RESTORATION OF GLENOHUMERAL MOTION IN ERB'S PALSY BY TENDON TRANSFERS

Syed Kamran Ahmed, Pervaiz Mehmood Hashmi
Division of Orthopaedics, Department of Surgery, The Aga Khan University Hospital.

Background: Children with erb's palsy have significant functional disability, mainly related to the shoulder. The objective of this study was to analyze the functional outcome of tendon transfers performed for restoration of shoulder motion in patients with Erb's palsy. **Methods:** This descriptive case series was conducted at Aga Khan University Hospital from May 1999 to December 2003. Ten patients who had functional deficit of shoulder elevation were operated by a single surgeon.. The surgical procedure; modified Sever L'Episcopo procedure was uniform in all cases. The data was collected through patient interviewing and medical records maintained through Health Information Management System (HIMS). Mallet class was recorded preoperatively and postoperatively. **Results:** Ten patients; seven females (70%) and three males (30%), with average age of 75 months at operation were included in this series. Right shoulder was affected in seven cases (70%) while left in three cases (30%). Preoperative mallet class for global abduction improved from 3 to 4; for global external rotation from 2 to 4 and for ability to bring the hand to mouth and neck from 1 to 3. Post operatively mallet class improved in all aspects to 4 and 5; statistically significant on paired t-test with p value of less than 0.005. There was a significant improvement in abduction, forward flexion and external rotation as compared to preoperative values; statistically significant on paired t-test with p value of less than 0.005. **Conclusion:** Tendon transfer improves the functional status of shoulder in late cases of Erb's Palsy with significant improvement in mallet class, cosmesis and patient satisfaction. A motivated patient, compliance and aggressive rehabilitation are important outcome parameters.
Keywords: Erb's palsy, Modified Sever L'Episcopo procedure, Mallet class, Putti sign

INTRODUCTION

Arm paralysis from birth injury was first described by Smellie in 1764[1] in his textbook on midwifery, but classic description of shoulder paralysis, internal rotation contracture and waiter's tip deformity was given by Erb in 1874 as cited by Gilbert A et al.[2]. Traction injury to the brachial plexus occurs during difficult delivery. Lowering of shoulder with opposite inclination of cervical spine causes widening of the head shoulder interval, which leads to stretching of the cervical nerve roots ($C_5C_6C_7$) of brachial plexus.[3]

Erb's palsy is the most common birth related neurapraxia. The incidence of Erb's palsy remains unchanged, 0.1 % to 0.4 %, over the last 30 years.[4, 5]. It is common in our country due to deliveries by untrained nursing staff. Most children resolve completely in first two years of life, 10 to 20 % have some residual problems, mainly related to the shoulder.[5]

Permanent damage to the upper roots is uncommon.[3] Usual involvement is of the suprascapular, axillary and musculocutaneous nerves. Muscles most often paralyzed are supraspinatus and infraspinatus supplied by the suprascapular nerve, which is fixed between two points and does not accommodate stretching. In more severely affected patients, deltoid, biceps, brachialis and subscapularis are also invovled. Patients with C5 and C6 palsies usually have residual weakness of rhomboids and serratus anterior leading to mild winging of scapula, an acceptable deformity.[3-6]

The important and commonest muscle imbalance[6] is that weak external rotators and abductors (supraspinatus, infraspinatus, posterior and middle fibers of deltoid), while adductors and internal rotators are normal in strength (pectoralis major, coracobrachialis, pectoralis minor, subscapularis, teres major and latissimus dorsi). This asynergy leads to formation of persistent internal rotation and adduction contractures of shoulder by six months of age with positive putti's (scapular elevation) sign on adduction and lateral rotation of the shoulder.[6] In C5, C6 palsies weakness of biceps causes difficulty in flexion and supination of forearm, which results in posterior subluxation/dislocation of the radial head. This deformity does not create a functional deficit; in fact aids in flexion and pronation, which is important for a disabled extremity. C7 involvement may manifest as weak elbow, finger and wrist extension.

Several procedures have been recommended for older children to improve shoulder elevation and ability to perform overhead activities. Fairbank[7] noted that release of subscapularis and capsule improved external rotation. Sever[8] released pectoralis major and subscapularis tendon with osteotomy of the coracoid, the capsule was left undisturbed. L'Episcopo[9] observed the recurrence of internal

rotation deformity following Sever's procedure. He suggested transfers of lattisimus dorsi and teres major by an osteoperiosteal flap from anteromedial to posterolateral aspect of the humerus in addition to releasing subscapularis, pectoralis major and joint capsule. Functional improvement was reported in his patients without any quantitative analysis. Hoffer[10] reported modification of L'Episcopo procedure by transferring tendons of teres major and latissimus dorsi to the rotator cuff. According to him, 9 out of 11 patients had improvement in active abduction and external rotation.

We performed modified Sever L'Episcopo procedure in all our patients and used modified shoulder spica with abdominal band for five weeks for immobilization. The aim of our case series was to analyze the functional outcome of this procedure in our patients and to compare them with other case series.

MATERIAL AND METHODS

This descriptive case series was conducted from May 1997 to December 2003 at Aga Khan University Hospital, Karachi. It is a tertiary care center for hand and upper extremity surgery with expertise available by virtue of experienced hand and micro surgeons in the section of Orthopaedics, Departmernt of Surgery. Ten cases of Erb's palsy were identified through medical records maintained in Health Information Management System (HIMS). One surgeon operated all cases. All these patients had weakness of shoulder elevation and external rotation limiting their abilities to bring the hand to the mouth, head and perform over head activities. All patients underwent X-rays of the shoulder which showed congruent glenohumeral joint. None underwent further radiological workup. All benefits and disadvantages of the operation were discussed in detail with the patient before operation. Modified Sever L'Episcopo procedure was performed uniformly on all patients. This procedure comprise of release of adduction contracture (Z-plasties of pectoralis major, coracobrachialis, short head of biceps, subscapularis and coracoidectomy) and transfer of teres major and latissimus dorsi to the external rotators (infraspinatus and teres minor). Postoperatively modified shoulder spica with abdominal band was given to all patients for 5 weeks (Figure 1).

A detailed questionnaire was developed addressing variables of interest, which included demographic data, antenatal and birth history, preoperative physiotherapy, preoperative assessment of abduction, forward flexion, external rotation with arm in adducted position at shoulder and arm in abduction of 90 degree at shoulder, the grading of power of various muscles of glenohumeral and scapulothoracic muscles and preoperative mallet class. A mallet criterion was used for preoperative and postoperative outcome assessment. Post operative improvement in shoulder abduction, forward flexion, and external rotation were documented. The data was analyzed with application of paired t-test.

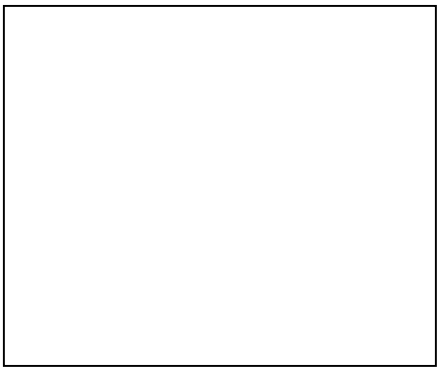
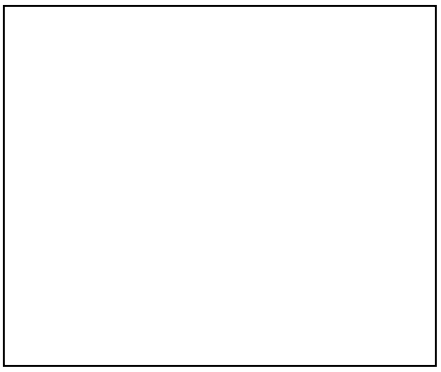


Figure-1: Modified shoulder spica with abdominal band



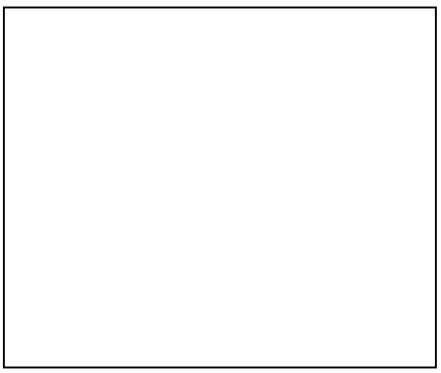


Figure-2.a and 2.b: Preoperative photograph of six year old boy showing limited shoulder elevation and internal rotation contracture.

RESULTS

There were ten cases of erb's palsy seven females (70%) and three males (30%), who underwent modified Sever L'Episcopo procedure. The average age at operation was 75 months ranging from 36 to 117 months. Right shoulder was affected in seven cases (70%) while left in three cases (30%).

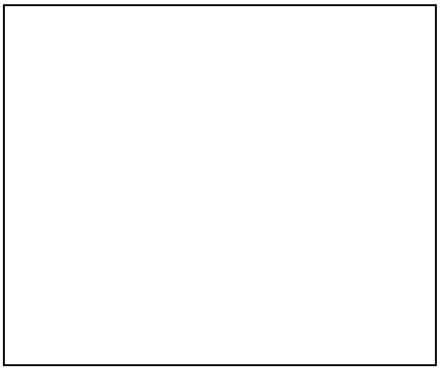
Seven out of ten children had internal rotation and adduction contractures of shoulder on presentation with positive putti scapular elevation sign. Restriction of abduction and external rotation was present in all. All cases were unilateral. There were 7 normal vaginal and 3 breech deliveries, large size baby (weight not mentioned) in 4 cases and difficult delivery was documented in all cases. All patients had undergone some physiotherapy to maintain muscle function and to prevent contractures preoperatively. None underwent previous surgical treatment for brachial plexus palsy. Mallet criterion was used for preoperative assessment and postoperative outcome. Nine patients had residual involvement of the shoulder only; one had weakness of finger and wrist extension. Preoperative demographic data including mallet class, shoulder abduction, forward flexion and ability to bring the hand to mouth, above and over the head can be judged from Table 1.

Postoperatively all the patients had tremendous improvement in shoulder function and activities of daily living. The abduction improved from average 95^{o} to 170^{o}, forward flexion from average 102^{o} to 167^{o}, external rotation with arm in adduction from average -18^{o} to 36^{o} and external rotation with arm in abduction from average 3^{o} to 70^{o}. All above parameters (abduction, forward flexion, external rotation with arm adducted and external rotation with arm abducted) are statistically significant with p-value of less than 0.005 through application of paired t-test.

The results of our series, assessed by mallet criteria, range of motion and ability to bring the hand above and over the head can be seen from Table 2. All the results especially improvements in mallet class are significant statistically on paired t-test with p-value of 0.005, comparing preoperative values with post-operative.

DISCUSSION

In late presenters and children with internal rotation contractures, anterior releases including Z-plasties of pectoralis major and subscapularis help to resolve the internal rotation contractures. The transfer of two tendons latissimus dorsi and teres major to rotator cuff (infraspinatus and teres minor) provides dynamic stabilization and essential gliding mechanism for the humeral head, which keeps the head in contact with glenoid cavity leading to increase in global elevation and external rotation. We believe that children in age group above 2 years are better surgical candidates as they comply better with postoperative rehabilitation protocol. Anterior releases combined with coracoidectomy resulted in resolution of putti sign.



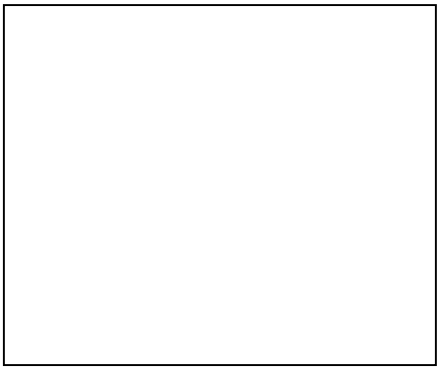


Figure-3.a and 3.b: Post-operative photograph at week ten, showing full abduction and forward flexion

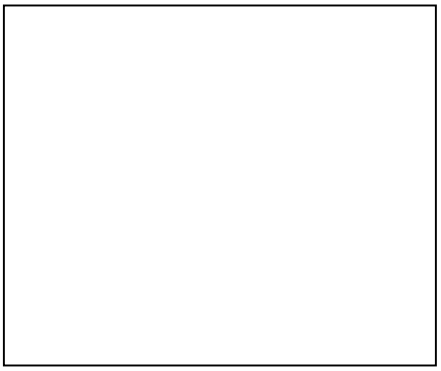


Figure-4: Early post-operative photograph showing limitation of internal rotation

Table-1: Preoperative status

		Age		Global Abd	Degrees		Global E.R	Degrees		Bring hand	Bring hand	Int. Rot
Pt.	Sex	(M)	R vs. L	Mallet Class	Abd.	F.F	Mallet Class	In Add.	In Abd.	to neck	to mouth	
1	M	69	R	3	90	90	2	-35	-20	2	2	5
2	F	57	L	3	80	90	2	-40	-15	2	2	5
3	F	36	R	3	70	80	2	-30	-10	2	2	5
4	F	75	R	3	70	80	3	-45	-15	2	2	5
5	F	96	R	4	120	120	3	-45	-10	3	3	4
6	F	117	L	3	40	60	3	-10	0	1	1	3
7	F	72	R	3	90	90	2	-20	-10	3	2	5
8	M	52	R	3	70	80	3	-10	20	3	2	5
9	F	78	R	4	170	170	4	20	30	3	3	5
10	M	96	L	4	150	160	4	40	60	4	4	3
Ave.		75			95	102		-18	3			

Key: Mo: Months, Abd: Abduction, E.R: External Rotation, Ave: Average, F.F: Forward Flexion, Add: Adduction

Table-2: Post Operative results

	Global Abd.	Degrees		Global E.R.	Degrees		Bring hand	Bring hand	Int. Rot	Follow-up
Pt.	Mallet Class	Abd.	F.F	Mallet Class	In Add.	In Abd.	to neck	to mouth		(mo)
1	5	180	180	4	25	45	4	4	4	79
2	5	170	180	4	30	75	4	4	4	46
3	5	180	180	4	30	50	4	4	3	23
4	4	160	180	4	35	75	4	4	4	21
5	5	180	180	5	45	90	5	5	4	46
6	4	100	100	4	25	40	4	4	4	14
7	4	110	170	4	10	80	4	4	3	27
8	5	160	180	4	40	70	4	4	4	12
9	5	180	180	5	60	90	5	5	5	10
10	5	180	180	5	60	80	5	5	3	07
Ave.		170	167		36	70				25
Ave. Inc.		75	65		54	67				

Key: Mo: Months, Abd: Abduction, E.R: External Rotation, Ave: Average, F.F: Forword Flexion, Add: Adduction

Table-3: Comparative Analysis (Chart-1)

	No. of Patients	**Age(mo)**	**Increase (Abd.)**	**Increase E.R.**	**Follow-up(mo)**
Covey DC[12]	19	71	26	29	50.4
Naulart L et al[14]	49	114	42	64	71
Hoffer MM, Phipps GJ[13]	8	28.6	30	65	37
Vasiu PS et al[17]	7	109	63	58	15
Waters PM[15]	9		Mallet class 3 to 4	Mallet class 2 to 4	28.8
This study	10	75	75	54	25

Key: Mo:Months, Abd: Abduction, E.R: External Rotation

Table-4: Comparative Analysis (Chart-2)

	No. of Patients	Age(mo)	Increase (Abd.)	Increase (F.F)	Inc. E.R (Add)	Inc. E.R (Abd.)	Follow-up (mo)
Green WT, Tachdjian MO[18]	22		46		50	46	72
Strecker et al[11]	16		1	5	80	78	39
This study	10	75	75	65	54	67	25

Key: Mo: Months, Abd: Abduction, E.R: External Rotation, F.F: Forward Flexion, Add: Adduction

The remarkable increase in abduction and external rotation is partly attributed to position of immobilization in modified shoulder spica with abdominal band maintaining full abduction and external rotation at shoulder. In our series, this procedure led to an average increase in abduction of 75 degrees, global external rotation of 54 and 67 degrees with the arm in adduction and abduction respectively.

Despite some loss of internal rotation in all children, definite subjective and objective improvement was noted in all cases. The ability to wash face, eating, combing, balancing the body while running and performing bimanual sports was significantly improved. One hypertrophic scar was seen. One patient had superficial wound infection, which settled with antibiotics. No postoperative axillary nerve palsies were encountered. Self resolving radial nerve neuropraxia occurred in one case. After the removal of spica, team of physiotherapists monitored rehabilitation exercises. The strict observation of physiotherapy and rehabilitation protocol proved to be an essential component of treatment for a better outcome in our series.

Strecker W.B et al.[11] combined anterior releases with transfer of latissimus dorsi and teres major into a subperiosteal tunnel. The postoperative immobilization was done at 20 degrees of forward flexion, 35 to 45 degrees of external rotation and 45 degrees of abduction. He reported an average increase in external rotation of 80° in adduction and 78° in abduction at shoulder. There was only slight betterment in shoulder elevation, 1 degree of abduction and 5 degrees of flexion in his series. Covey DC et al.[12] modified the L'Episcopo procedure by replacing the osteoperiosteal flap with direct tendon to tendon anastomosis without anterior releases. Average increase in abduction and external rotation was 26 and 29 degrees respectively. Hoffer MM and Phipps JG[13] reported average increase in abduction of 30° and external rotation of 65° with modification of Sever L'Episcopo procedure. Naulart L[14] reported an improvement in abduction/external rotation, averaging 42° and 64° respectively. More recently, Waters PM[15] performed anterior release of pectoralis major along with tendon transfers leading to increase in global abduction from Mallet class 3 to class 4 and increase in external rotation of 30.5°. Edwards TB et al[16] performed tendon transfers in 10 children with release of pectoralis major and subscapularis. Average increase in abduction was 64° with significant increase in active external rotation. Vasiu PS et al[17] reported an average increase in abduction of 63°, flexion 45° and external rotation of 58°.

Comparative analysis with other series show definite improvement of global abduction and external rotation in our series as seen in Table 3. Only few authors have assessed abduction, forward flexion, external rotation with arm in adduction and abduction of 90°at shoulder separately. We have compared our results separately with those studies (Table 4).

CONCLUSION

We conclude that Modified Sever L'Episcopo Procedure is valuable for late presenters of Erb's palsy, if combined with anterior releases, coracoid ectomy and combined tendon transfer of latissimus dorsi and teres major to the rotator cuff. Modified shoulder spica increases patient compliance and overall outcome. An aggressive physiotherapy protocol in a complaint and motivated patient for at least 3 to 4 months helps in the resolution of internal rotation, adduction contracture and putti's sign. Proper patient selection is essential for a predictable outcome. Remarkable patient satisfaction is the hallmark of the procedure.

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Address For Correspondence:
Dr. Pervaiz Mehmood Hashmi, Division of Orthopaedics, Department of Surgery, The Aga Khan University Hospital, P.O.Box 3500, Stadium Road, Karachi - 74800, Pakistan.
Tel: 92 21 48594751/ 52; Fax: 92 21 4934294, 92 21 4932095
E-mail: pervaiz.hashmi@aku.edu