Entire pectoralis major tendon transfer with the hamstring tendon autograft for the treatment of scapular winging due to long thoracic nerve injury

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Aim
The aim of this study was to evaluate the results of treatment of patients with scapular winging due to long thoracic nerve (LTN) injury through the indirect transfer of the entire pectoralis major tendon (PMT) using the hamstring autograft.
Patients and methods
Between November 2011 and October 2012, six patients with painful scapular winging due to LTN injury underwent PMT transfer at Mansoura University Hospital and a private hospital. All patients were male with a mean age of 35.2 years at the time of surgery. All patients underwent clinical examination. All patients underwent plain radiography of the shoulder and electromyography and nerve conduction for the LTN. All patients were treated with the indirect transfer of the entire PMT to the inferior angle of the scapula using the hamstring autograft.
Results
The mean preoperative to postoperative results included increases in active forward flexion from 142.5° to 167.5° and active external rotation from 50° to 65°, and improvement in the American Shoulder and Elbow Surgeons score from 30 to 71.6 and Visual Analog Scale pain score from 6.3 to 1.8.
Conclusion
Entire PMT transfer with the hamstring tendon autograft is effective for restoring shoulder function, relieving shoulder pain, and treating scapular winging caused by serratus anterior paralysis due to electromyography-confirmed LTN injury.

Keywords:
hamstring tendon, nerve injury, pectoralis major tendon

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Introduction

The serratus anterior muscle stabilizes the scapula to the thorax during arm elevation [1]. Paralysis due to long thoracic nerve injury (LTN) is infrequently encountered [2]and results in pain and significant dysfunction of the shoulder [3–5].

Observation for up to 18 months, with maintenance of range of motion (ROM), should be the basis of treatment [1]. If failed, transfer of the pectoralis major tendon (PMT) to the inferior angle of the scapula should be considered. The transfer is either direct [4,6] or indirect [1,3,7–10] of the entire muscle or the sternal head alone.

This study describes the results of treatment of patients with scapular winging due to LTN injury through indirect transfer of the entire PMT using the hamstring autograft.

Patients and methods

Between November 2011 and October 2012, six patients underwent PMT transfer at Mansoura University Hospital and a private hospital for the treatment of painful scapular winging resulting from LTN injury. Patients were included if they had painful winging of the scapula due to LTN injury confirmed by electromyography (EMG) and after failure of conservative management for a minimum of 12 months. The study excluded patients with a diagnosis not confirmed by EMG. Patient's consent was taken.

All patients underwent clinical examination to exclude lateral winging and secondary winging caused by glenohumeral and subacromial disorders, cervical radiculopathy [11], scapular osteochondroma, or scapulothoracic dyskinesia [12]. To distinguish whether scapular winging is due to true LTN palsy, a direct downward force is applied to the upper extremity flexed to 90° in the sagittal plane; if scapular instability is observed with this maneuver, scapulothoracic dyskinesia should be investigated as

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the cause for winging [13]. Routinely, all patients underwent plain radiography of the shoulder and EMG and nerve conduction for the LTN. Some patients underwent MRI of the cervical spine.

Preoperative and postoperative evaluation of the affected shoulder consisted of assessment of active forward flexion and external rotation, observation of scapular winging, and the clinical scoring using American Shoulder and Elbow Surgeons (ASES) score and Visual Analog Scale (VAS). All patients were male with a mean age of 35.2 (range: 25–45) years at the time of surgery [5]. All patients had occupations involving at least light manual labor before injury. The average follow-up at the time of the study was 17.6 (range: 12–24) months (Table 1).

The six patients were treated with indirect transfer of the entire muscle with interposed hamstring autograft to the inferior angle of the scapula. Postoperative care consisted of sling immobilization for 6 weeks to allow for healing, followed by passive ROM for 6 weeks, and finally active ROM for 12 weeks before resumption of normal activities.

Surgical technique

The patient is placed in a semilateral position, and a 6 cm curvilinear incision is made, beginning just lateral and inferior to the coracoid process and medial to the anterior axillary crease. The deltopectoral interval is developed. The insertion of the pectoralis major on the humerus is identified and sharply harvested (Fig. 1). The muscle is mobilized and its medial attachments are freed to allow maximal excursion.

The semitendinosus and gracilis tendons are harvested under a tourniquet and sewn together along their length. The autograft is woven through the end of the PMT and the two limbs of the graft are sewn together and to the PMT (Fig. 2).

The shoulder is then flexed forward to bring the inferior pole of the scapula anteriorly. A 4-cm incision is made over the posterior chest over the palpable edge of the scapula. The latissimus muscle is split, the muscular attachments to the dorsal and ventral surfaces of the scapula are elevated subperiosteally, and an 8–10 mm hole through the inferior angle of the scapula is created. Fracture of the inferior pole of the scapula can occur if the hole is drilled too close to the scapular edge.

Next, a soft tissue tunnel is created through the posterior incision to allow careful passage of the tendon autograft from anterior to posterior (Figs. 3–5). Correct graft tunnel placement is important to avoid compression of the brachial plexus between the graft and the chest wall. To avoid this complication, the latissimus and brachial plexus are elevated off the chest wall before passing the tendon.

While an assistant manually reduces the scapula to the chest wall, the graft is passed through the hole created in the scapula, doubled back, and sutured on itself in a u-shape, thereby doubling its thickness in this area. Adequate ROM and the absence of scapular winging are confirmed before wound closure.

Results

The mean preoperative to postoperative results included increases in active forward flexion from

Table 1 Patient findings

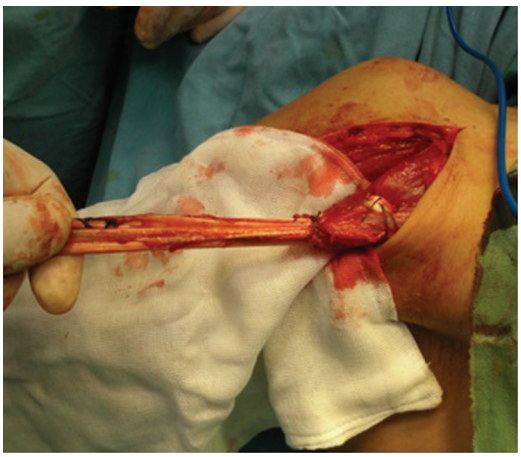
	Patient 1	Patient 2	Patient 3	Patient 3	Patient 4	Patient 5	Patient 6
Age (years)	25	29	41	41	34	37	45
Preoperative (deg.)							
AFF	130	160	145	145	135	150	135
AER	35	75	60	60	40	50	40
Winging	+	+	+	+	+	+	+
VAS score	9	4	6	6	7	4	8
ASES score	10	60	50	50	20	30	10
Follow-up (months)	24	20	18	18	17	15	12
Postoperative (deg.)							
AFF	170	175	175	175	165	160	160
AER	70	85	70	70	50	65	50
Winging	–	–	–	–	–	–	–
VAS score	4	1	3	3	2	0	1
ASES score	60	90	80	80	80	70	50

AER, active external rotation; AFF, active forward flexion; ASES, American Shoulder and Elbow Surgeons score; VAS, Visual Analog Scale.

Figure 1

The insertion of the pectoralis major is sharply harvested.

Figure 2



The autograft is woven through the end of the pectoralis major tendon.

Figure 3

The passage of the pectoralis major tendon and the autograft from anterior to posterior.

Figure 4

A 35-year-old patient had primary, dynamic, medial winging of the scapula (preoperative).

Figure 5

The same patient after 12 months of pectoralis major tendon transfer and hamstring tendon autograft (postoperative).

142.5° to 167.5° and active external rotation from 50° to 65°, and improvement in the ASES score from 30 to 71.6 and the VAS pain score from 6.3 to 1.8 (Table 1).

Postoperative complications occurred in some patients. One patient developed a hematoma that resolved without evacuation. Another patient described a small area of numbness in the anterior leg, over the site of graft harvest. In four patients, there was asymmetry of the anterior axillary fold.

No one had fracture of the inferior pole of the scapula. There were no neurological complications due to compression of the brachial plexus between the graft and the chest wall and no recurrent scapular winging.

Discussion

Winging of the scapula may be medial or lateral/static or dynamic [14] per primary, secondary, or voluntary

[15]. LTN injury causes medial, dynamic, primary winging of the scapula.

The serratus anterior muscle stabilizes the scapula to the thorax during arm elevation [1]. It balances the action of the trapezius, levator scapulae, and the rhomboid muscles on the scapula and counters the rotational force of the biceps and coracobrachialis tendons when the arm is held extended or abducted [16]. Paralysis of the serratus anterior changes the position of the scapula during arm elevation, causing upward elevation, lateral rotation of the upper medial corner, medial rotation of the lower pole, and internal rotation of the scapula [17,18] and hence predisposing to increased anterior translation of the humeral head [17–19].

LTN injury may be due to blunt trauma or stretch [3,6,9,10]. A single severe traumatic event (e.g. a weight falling on the shoulder) or repetitive minor episodes (e.g. lifting heavy objects) causes depression of the shoulder girdle and stretching of the LTN over the prominence of the second rib [7].

Painful scapular winging associated with this condition usually resolves spontaneously. Conservative management can be carried out for up to 1 year; if there is no improvement, PMT transfer is an effective treatment. Tubby [5] was the first to describe PMT transfer. Marmor and Bechtol [20], were the first to describe elongation of the PMT with a fascia lata graft. There are different variations in the method of transfer; the indirect method using the autograft has been the mainstay of treatment, with excellent results [1,3,4,6,8,9,13,21,22].

Povacz and Resch [23] showed that the excursion of the PMT was sufficient for direct transfer, allowing direct bone-to-bone healing and avoiding the morbidity of graft harvest. However, this increases tension on the muscle, leading to iatrogenic traction injury of the medial and lateral pectoral nerves and hence recurrent scapular winging [24]. Moreover, it needs excessive release of the muscle from its chest wall attachments and may affect its blood supply.

Many authors [1,3,4,6,9,10,13] (Table 2) demonstrated that the indirect transfer of the PMT is an effective treatment for painful scapular winging and shoulder weakness as a result of EMG-confirmed LTN injury. The results of our study are in agreement with these authors. The mean active forward flexion of 167.5° attained by our patients was within the range of 144° to175° reported in previous studies of direct and indirect methods of transfer. Our ASES and VAS results were also similar to those reported by these authors (Table 2), indicating that PMT transfer is effective in restoring function and relieving pain caused by weakness of the serratus anterior muscle.

Recurrent winging of the scapula is a known postoperative complication of indirect transfer of the PMT and ranged from 0 to 26% [1,4,6,9,10,13,23]. It is caused by stretching of the avascular graft tissue [1,7,10,22,24,25] or inadequate tension of the transfer or if patients with scapulothoracic dyskinesia are treated with PMT transfer [13,22]. In our study, with the use of EMG-confirmed diagnosis before surgical treatment, the use of hamstring autograft, and the fixation of the graft with the arm maximally flexed, the rate of recurrent winging was 0%.

Tauber *et al.* [4] obtained excellent outcomes with direct transfer of the sternal head alone and noted no dissatisfaction with cosmetic appearance, and Galano *et al.* [6] reported that only one patient was dissatisfied with cosmetic appearance. In our study, in favor of scapulothoracic stability, transfer of both heads of the PMT left a noticeable depression inferior to the clavicle. Asymmetry of the anterior axillary fold was obvious in some patients and negligible in others.

Table 2 The reported results of pectoralis major tendon transfer

References	No	AFF (deg.)		ASES		VAS	
		Preoperative	Postoperative	Preoperative	Postoperative	Preoperative	Postoperative
Connor *et al.* [1]	10	110	175	NR	71	8.2	3
Galano *et al.* [6]	11	158.2	164.5	53.3	63.8	5.2	9
Noerdlinger *et al.* [9]	15	NR	156	NR	63	NR	NR
Perlmutter *et al.* [10]	16	87	158	NR	NR	NR	NR
Steinmann *et al.* [3]	9	90	144	NR	67.4	NR	NR
Tauber *et al.* [4]	12	89	171	NR	NR	NR	NR
Warner and Navarro [13]	8	97	150	NR	NR	NR	NR
Jonathan *et al.* [25]	26	112.1	148.7	28.1	67.1	7.7	3.0
This study	6	142.5	167.5	30	71.6	6.3	1.8

AER, active external rotation; AFF, active forward flexion; ASES, American Shoulder and Elbow Surgeons score; NR, not reported; VAS, Visual Analog Scale.

Conclusion

Entire PMT transfer with the hamstring tendon autograft is effective for restoring shoulder function, relieving shoulder pain, and treating scapular winging caused by serratus anterior paralysis due to EMG-confirmed LTN injury.

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Conflicts of interest

There are no conflicts of interest.

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