Egypt, J. Plast. Reconstr. Surg., Vol. 35, No. 1, January: 83-92, 2011

Combined Latissimus Dorsi and Trapezius Transfer to Improve Zero Shoulder after Brachial Plexus Palsy

MOHAMMAD REDA AHMAD, M.D.*; ALAA N. EL-SADEK, M.D.* and ASHRAF ABDELDAYM, M.D.**

The Departments of General Surgery, Plastic and Reconstructive Surgery Unit and Orthopedics Surgery**, Faculty of Medicine, Zagazig University.*

ABSTRACT

Background: Shoulder stability and restoration of functions are very important goal in dealing with zero shoulder cases. When brachial plexus is severely injured, shoulder stability and functions become very bad, in this situation; shoulder joint is defined as zero shoulder. Increasing stability, and function cab be achieved, by adding latissimus dorsi transfer to traditional trapezius transfer.

Aims and Objectives: For restoration of stability, abduction, and external rotation, we propose increasing stability, and function, by adding latissimus dorsi transfer to traditional trapezius transfer.

Subjects and Methods: From January 2008 to February 2010, we had operated 11 patients of brachial plexus injury with very poor shoulder abduction. 5 cases were operated by combined latissimus dorsi and trapezius transfer. And 6 cases operated with trapezius transfer only. Before and after operations full evaluation of muscles functions in the affected arms were carried out.

Results: All patients had improved functions and were satisfied with the outcome. Combined trapezius and latissimus dorsi muscle transfer (group A) results (abduction, active external rotation and forward flexion) were significantly better than those achieved by the transfer of the trapezius alone ($p<0.05$, $p<0.001$ and $p<0.001$ respectively).

Conclusion: The combination between transfer of latissmus dorsi and trapezius significantly improve both stability and function of the shoulder joint more than trapezius transfer alone.

INTRODUCTION

Supraspinatus and deltoid muscles provide abduction of the shoulder to 90°. After 90° of abduction at the glenohumeral joint, the main external rotators of the scapula for full shoulder abduction are serratus anterior and trapezius, while other muscles are involved in rotating and stabilizing the humeral head. In the scapular plane, the anterior and middle thirds of deltoid with some involvement of posterior third are responsible for shoulder abduction. In the coronal plane and posterior to it, the contribution of the anterior third decreases and that of the posterior third becomes more and more apparent **[1-3]**.

Most brachial plexus palsies are due to trauma, often resulting from motorcycle accidents **[4-7]**.

Paralysis due to brachial plexus palsy produces weakness in abduction and some flexion. Loss of abduction at the shoulder is a severe disability in daily living and in employment **[1]**.

In cases of global palsy or upper root avulsions the shoulder may be flaccid and paralytic, so it is considered zero shoulder. Treatment of the paralytic sequelae is more complex since shoulder movements require the coordination of several muscles **[8,9]**.

When nerve repair and physiotherapy are unsuccessful, secondary operations are sometimes required to restore function **[4,5,10]**.

The secondary procedures include shoulder arthrodesis, rotational osteotomy of the humerus, muscle transfer or a combination of these techniques. For paralysis of the deltoid and supraspinatus muscle many different muscle transfers have been described to improve function and stability **[4,6,11,12]**. These include transfer of the trapezius **[13-17]**, pectoralis major and teres major **[18]**, latissimus dorsi (LD) **[6,19]**, gracilis **[19]** and combined biceps and triceps **[13,20-23]**. Other combinations of muscles have been described such as teres major, LD and levator scapulae **[24]** and biceps, coracobrachialis and pectoralis major **[13,25]**.

It is well known that, tendon transfer technique using the trapezius to restore the function of paralyzed shoulder has a long history **[1,14-17,26-30]**. LD tendon transfer has also been widely applied to restore shoulder function **[31-35]**.

Transfer of the trapezius insertion was first described by Mayer [26], who used a fascia lata graft to extend its attachment to the deltoid tuberosity. The results of his work were poor because the graft stretched and became adherent to surrounding structures. Bateman [15], modified the procedure by resecting part of the spine of scapula with the trapezius, to allow screw fixation of the transfer to the humerus. This procedure was further modified by Saha [17]. Saha's [17] logical modification of the trapezius transfer described by Bateman [15] provides a more distal fixation of the transfer after a more proximal release. This gives a greater lever arm allows better fixation to the narrow cylindrical shaft of the humerus. An important modification was to consider transfer for paralyzed muscles of the rotator cuff, to improve control of the humeral head and prevent subluxation. Saha [17] recommends careful assessment of all muscles about the joint. He considered the deltoid and the clavicular head of the pectoralis major as prime movers for abduction; they also lift the humeral shaft. Subscapularis, supraspinatus and infraspinatus are a steering group which stabilise the humeral head in the glenoid. The sternal head of pectoralis major, LD, teres major and teres minor form a depressor group which also rotate the shaft and pull the humeral head downwards during the last few degrees of abduction.

Some authors like Rühmann et al. [30] stated that, trapezius transfer alone for flail shoulder can give satisfactory function and stability. While other authors as Gilbert et al. [36] and Terzis and Kokkalis [9] confermed that, the concomitant transfer of the trapezius with other pedicle muscle had given significantly better results Therefore, we decide to evaluate the merits of combined LD transfer to trapezius transfer in improving shoulder function and stability.

PATIENTS AND METHODS

From January 2008 to February 2010, eleven patients suffering from post traumatic brachial plexus injury were presented by zero shoulder abduction, five of them were treated by combined trapezius and LD muscle transfer, and the other six cases were treated only by trapezius muscle transfer. Before operation a full evaluation of muscle function in the affected arm was carried out. All the muscles of the shoulder girdle and upper extremity was examined and graded to assess shoulder function, a modified Mallet [37] scale was used with a grading of I-IV for evaluation of (a) shoulder abduction, (b) shoulder external rotation, (c) hand to nape, (d) hand to back, (e) hand to pocket, and (f) hand to mouth position. The trapezius must show full strength against resistance. Also being sure that LD is of good function is very important. Radiographs of the shoulder are essential to show any malposition after fracture or osteosynthesis. Passive abduction of 80° is needed to transfer the acromial fragment to the humerus. The patient must be fully informed of the expected result and the possible recovery of function.

We have divided the cases into 2 groups; Group A including 5 patients operated by combined LD and trapezius transfer. Group B operated by trapezius transfer only.

Operative technique:

For group A we used the technique of Saha [17], a modification of the Bateman [15] method. With adding LD transfer to the usual surgery. The patient is placed supine with a sand-bag under the shoulder. A Y-shaped incision is made over the lateral third of the clavicle and the acromioclavicular joint and acromion, extending down the arm. The origin of the deltoid is exposed and detached subperiosteally. The clavicle is then divided lateral to the conoid ligament and the spine of the scapula medial to the acromion with posterior beveling. The central part of the insertion of the trapezius is elevated with the cut end of the clavicle, the acromioclavicular joint, and the scapular fragment, freeing the remainder of the posterior insertion from the scapular spine. The bone fragments of the clavicle and acromion are then fractured in several places. The proximal humerus is exposed by splitting the paralysed deltoid and the bone is roughened with an osteotome. LD muscle dissected through an incision along lateral scapular edge. Then its tendon transferred from bicipital groove to greater tuboristy of humerus through a tunnel in posterior fibres of deltoid. The rotator cuff is left untouched. With the humerus in 90° of abduction, the acromial fragment with its trapezius insertion is transferred and fixed to the humerus with two 4.5mm screws. The deltoid is then sutured over the trapezius and the skin is closed over two suction drains. Check radiographs are taken to assess the position of the screws and the acromial fragment.

For group B only trapezius transferred by the technique of Saha [17], a modification of the Bateman [15] method.

Immobilization in an abduction support is adopted for six weeks. Rehabilitation started on the first postoperative day with active exercises for the elbow, hand and fingers [16].

Statistical analysis:

Data were represent as mean ± standard error (SE). Statistical analysis was performed using the 15.0 version of SPSS statistical software for windows. Paired student *t*-test used in the comparison between preoperative and postoperative evaluation and unpaired student t test used in the comparison between 2 groups *p*-values less than 0.05 were considered significant.

RESULTS

As regard our results in group A (5 cases of combined trapezius and LD muscle transfer), the abduction of the shoulder had significantly improved from 8°±3.74° (mean ± SE) to 58±6.8 ($p<0.001$). The active external rotation also significantly improved from 8°±3.74° to 66°±2.45° ($p<0.001$). Moreover, the forward flexion simultaneously, increased from 6°±2.45° to 24°±2.44° ($p<0.001$).

As regard our results in group B (6 cases trapezius muscle transfer) there was a significant improvement of shoulder abduction from 13.33°± 4.21° to 40.83°±3.27 ($p<0.01$). The active external rotation also significantly improved from 6.67°± 2.11° to 20.0°±2.58° ($p<0.01$). However, there was non significant change in the degree of forward flexion, it was 8.33°±1.67° and became 13.33°± 2.11° ($p>0.05$).

As regard the comparison between two the groups combined trapezius and LD muscle transfer (group A) has given significantly better abduction, better active external rotation and successful forward flexion results than the transfer of the trapezius alone ($p<0.05$, $p<0.001$ and $p<0.001$ respectively). In shoulder reconstruction after traumatic brachial plexus palsy.

Table (1): Preoperative and postoperative data of all patients.

Case	Age/sex	Abduction		Active external rotatotion		Forward flexion	
		Pre	Post	Pre	Post	Pre	Post
1A	18Y/♂	10	55	10	70	10	20
2A	22Y/♂	0	50	0	60	0	20
3A	6Y/ ♂	20	80	10	70	10	30
4A	16Y/♀	0	40	0	50	0	20
5A	35Y/♀	10	65	20	80	10	30
6B	16Y/♂	10	40	0	20	10	10
7B	30Y/♂	10	55	10	30	10	20
8B	8Y/ ♀	0	30	0	10	0	10
9B	20/ ♂	20	40	10	20	10	10
10B	16Y/♂	10	40	10	20	10	10
11B	30Y/	30	40	10	20	10	20

Table (2): Results of combined LD + trapezius muscle tendon transfer and only trapezius muscle transfer in patients of traumatic BPP.

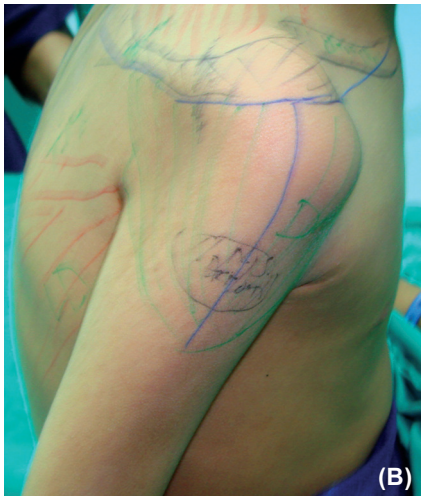
		Abduction		Active external rotation		Forward flexion	
		Pre	Post	Pre	Post	Pre	Post
Group A	Range	0-20	40-80	0-20	50-80	0-10	20-30
	± SE	8 ± 3.74	58 ± 6.8	8 ± 3.74	66 ± 5.10	6 ± 2.45	24± 2.44
	p-value	<0.001		<0.001		<0.001	
Group B	Range	0-30	30-55	0-10	10-30	0-10	10-20
	± SE	13.33 ± 4.21	40.83 ± 3.27	6.67 ± 2.11	20 ± 2.58	8.33 ± 1.67	13.33 ± 2.11
	p-value	<0.01		<0.01		0.076 (NS)	

Table (3): Comparison between results of LD + trapezius muscle transfer and trapezius muscle transfer alone.

Post operative	Group A	Group B	*p*-value
Abduction	58±6.8	40.83±3.27	<0.05
Active external rotation	66.00±5.10	20.0±2.58	<0.001
Forward flexion	24.00±2.44	13.33±2.11	<0.001

Photo (1): Preoperative zero shoulder.

Photo (2): Assessment of trapezius function.



Photos (3-A,B,C): Preoperative drawing

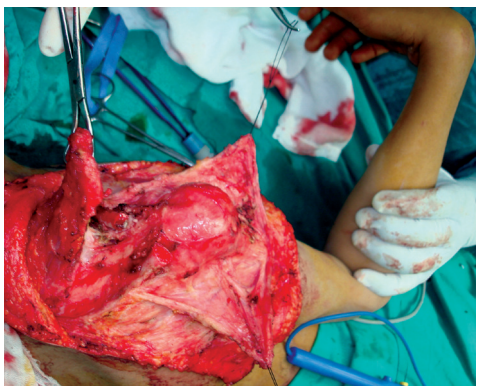


Photo (4-A,B,C): Intraoperative dissection.

(A)

(B)

(C)

Photo (5): Preoperative (A) and postoperative (B&C) results of an adult case.

Photo (6): Preoperative X-ray.

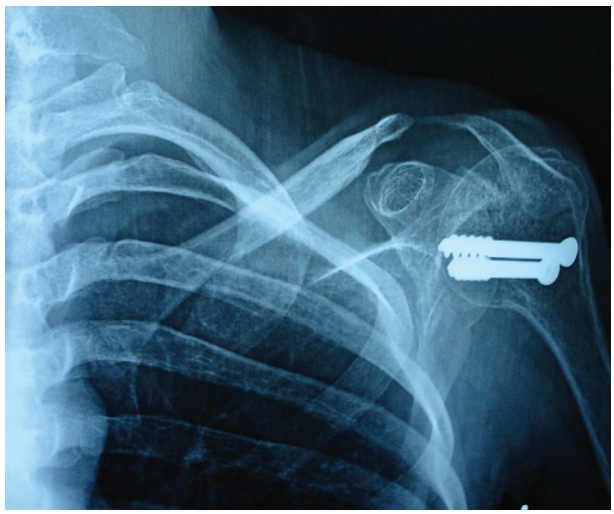


Photo (7): Post operative X-ray.

(A)

(B)

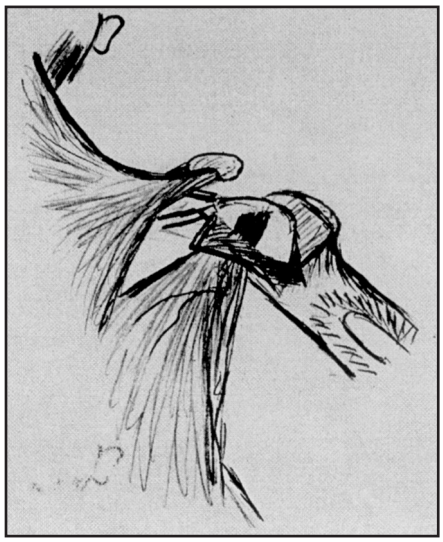
(C)

Photo (8-A,B,C): Preoperative evaluation of a child case.

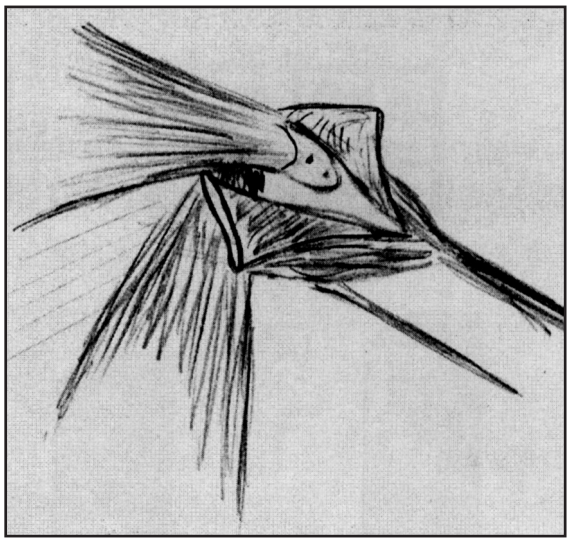
(A)

(B)

Photo (9-A,B): Postoperative results of a child case.



Hand Drawing (1): Illustrates dissection of the trapezius muscle and site of new insertion of LD.



Hand Drawing (2): Illustrates fixation of acromial fragment of the trapezius muscle.

	Pre op.	Post op.	Pre op.	Post op.	Pre op.	Post op.
Mean	8	58	8	66	6	24
SE	3.74	6.8	3.74	5.1	2.45	2.44

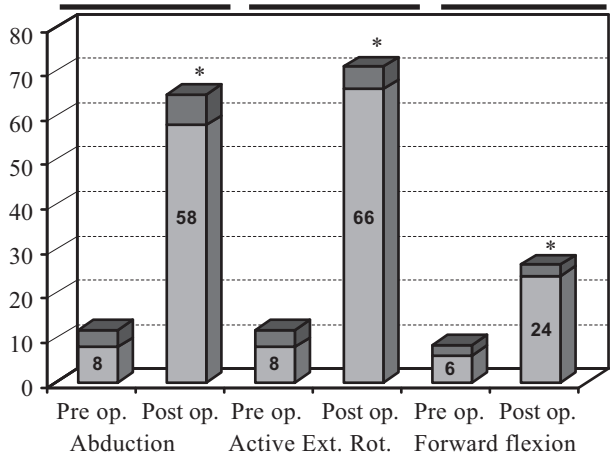


Fig. (1): Mean values + SE of the effect of L D + trapezius muscle transfer in traumatic BPP.

	Pre op.	Post op.	Pre op.	Post op.	Pre op.	Post op.
Mean	13.33	40.83	6.67	20	8.33	13.33
SE	4.21	3.27	2.11	2.58	1.67	2.11

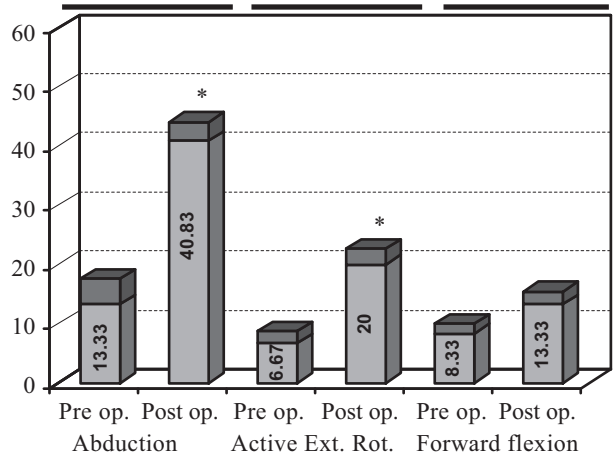


Fig. (2): Mean values + SE of the effect of trapezius muscle transfer in traumatic BPP.

	Group A	Group B	Group A	Group B	Group A	Group B
Mean	58	40.83	66	20	24	13.33
SE	6.8	3.27	5.1	2.58	2.44	2.11

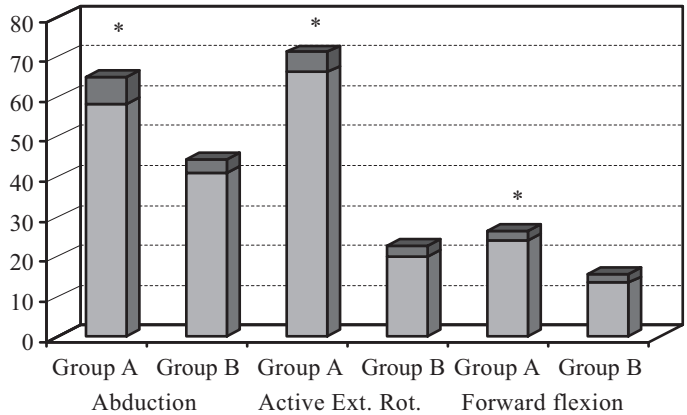


Fig. (3): Comparison between results of LD + trapezius muscle transfer and trapezius muscle transfer alone.

DISCUSSION

In brachial plexus palsy after full neurological treatment and adequate physiotherapy, secondary surgery may be needed to improve the stability and function of the shoulder [4,13,38].

Deltoid and supraspinatous muscles paralysis is a big challenge. Many solutions had been suggested, like shoulder arthrodesis, single tendon transfer, and combined tendons or muscles transfer.

Aziz, et al. [14] discussed trapezius transfer for flail shoulder after injury to the brachial plexus, and found it a simple procedure with minimal blood loss, which provided functional improvement and usually eliminated pain.

The main advantage of arthrodesis is the increase in active function [12,38-40], and this is indicated particularly for patients engaged in physical work and those with almost fully preserved or restored function of the elbow and hand. Trapezius transfer is better in terms of passive movement and arthrodesis is irreversible,with a higher complication rate and a longer operating time [14]. Failure after muscle transfer may be salvaged by shoulder fusion [16] for those reasons, Goldner [13] preferred transfer operations, considering arthrodesis as the final option.

Cofield and Briggs point out that the disadvantages of arthrodesis include a high incidence of fracture, worsening of pain and relative reduction of passive movements [41]. Aziz et al. [14] also argue that simple trapezius transfer is compatible with the later return of some function to other shoulder girdle muscles, while arthrodesis is irreversible and no benefit can be derived from any late return of brachial plexus function. They considered that trapezius transfer can provide satisfactory functional improvement and is a better procedure than arthrodesis for paralysis of shoulder abduction caused by injury to the brachial plexus.

Saha confirmed that when any two of the steering group of muscles were paralysed a single muscle transfer to replace the deltoid would not provide abduction beyond 90° [17]. He describes the transfer of pectoralis minor, the upper two digitations of serratus anterior, latissimus dorsi and teres major in various combinations. He also discussed transfers of the levator scapulae, sternocleidomastoid, scalenus anterior, scalenus medius and scalenus capitis. He reported that these principles make it possible to restore reasonable function of the shoulder with nearly normal control and no subluxation [17].

Other view of this subject supposes that, in spite of favorable results yielded by trapezius transfer, the procedure sacrifices part of the acromion and the distal clavicle for the trapezius pathway and for the bone-to-bone fixation. This may disrupt the shoulder integrity and its stability. Due to insufficient length of the trapezius for its distal attachment to the humerus, the transferred trapezius may be extensively stretched. The stretch of the trapezius may lead to unsatisfactory shoulder stiffness and an ineffective trapezius pull [42].

Gilbert et al. [36] concluded that rerouting of the latissimus dorsi and concomitant trapezius muscle transfer have given consistently good results. Chen et al. [43] stated that for improvement of both abduction and external rotation, transfer of the latissimus dorsi with teres major can be performed only when abduction is ≥90°; otherwise, transfer of the trapezius should be added. In the study done by Terzis and Kokkalis [9] the concurrent transfer of the trapezius with other pedicle muscles, has given significantly better results than the transfer of the trapezius alone and/or free muscle transfers. Transfers involving rerouting of latissimus dorsi and/or teres major tendons, combined with appropriate extra-articular musculotendinous lengthening, significantly improved global shoulder function.

In Conclusion:

It is concluded that the concomitant transfer of the trapezius with other pedicle muscles has given significantly better results than the transfer of the trapezius alone for the treatment of the paralytic shoulder sequelae.

REFERENCES

1- Kotwal P.P., Mittal R. and Malhotra R.L: Trapezius transfer for deltoid paralysis From the All India Institute of Medical Sciences, New Delhi, India J. Bone Joint Surg. [Br.], 80-B: 114-6, 1998.

2- Orr T.E., Carter D.R. and Schurman D.J.: Stress analyses of glenoid component designs. Clinical Orthopaedics and Related Research, 232: 217-224, 1988.

3- Lacroix D., Murphy, L.A. and Prendergast P.J.: Three-dimensional finite element analysis of glenoid replacement prosthesis; a comparison of keeled and pegged anchorage systems. J. Biomechanical Engineering, 122: 430-436, 2000.

4- Berger A. and Becker M.H.: Brachial plexus surgery: Our concept of the last twelve years. Microsurgery, 15: 760-7, 1994.

5- Berger A. and Brenner P.D.: Secondary surgery following brachial plexus injuries. Microsurgery, 16: 43-7, 1995.

6- Berger A., Schaller E. and Mailänder P.: Brachial plexus injuries: An integrated treatment concept. Ann. Plast. Surg., 26: 70-6, 1991.

7- Urgens-Becker J.Ä, Penkert G. and Samii M.: Therapie traumatischer Armplexusl¨asionen. Dt Arztebl, 93: 3262-8, 1996.

8- Gilbert A.L. and Beveridge J.A.: The surgical treatment of obstetrical palsy. In: G. Brunelli, Editor, Textbook of microsurgery, Masson, Milano, pp771-779, 1988.

9- Julia K. Terzis and Zinon T.: Kokkalis Orthoplasty in Trauma and Reconstructive Microsurgery: Primary and secondary shoulder reconstruction in obstetric brachial plexus palsy Injury, 39 (3): 5-14, 2008.

10- Cohen G., Rampal V., Aubart-Cohen F., Seringe R. and Wicart P.: Brachial plexus birth palsy shoulder deformity treatment using subscapularis release combined to tendons transfer. Orthopaedics & Traumatology: Surgery & Research, 96: 334-339, 2010.

11- Charnley J. and Houston J.K.: Compression arthrodesis of the shoulder. J. Bone Joint Surg. [Br.], 46-B: 614-20, 1964.

12- Chuinard R.G. and Kinnard W.H.: Shoulder fusion in treatment of C5/6 brachial plexus palsy: Case report. Orthopedics, 3: 901-3, 1980.

13- Goldner J.L.: Strengthening of the partially paralyzed shoulder girdle by multiple muscle-tendon transfers. Hand Clin., 4: 323-36, 1988.

14- Aziz W., Singer R.M. and Wolff T.W.: Transfer of the trapezius for flail shoulder after brachial plexus injury. J. Bone Joint Surg. [Br.], 72-B: 701-4, 1990.

15- Bateman J.E.: The shoulder and environs. St Louis: CV Mosby, 1955.

16- Karev A.: Trapezius transfer for paralysis of the deltoid. J. Hand Surg. [Br.], 11-B: 81-3, 1986.

17- Saha A.K.: Surgery of the paralyzed and flail shoulder. Acta. Orthop. Scand, l: 97, 1967.

18- Hildebrandt A.: Muskel transplantation. Dt. Med. Wschr., 39: 1578, 1905.

19- Chwei-Chin Chuang D.: Functioning free muscle transplantation for brachial plexus injury. Clin. Orthop., 314: 104-11, 1995.

20- Davidson W.D.: Traumatic deltoid paralysis treated by muscle transplantation. JAMA, 106: 2237-8, 1936.

21- Haas S.L.: The treatment of permanent paralysis of the deltoid muscle. JAMA, 104: 99-103, 1935.

22- Harmon P.H.: Surgical reconstruction of the paralytic shoulder by multiple muscle and tendon transplantations. J. Bone Joint Surg. [Am.], 32-A: 583-95, 1950.

23- Ober F.R.: An operation to relieve paralysis of the deltoid muscle. JAMA, 99: 2182, 1932.

24- Narakas A.O.: Muscle transpositions in the shoulder and upper arm for sequelae of brachial plexus palsy. Clin. Neurol. Neurosurg., 95: Suppl. 89-91, 1993.

25- Chun-lin H. and Yong-hua T.: Transfer of upper pectoralis major flap for functional reconstruction of deltoid muscle. Chin. Med. J., 104: 753-7, 1991.

26- Mayer L.: Transplantation of the trapezius for paralysis of the abductors of the arm. Journal of Bone and Joint Surgery, 9: 412-420, 1927.

27- Mayer L.: Operative reconstruction of paralyzed upper extremity. Journal of Bone and Joint Surgery, 21: 377-383, 1939.

28- Kotwal P.P., Mittal R. and Malhotra R.: Trapezius transfer for deltoid paralysis. Journal of Bone and Joint Surgery, B 80: 114-116, 1997.

29- Mir Bullo X., Hinarejos P., Mir B., Busquets R., Carrera L. and Navarro A: Trapezius transfer for shoulder paralysis. 6 patients with brachial plexus injuries followed by 1 year. Acta. Orthopaedica Scandinavica, 69: 69-72, 1998.

30- Rühmann O., Schmolke S., Bohnsack M., Carls J. and Wirth C.J.: Trapezius transfer in brachial plexus palsy: Correlation of the outcome with muscle power and operative technique. J. Bone Joint Surg. [Br.], 87 (2): 184-190, 2005.

31- Harmon P.H.: Surgical reconstruction of the paralytic shoulder by multiple muscle transplantations. Journal of Bone and Joint Surgery, A 32: 583-595, 1950.

32- Moneim M.S. and Omer G.E.: Latissimus dorsi muscle transfer for restoration of elbow flexion after brachial plexus disruption. Journal of Hand Surgery, A 11: 135-139, 1986.

33- Gerber C.: Latissimus dorsi transfer for the treatment of irreparable tears of the rotator cuff. Clin. Orthop., 275: 152-159, 1992.

34- Otis J.C., Jiang C.C., Wickiewicz T.O., Peterson M.G.E. and Santner T.J.: Changes in the moment arms of the rotator cuff and deltoid muscles with abduction and rotation. Journal of Bone and Joint Surgery, A 76: 667-676, 1994.

35- Phipps G.J. and Hoffer M.M.: Latissimus dorsi and teres major transfer to rotator cuff for Erb's palsy. Journal of Shoulder Elbow Surgery, 4: 124-129, 1995.

36- Gilbert A., Brockman R. and Carlioz H.: Surgical treatment of brachial plexus birth palsy, Clin. Orthop., 264: 39-47, 1991.

37- Mallet J.: Obstetrical paralysis of the brachial plexus. II. Therapeutics. Treatment of sequelae. Priority for the treatment of the shoulder, Rev. Chir. Orthop. Reparatrice Appar Mot., 58 (1): 166-168 [French], 1972.

38- Jäger M. and Wirth C.J.: Shoulder arthrodesis and muscle transplantation for the functional improvement of upper-plexus lesions. Aktuelle Probl. Chir. Orthop., 1: 80-3, 1977.

39- Richards R.R., Sherman R.M.P., Hudson A.R. and Waddell J.P.: Shoulder arthrodesis using a pelvic-reconstruction plate: A report of eleven cases. J. Bone Joint Surg. [Am.], 70-A: 416-21, 1988.

49- Rouholamin E., Wootton J.R. and Jamieson A.M.: Arthrodesis of the shoulder following brachial plexus injury. Injury, 22: 271-4, 1991.

41- Cofield R.H. and Briggs B.T.: Glenohumeral arthrodesis: Operative and long-term functional results. J. Bone Joint Surg. [Am.], 61-A: 668-77, 1979.

42- Tanga C.Y., Maka A.F.T., Hungb L.K., Wongb H.S. and Pacaldob T.: Short communication: Reconstruction of shoulder function using a reflected long head biceps: A moment arm study. Journal of Biomechanics, 35: 1143-1147, 2002.

43- Chen L., Gu Y.D. and Hu S.N.: Applying transfer of trapezius and/or latissimus dorsi with teres major for reconstruction of abduction and external rotation of the shoulder in obstetrical brachial plexus palsy. J. Reconstr. Microsurg., 18 (4): 275-280, 2002.