



## Trapezius tendon transfer according to Saha after neglected complete axillary nerve injury

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Traumatic axillary nerve injury represents less than 1% of all nerve injuries. It is often subclinical because it is masked by the pain due to a shoulder fracture or dislocation, so that treatment is neglected for a long period. When nerve repair and physiotherapy are unsuccessful, trapezius tendon transfer may be considered. Between March 2008 and May 2009, 10 patients with neglected deltoid paralysis were treated by trapezius tendon transfer at Mansoura University hospital and in a private hospital. All patients were males. Their mean age was 27.8 years (range : 17-35). The mean follow-up period was 30 months (range : 24 to 36 months). The operations were performed according to the method described by Saha in 1967, involving transfer of the lateral extremity of the clavicle, the acromioclavicular joint and the acromion, with the insertion of the trapezius, to the proximal humerus. The authors retrospectively assessed the results according to the 5 items (a-e) of the Rowe and Zarins score : all 10 patients had (a) improved shoulder function with (e) a more stable shoulder. The mean active abduction (b) was 76° (range : 50-100 °) and the mean active flexion (c) 78° (range : 45-110°). However, most authors report lower values : from 34 to 76° of abduction, and from 30 to 78° of flexion. Arthrodesis results in 59 to 71.43° of abduction. The abduction power (d) was improved : it reached grade 3 in 7 cases and grade 4 in 3 cases. In this study, trapezius tendon transfer provided satisfactory functional improvement for paralysis of shoulder abduction after neglected complete axillary nerve injury, with improvement in shoulder stability, power and range of motion.

**Keywords** : axillary nerve ; paralysis ; Saha technique.

### INTRODUCTION

Abduction is the most important functional movement of the glenohumeral joint, and at the same time one of the most complex movements of the entire body (15). Loss of shoulder abduction is a severe disability in daily living and in employment (22).

Traumatic axillary nerve injury may be complete or partial, combined or isolated, iatrogenic or due to direct contusion, fracture or dislocation. It leads to weakness of shoulder abduction. Two types of management have been advocated : shoulder arthrodesis and tendon transfers (25).

Shoulder arthrodesis also permits a certain range of abduction, but includes a high incidence of complications, e.g. fractures (9,12) and pseudarthrosis (9,43). Trapezius tendon transfer is a valuable

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alternative (2,20,21,25,35,36,37). It was first described by Mayer (24) in 1927. He used a fascia lata strip to increase the length of the trapezius tendon. Bateman (3) modified the Mayer technique in 1955 by transferring the trapezius tendon with the acromion and part of the spine of the scapula as far down the humeral shaft as possible. The bony insertion of the trapezius was fixed with two or three screws. Saha (5,39) modified Bateman's technique in 1967. He carefully mobilized the superior and middle trapezius, so that the transfer was made 5 cm longer, without endangering its nerve or blood supply. This yielded a greater lever arm. The entire insertion of the trapezius, along with the attached lateral end of the clavicle, the acromioclavicular joint, the acromion and adjacent part of the scapular spine, were anchored to the lateral aspect of the humerus distal to the tuberosities.

#### MATERIALS AND METHODS

Patients were included if they had a complete isolated axillary nerve injury, since one year or more. Patients were excluded if they had non-traumatic paralysis, partial nerve lesions, combined nerve lesions, paralysis less than one year, passive abduction less than 80° (one case with adhesive capsulitis needed arthroscopic release), or a weak trapezius muscle. Between March 2008 and May 2009, 10 patients with deltoid paralysis were treated by trapezius transfer according to Saha (5,39). All patients were males. Their average age was 27.8 years (range : 17-35). Table I yields further details. The diagnosis had been missed in most cases because of the pain due to an

associated fracture. Nerve repair was not tried at this late stage, because it is known to have a poor prognosis after such a delay (11).

The 5 items (a-e) of the Rowe and Zarins score (34) were used to evaluate the pre- and postoperative condition of the patients (Table II). This score includes, among others, limb function (a) : throwing, working, overhead working, sports activities (34) and employment (25). All patients were severely disabled in daily living and in employment. All had a full passive range of movement, except one who needed arthroscopic release, after which the abduction improved to 140° and the flexion to 150°. Preoperative abduction (b) and flexion (c) are shown in table II. The abduction strength (d) was grade 1 in 7 cases and grade 2 in 3 cases. There was deltoid atrophy and loss of shoulder contour in all cases. Nine patients had a sense of subluxation (e), except the one who needed arthroscopic release. All patients had good ipsilateral elbow and hand function.

Plain radiographs showed inferior subluxation of the humeral head in all cases. An EMG was obtained in all patients.

The technique of Saha (5,39) was used in all cases. Saha starts from a saber-cut incision. The trapezius is exposed to 2.5 cm medial to the vertebral border of the scapula. The deltoid is reflected laterally. The clavicle is transected lateral to the conoid ligament ; the spine of the scapula is also divided. These bony elements remain fixed to the trapezius tendon. The lateral aspect of the humerus, selected for attachment of the transfer, is denuded. The point of fixation should be on the anterolateral aspect of the humerus (25,39) : if the acromial fragment is placed on the posterolateral area, this will produce retroversion and external rotation (41). Many patients have osteoporosis secondary to disuse after

Table I. — Demography

Patient #	Causative trauma	Initial diagnosis	Initial management	Other management	Cause of axillary nerve injury
4	road-traffic accident	proximal humeral fracture	reduction and K-wires	physiotherapy	fracture or iatrogenic
3	fall on shoulder	acromio-clavicular dislocation	ORIF	physiotherapy	direct contusion
2	traction trauma	rotator cuff tear ?	conservative	physiotherapy	traction
1	road-traffic accident	proximal humeral fracture	conservative	physiotherapy, arthroscopic arthrolysis	fracture or iatrogenic

Table II. — Results according to the Rowe and Zarins score

	preoperatively	postoperatively
a. limb function	severe disability	4 : no limitation 6 : moderate limitation
b. active abduction	+/-13° (range, 0-30°)	+/-76° (range, 50-100°)
c. active flexion	+/-18° (range, 0-40°)	+/-78° (range, 45-110°)
d. abduction strength	grade 1 : 7 patients grade 2 : 3 patients	grade 3 : 7 patients grade 4 : 3 patients
e. sense of subluxation	9 patients	0 patients

axillary nerve lesion ; this can hamper fixation of the bony fragments to the humerus. Adequate preparation of the undersurface of the acromion and the surface of the humerus is very important (37). Then with the shoulder in 45 to 60° of abduction the transfer is anchored to the humerus with two screws. A spica cast is applied with the shoulder abducted 45°, neutrally rotated, and flexed in the plane of the scapula. At 10 days radiographs are made to ensure that the humeral head is not dislocated inferiorly. At 6 to 8 weeks the cast is removed and active mobilization is started.

## RESULTS

The results were assessed according to the Rowe and Zarins score (34), which is based on limb function (a), active range of motion (b,c), strength of shoulder abduction (d) and tendency to joint subluxation (e) (Table II). All variables improved. Active abduction improved from +/- 13° (range, 0-30°) to +/- 76° (range, 50-100°).

Complications : no infection, failure of fixation, fracture, pseudarthrosis or pain were noted. All patients were satisfied, especially with the improved shoulder contour.

## DISCUSSION

### Axillary nerve injury

Traumatic axillary nerve injury represents less than 1% of all nerve injuries. Most axillary nerve injuries are part of a *combined* brachial plexus injury. *Isolated* axillary nerve injuries constitute only 0.3% to 6% of all brachial plexus injuries (28).

Injury to the axillary nerve most commonly follows closed trauma involving a traction injury to the shoulder, usually associated with dislocation or fracture. Axillary nerve injury has been reported to occur in 19 to 55% of all anterior shoulder dislocations (7,8,14,42,44) and in up to 58% of all proximal humeral fractures (45). Blunt trauma to the anterolateral aspect of the shoulder, such as the impact of a helmet on the shoulder, has also been noted to cause axillary nerve injury by direct contusion (4,27). The axillary nerve may be injured with most surgical procedures about the shoulder, such as arthroscopy, shoulder stabilization, or rotator cuff repair (38). Many of these injuries to the axillary nerve may be subclinical because the nerve injury may be masked by the pain due to a shoulder fracture or dislocation (7), and so their management is neglected for long periods.

### Arthrodesis or transfer ?

Most authors prefer arthrodesis for palliation of the posttraumatic flail shoulder (6,12,30,33). The main advantage of arthrodesis is the increase in active function (10,20,30,31,32), particularly for patients engaged in physical work and with almost fully preserved or restored function of the elbow and hand. Shoulder arthrodesis is an irreversible procedure, requires normal mobility of the scapulothoracic joint and inhibits the passive mobility of the joint, making some daily activities like dressing (12) or putting the hand into the pocket (16) difficult. Arthrodesis permits a certain range of abduction, +/- 59° according to Atlan *et al* (1),

Table III. — Results obtained with Saha transfer for deltoid paralysis

Author	Aziz	Mir-Bullo	Rühmann	Rühmann	Rühmann	Kotwal
Year of publication	1990	1998	1998	1999	2005	1998
Number of patients	27	6	31	54	80	8
Injury	brachial plexus	brachial plexus	deltoid & supraspinatus	deltoid & supraspinatus	brachial plexus	brachial plexus
Preop. abduction	3.5°	13° (0-30°)	7.3°(0-45°)		6° (0-45°)	
Postop. abduction	45.4° (20°-120°)	76° (50-100°)	39°(25-80°)	37.1° (5-80°)	34° (5-90°)	60°
Preop. flexion	0-120°	18° (0-40°)	20°(0-85°)		12° (0-85°)	
Postop. flexion	35.2° (0-120°)	78 (45-110°)	44°(20-90°)	36.2° (10-90°)	30° (5-90°)	

and +/- 71.43° according to Richards *et al* (31). However, these values compare favourably with those obtained with trapezius transfer (Table III). Arthrodesis leads to a high percentage of complications (20%), such as fractures (9,12) and pseudarthroses (16,43). Also pain is common after arthrodesis (18,31). Many patients are dissatisfied (9,12), and some feel even worse than before surgery (18). Revision is often necessary : in 35.2% of the cases, because of persistent shoulder pain, pseudarthrosis or malposition (12).

Therefore, some authors consider that tendon transfers are better than shoulder arthrodesis (17,23). For instance, Aziz, Singer and Wolff (2) stress that trapezius tendon transfer is a simple procedure with minimal blood loss, which provides functional improvement and usually elimination of pain. Moreover, it is compatible with later return of some function in other shoulder girdle muscles, while arthrodesis is irreversible and immune to any late return of brachial plexus function. Also Kotwal *et al* (22) claim that trapezius transfer can provide satisfactory functional improvement and that it is a better procedure than arthrodesis for paralysis of shoulder abduction caused by poliomyelitis or injury to the brachial plexus. Trapezius transfer is certainly better in terms of passive movement.

Importantly, failure after tendon transfer may still be salvaged by shoulder arthrodesis (37).

### Combined or single transfer ?

Reports on the functional outcome after trapezius tendon transfer and other transfers vary considerably. Saha (5,39) recommends careful assessment of all muscles about the joint. If the steering muscles (subscapularis, supraspinatus, infraspinatus) are also paralyzed, he proposes specific transfers to replace them. When suitable transfers are not available, the insertion of the trapezius can be anchored more anteriorly or posteriorly on the humerus to restore internal or external rotation.

### Which single transfer ?

Itoh *et al* (19) reported on latissimus dorsi transfer to replace the anterior deltoid, and obtained a mean postoperative flexion of 116°. However, the abduction obtained with the latissimus dorsi transfer was much less (+/-37°), and the surgical technique appears more difficult, with a substantial danger of injury to the vascular bundle of the muscle and necrosis of the muscle (26). Mir-Bullo *et al* (25) think that trapezius tendon transfer, in spite

of the shorter lever arm, is better than latissimus dorsi transfer, because the trapezius acts in the scapular plane.

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