 149.4° on the contralateral side. The results showed poor ROM with shoulder abduction compared to external rotation. Active and passive ROMs were also assessed by our rehabilitation physicians (Fig. 9A and B). The ULCA shoulder score was rerated and showed improvement to 30 points, and the VAS score was decreased to 1 to 2 points. The follow-up MRI showed no rupture of the transferred latissimus dorsi tendon (Fig. 10A and B). The results are shown in Tables 1a, 1b and 2.

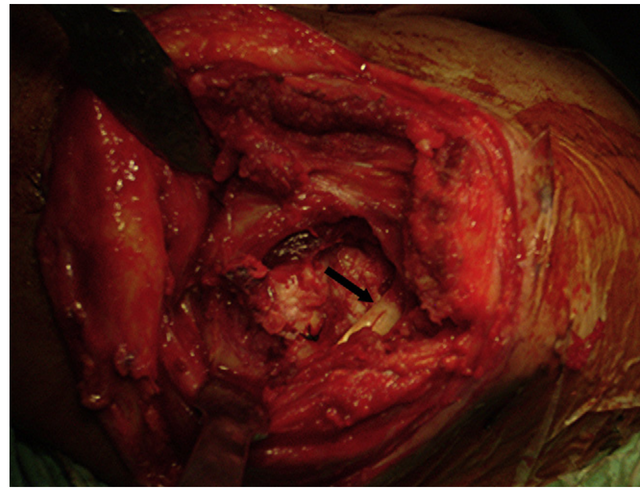


Fig. 6. No identified remnants of the supraspinatus, infraspinatus, or teres minor were identified; however, the long head of the biceps tendon (arrow) was intact.

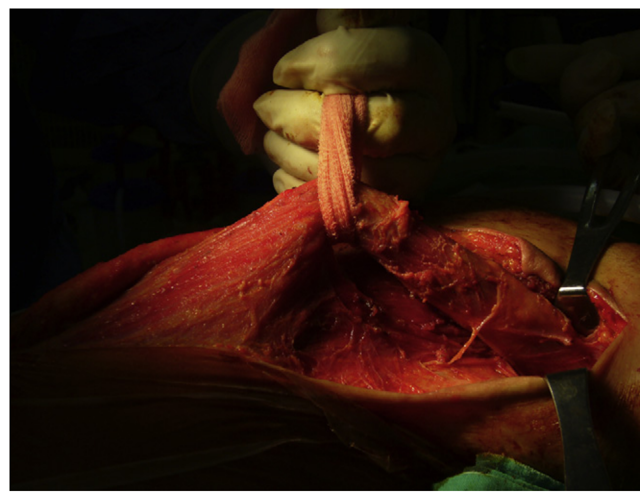


Fig. 7. Latissimus dorsi muscle belly was identified.

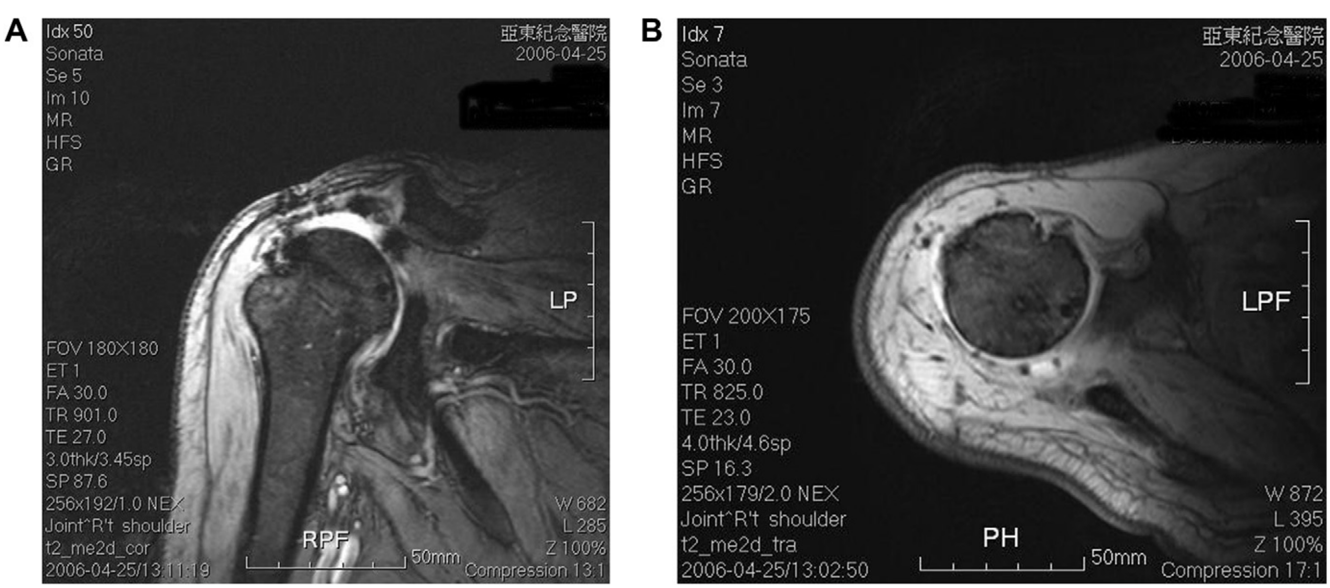


Fig. 5. Magnetic resonance imaging shows massive tears of the rotator cuff. The subscapularis was intact.

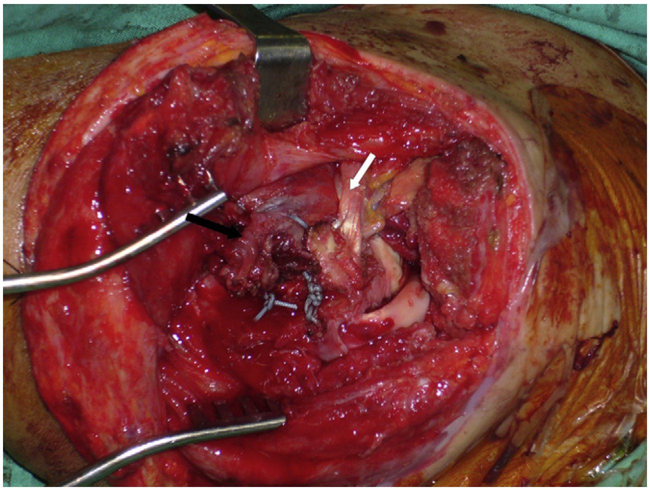


Fig. 8. The tendon of the latissimus dorsi (black arrow) and the remnants of the rotator cuff (white arrow) were intraosseously sutured at the greater tuberosity.

3. Discussion

The majority of superior-posterior RCTs can be repaired back to their insertion sites by direct repair. Very large or chronic defects in the rotator cuff greatly impair the surgeon's ability to repair the rotator cuff due to the fragility of the remaining soft tissues. In 1988, Gerber et al proposed using a latissimus dorsi tendon transfer technique to improve shoulder pain and function.[1] Fourteen cases showed highly encouraging results.[1] In 2006, Gerber[8] presented a total of 67 cases and reported significant improvements in shoulder pain and function, especially when the subscapularis was intact. Several authors have corroborated those results.[2–6]

The idea for the latissimus dorsi tendon transfer technique originated as a result of a patient with a brachial plexus deficit involving the C5 nerve root that produced a neurologic cuff defiency.[1] The latissimus dorsi tendon transfer was used to improve the abduction and external rotation functions of the affected shoulder. In 1999, Miniaci et al[5] transferred latissimus dorsi muscle in order to salvage the failed repair of massive RCTs. In 2001, Warner et al[6] compared the results of primary irreparable RCTs with failed prior rotator cuff repairs. The primary one yielded more

Fig. 9. The patient could freely perform forward flexion and external rotation.

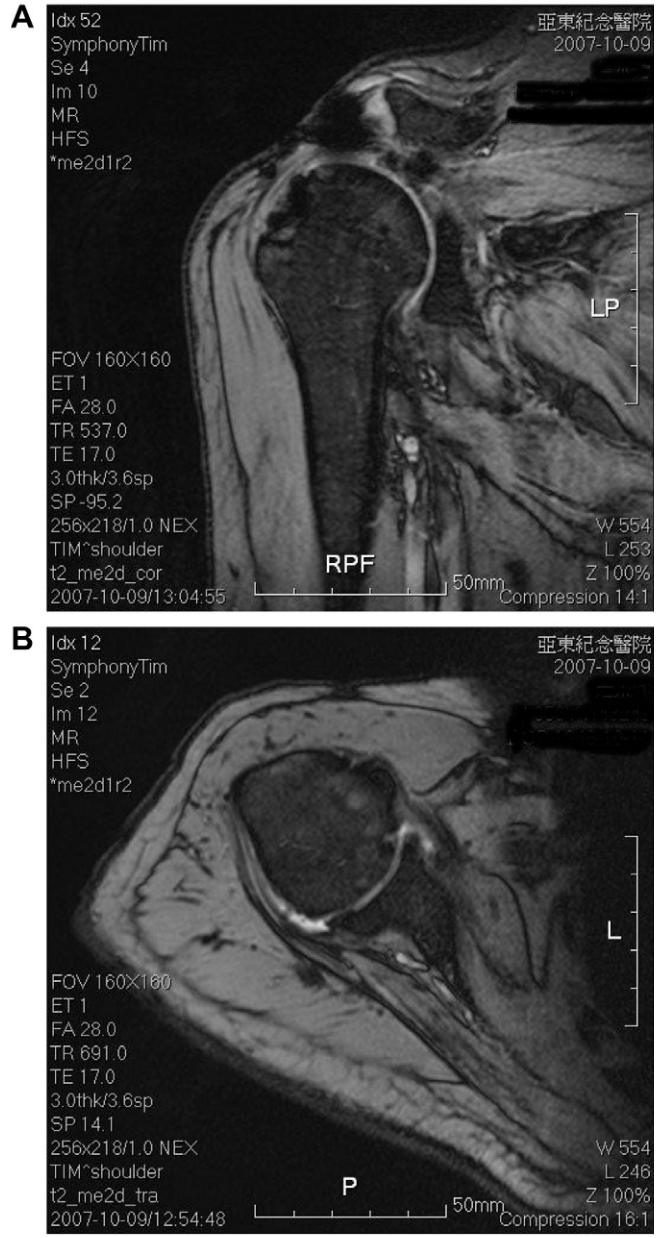
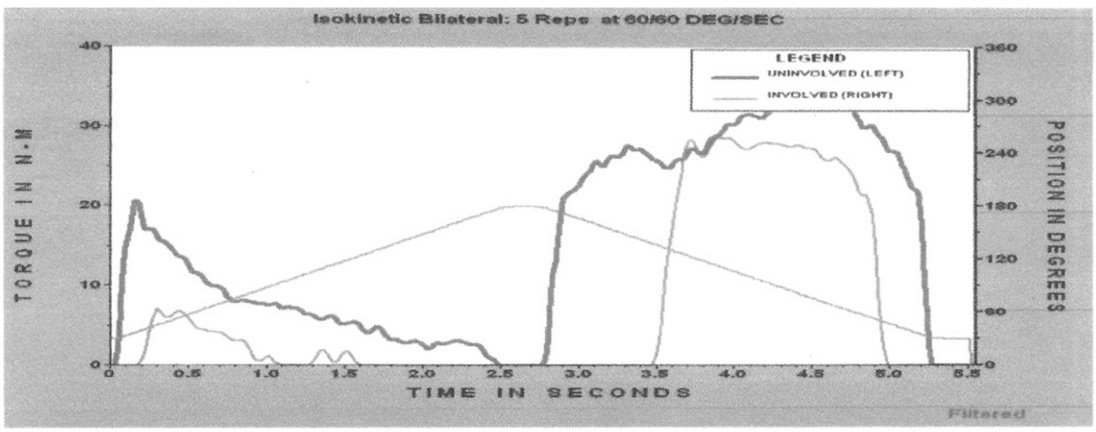


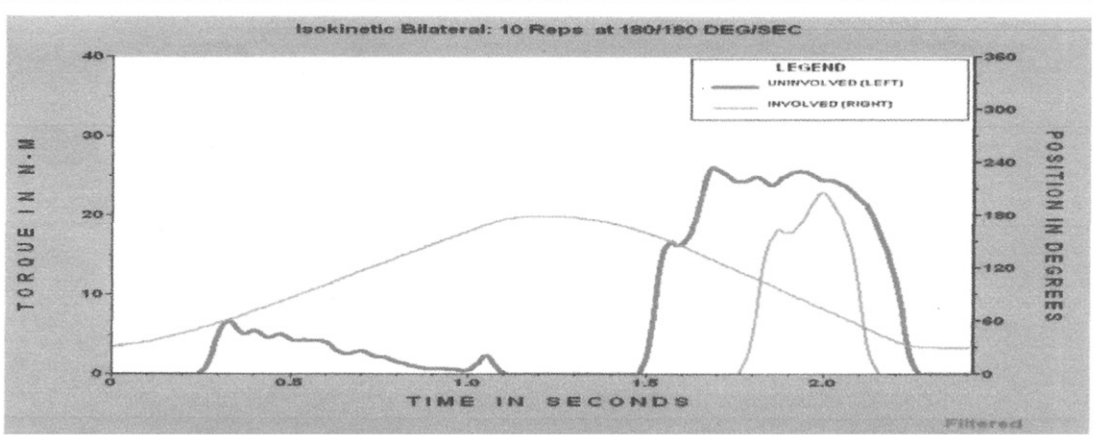
Fig. 10. No rerupture of the transferred tendon was identified postoperatively 1 year later.

Table 1a
The initial radiograph taken at the first evaluation.

		ABDUCTION 60 DEG/SEC			ADDUCTION 60 DEG/SEC		
# REPS: Righ 5		UNINVOLVED	INVOLVED	DEFICIT	UNINVOLVED	INVOLVED	DEFICIT
# REPS: Left 5		LEFT	RIGHT		LEFT	RIGHT	
PEAK TORQUE	N-M	20.8	7.2	65.2	35.6	28.7	
ROM	DEG	149.4	65.0		149.4	65.0	



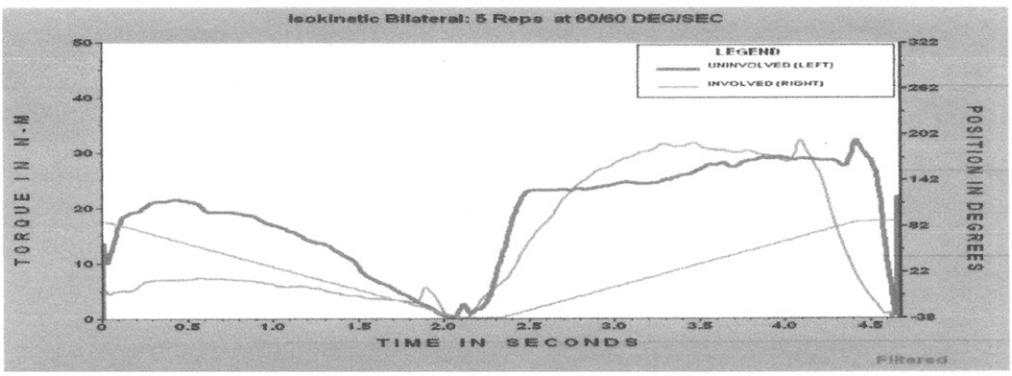
		ABDUCTION 180 DEG/SEC			ADDUCTION 180 DEG/SEC		
# REPS: Right 10		UNINVOLVED	INVOLVED	DEFICIT	UNINVOLVED	INVOLVED	DEFICIT
#REPS: Left 10		LEFT	RIGHT		LEFT	RIGHT	
PEAK TORQUE	N-M	6.8	0.0	100.0	26.2	22.9	12.4
ROM	DEG	148.2	63.0		148.2	63.0	



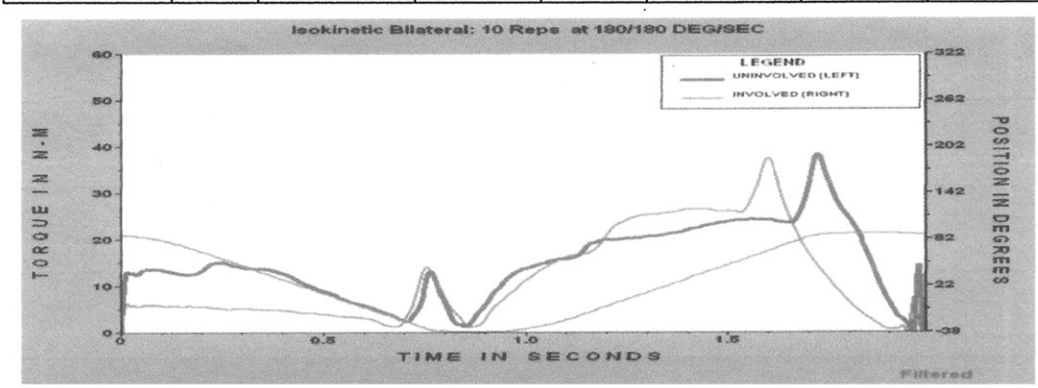
gains in satisfactory and function than the salvage reconstruction. Warner et al mentioned re-ruptures of the transferred tendon in 44% of his patients, which affected the overall outcome of the procedure.[6] Tauber et al presented a modified technique to improved tendon fixation on 2010.[4] The latissimus dorsi tendon was harvested with a chip of bone in order to achieve better direct bone-to-bone fixation, and a significant reduction in complications of re-ruptures was noted.[4]

Table 1b

		EXTERNAL ROTATION 60 DEG/SEC			INTERNAL ROTATION 60 DEG/SEC		
# REPS: Right 5		UNINVOLVED	INVOLVED	DEFICIT	UNINVOLVED	INVOLVED	DEFICIT
#REPS: Left 5		LEFT	RIGHT		LEFT	RIGHT	
PEAK TORQUE	N-M	21.7	7.5	65.4	32.5	32.4	0.0
ROM	DEG	126.2	86.9		126.2	86.9	



		EXTERNAL ROTATION 180 DEG/SEC			INTERNAL ROTATION 180 DEG/SEC		
# REPS: Right 10		UNINVOLVED	INVOLVED	DEFICIT	UNINVOLVED	INVOLVED	DEFICIT
#REPS: Left 10		LEFT	RIGHT		LEFT	RIGHT	
PEAK TORQUE	N-M	15.3	14.1	7.3	38.4	37.6	1.9
ROM	DEG	125.4	85.6		125.4	85.6	



The latissimus dorsi tendon is an adductor and internal rotator of the shoulder. Transfer of this tendon to the greater tuberosity of the proximal humerus has been shown to improve forward flexion and external rotation. The mechanism of action remains controversial. Some authors suggest an increased electromyographic activity of the transferred tendon (which others refute) with forward flexion, external rotation, and abduction of the shoulder.[1,2] Although patients can adapt to the new tendon

Table 2
The sagittal view on the initial MRI showed a bony fragment (arrow) entrapped in the shoulder joint. Coronal view (A) and transverse view (B).

	FLEXION	EXTENSION	ABDUCTION	ADDUCTION	EXTERNAL ROTATION	INTERNAL ROTATION
PASSIVE ROM (DEG)	0-150	0-40	0-125	0-30	0-60	0-45
ACTIVE ROM (DEG)	0-145	0-40	0-125	0-30	0-55	0-40

function,[1] the improved movement may ultimately originate from synergistic and/or tenodesis effects. The shoulder movement is controlled by the rotator cuff tendons and other muscles around the shoulder girdle that act cooperatively. The rotator cuff tendons (i.e., subscapularis, supraspinatus, infraspinatus, teres minor) are dynamic stabilizers of the shoulder. The subscapularis acts as an internal rotator, while the supraspinatus acts as an abductor. The infraspinatus and teres minor are both responsible for external rotation. The teres major and the latissimus dorsi muscles are responsible for adduction. Our patient experienced a superior–posterior rotator cuff deficiency, and the major functional losses involved abduction and external rotation. Our primary concern was whether latissimus dorsi tendon transfer could improve the ROM deficits in our patient. The isokinetic dynamometer showed a peak torque of abduction 7.2/20.8 N-M at 60° per second and 0/6.8 N-M at 180° per second. External rotation was measured at a peak torque of 7.5/21.7 N-M at 60° per second and 14.1/15.3 N-M at 180° per second. These data suggest less gain in abduction from latissimus dorsi tendon transfer compared to external rotation. We are unable to explain why our patient performed poorer with abduction at 180° per second than at 60° per second. Because the resistance is larger at 60° per second than at 180° per second rotation, we would expect the data (0 N-M) may be better than 7.5 N-M just as the results from the external rotation (Table 1).

The line of action of the transferred latissimus dorsi muscle from the scapula to the greater tuberosity of the humeral head contributed to forward flexion and external rotation.[9] There did not appear to be any significant improvement in abduction after this procedure; however, it may be beneficial due to its tenodesis effect. The force of the internal rotation of the affected shoulder was nearly identical to the opposite shoulder, which was likely as a result of an intact subscapularis. The results of adduction revealed less peak torque defect (28.7/35.6 N-M at 60°/second or 22.9/26.2 N-M at 180°/second) on the affected shoulder due to the deficiency of the latissimus dorsi tendon after tendon transfer (Table 1).

To our surprise, the active ROM and passive ROM, as measured by our rehabilitation physician, did not reveal the same poor results (Table 2). The motion arc of abduction and adduction reached 125°, which was nearly twice the result from the dynamometer test. This inconsistency may be related to the actual method of the ROM measurement. When the rehabilitation doctor measured ROM, our patient moved his shoulder as far as he possibly could. The muscles around the shoulder girdle could assist more with this motion. With the dynamometer, straps prevented the patient from recruiting other muscles to facilitate more ROM.

Forward flexion was not tested because so many muscles around the shoulder girdle were involved. Furthermore, the supraspinatus only provided approximately 50% of the total torque for forward flexion.[10] Despite poor abduction related to the supraspinatus, our patient had no difficulty with forward flexion and exhibited no limitation of ROM.

4. Conclusion

The management of irreparable RCT is a challenge for the orthopedic surgeon. Latissimus dorsi tendon transfer would seem to be a good therapeutic choice for young and active patients who have primary RCTs involving the supraspinatus, teres minor, and infraspinatus, as well as those who have an intact subscapularis. Latissimus dorsi tendon transfer may provide better functional improvement in external rotation and forward flexion than it will for abduction. This procedure may also relieve shoulder pain and return the patient to his daily activities.

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