

Muscles Transfer around the Shoulder in Cases of Brachial Plexus Birth Palsy

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Abstract

Background: Disabling internal rotation contractures are frequently experienced in children with unresolved birth brachial plexus palsies. Multiple surgical options like muscle release, tendon transfer, or humeral osteotomy are available to treat such cases. **Purpose:** Evaluation of the outcome of subscapularis release and latissimus dorsi and teres major tendon transfer in the management of obstetric brachial palsies in Mansoura University neurosurgical department. **Study type:** Retrospective observational study. **Patients and Methods:** Twenty-five cases who underwent subscapularis release and latissimus dorsi and teres major transfer were included in the study. All patients were subjected to complete history taking, through clinical examination. The degree of shoulder movement and disability was assessed via Modified Gilbert shoulder evaluation scale. **Results:** The least follow up period for our patients was 9 months. There was a clear improvement of shoulder function evaluated using Modified Gilbert shoulder evaluation scale as there were 73% of postoperative group between GIV and GV while about 84% of preoperative group were between GII and GIII. **Conclusion:** Tendon transfer is a valid easy procedure for correction of shoulder deformities in patients with obstetrical brachial plexus palsy. It is considered a very good option for patients who missed the chance of microsurgical repair or patients with poor shoulder recovery after surgery. Although some authors reported deterioration of shoulder function with long time follow up after tendon transfer, it is still better than those who were not operated.

Keywords

Brachial Plexus, Tendon Transfer, Shoulder

1. Introduction

Neonatal brachial plexus palsies (NBPP) are a clinical entity that is identified

immediately after birth as a result from trauma to the fetal brachial plexus that may occur before completion of delivery. The exact timing of that pathology is still not completely understood. Although the majority of researchers believe that it occurs during the second stage of labour during shoulder extraction, other assume that it may occur before delivery as a consequence of endogenous or exogenous force to which the fetus is exposed [1].

NBPP have been reported to affect 1.5 per 1000 live birth, and that ratio has not been decreased in recent days [2]. The majority of these injuries are transient in nature and function will be restored completely in about 70% - 92% of cases, while in other cases, permanent disabling functional outcomes are also reported [3].

NBPP have six clinical subtypes including: complete (total) brachial plexus palsy, Duchenne-Erb palsy, upper-middle trunk brachial palsy, Klumpke palsy, fascicular palsy, and bilateral brachial plexus palsy [4]. Of note, Duchenne-Erb and Klumpke palsies are the most commonly encountered types in the obstetric practice [1].

The etiopathogenesis of such condition can be attributed to compression, traction, vascular disruption, or inflammation, and according to the degree of injury, permanent or transient neurological deficits may result. Intrauterine compression can occur in cases with uterine anomalies, masses, or pelvic masses during pregnancy, and such cases usually have an obvious deformity in the upper limb at the time of delivery [5] [6].

Because of muscle weakness and soft tissue contractures, functional limitations may arise in children who experienced incomplete recovery from such injury. Both bone growth and joint development are affected by this muscular imbalance that may result in glenohumeral deformity on the long-term [7] [8].

Although there is a global agreement that the disturbance in muscle power and contraction should be corrected, there is no consensus on how to perform that correction. Release of internal shoulder rotators along with contracted tissues, transfer of tendons that augment abduction and external rotation are available options. Some surgeons prefer to combine both procedures [9].

Rotational osteotomy is recommended for older patients who present with advanced deformity of the glenohumeral joint. In addition, latissimus dorsi and teres major tendon transfer are the commonest transfers to be done for such cases to restore external rotation and abduction. However, there is no clear evidence that supports the superiority of one technique over the other [10].

Subscapularis contracture may hinder the functional rotators to act normally, as it is considered the largest rotator cuff muscle and thus, subscapularis release is of crucial importance to restore the limited shoulder movements. This contracture is assessed clinically by a decrease in shoulder passive external rotation with the arm along the trunk and the elbow in 90° flexion [11].

Therefore, we can notice the clear agreement that shoulder deformity and limited mobility is a common complication of obstetrical brachial plexus palsy.

This deformity affects patient daily activity and adds more burden to his suffering. On the other hand, there are different surgical options, multiple techniques and absence of solid consensus about the management strategies of these deformities and timing of surgeries. We conducted this study to evaluate the outcome of subscapularis release, latissimus dorsi and teres major tendon transfer in the management of obstetric brachial nerve palsies.

2. Patient and methods

2.1. Study Design

This is a retrospective study of patients presented with shoulder deformity and limited mobility due to obstetrical brachial plexus birth injury who presented at Mansoura University Hospitals neurosurgical clinics from 2014 to 2017. The study was approved and accepted by the local ethical committee.

2.2. Patient Sample

Twenty-five patients (n = 25) including 11 males and 14 females were included in our study (**Table 1**).

2.3. Inclusion Criteria

- 1) Obstetrical brachial plexus palsy.
- 2) Adequate power of latissimus dorsi and teres major muscles.
- 3) Possible shoulder abduction and external rotation.

2.4. Exclusion Criteria

- 1) Sever shoulder contracture with difficult passive exercise.
- 2) Patients older than 18y old.
- 3) Flail limb with weak hand grip.

2.5. Patient Consent

A written formal consent was obtained from patients after the explanation of the details, advantages and drawbacks of the surgical procedure.

2.6. Patient Evaluation

Thorough medical history was taken from all patients with careful reviewing of both labor and delivery history. We also reviewed all relevant events throughout the patient's life including their limbs power improvement, all medications they were commenced on, physiotherapeutic programs and any previous surgical procedures.

A modified Gilbert shoulder evaluation scale was used to assess the shoulders of these children as a preoperative evaluation and in regular follow up to evaluate shoulder improvement as shown in **Table 2**. All these children should have possible passive arm abduction and external rotation, enough muscle strength of the latissimus dorsi and adequate elbow and hand function.

Table 1. Demographic data of the patients.

	Age in months	Sex	Side	Delivery	Previous Surgery
1	24	Female	Right	CS	NO
2	27	Female	Right	CS	NO
3	626	Female	Right	CS	NO
4	32	Male	Right	CS	YES
5	48	Female	Left	CS	YES
6	123	Male	Right	CS	NO
7	144	Female	Right	CS	NO
8	34	Male	Right	CS	NO
9	47	Female	Right	CS	YES
10	52	Male	Right	CS	NO
11	31	Female	Right	CS	YES
12	24	Male	Right	CS	NO
13	27	Male	Right	CS	NO
14	25	Female	Left	CS	NO
15	29	Male	Right	CS	NO
16	46	Male	Right	CS	NO
17	34	Female	Right	CS	NO
18	50	Female	Right	CS	YES
19	24	Male	Left	CS	NO
20	32	Male	Right	CS	NO
21	26	Male	Right	CS	NO
22	27	Female	Right	CS	NO
23	48	Female	Right	CS	YES
24	24	Female	Right	CS	NO
25	27	Female	Right	CS	YES

Table 2. Modified Gilbert shoulder evaluation scale [12].

Grade	Joint description
0	Flail shoulder.
I	Abduction = 45°, no active external rotation.
II	Abduction < 90°, no active external rotation.
III	Abduction = 90°, active external rotation < 30°.
IV	Abduction < 120°, active external rotation 10° to 30°.
V	Abduction > 120°, active external rotation 30° to 60°.
VI	Normal shoulder.

2.7. Preoperative Preparation

An extensive physiotherapeutic program was applied to these children as a preoperative preparation to improve shoulder functions and increase the range of passive movement. Patients were prepared for surgery after routine labs and preoperative medical evaluation.

2.8. Surgical Procedure

Surgery was done under general anesthesia. Infants were put in lateral position on the operating table with the affected arm draped free and able to move in all directions. The surgical incision was infiltrated with 1:100,000 concentration of saline adrenaline for a bloodless operative field. The first incision as in **Figure 1** was taken at the posterior axillary fold going across the axillary skin fold to expose and detach the latissimus dorsi and teres major muscle tendons from their humeral insertion.

These tendons were then elevated up to their neurovascular pedicle that was found proximally along the lateral scapular border. A great care was taken not to disrupt this neurovascular bundle for the success of our repair.

Another small incision was made at the upper surface of the shoulder at the planned site for insertion. Both tendons were anchored by 2\0 nylon suture and then mobilized through a tunnel under the dorsal part of the deltoid muscle to be reinserted in the tendon of the rotator cuff at the greater tuberosity of the humerus as shown in **Figure 2**.

Then a silk suture was applied to the lower tip of the scapula to help in its elevation and fixation during subscapularis release. A dissector was introduced through the undersurface of the lateral border of the scapula gently separating it from the subscapularis muscle then a drain was inserted in this space and anatomical closure was accomplished.

2.9. Postoperative Care

The shoulder was immobilized in 120-degree abduction and 90-degree external rotation in a plaster cast for 6 weeks. After cast removal, we started a condensed physiotherapeutic program for at least six months.



Figure 1. The 1st skin incision at the posterior axillary fold.



Figure 2. Tunneling of the tendons of latissimus dorsi and teres major muscles undersurface of the deltoid muscle.

2.10. Follow Up

We used Modified Gilbert shoulder evaluation scale to evaluate the shoulder recovery of our patients. We evaluate our patients immediately after cast removal and then every three months for at least nine months some of our patients were followed up for four years. The amazing finding is that some patients showed shoulder improvement immediately after cast removal.

2.11. Statistical Analysis

The collected data were coded, processed and analyzed using the SPSS (Statistical Package for Social Sciences) version 22 for Windows® (SPSS Inc, Chicago, IL, USA). Qualitative data was presented as number (frequency) and Percent. Quantitative data was tested for normality by Kolmogorov-Smirnov test and was expressed as median (range). Chi square test (X^2) was used to compare two groups with categorical variables. P value ≤ 0.05 was considered significant.

3. Results

We included 25 patients; eleven of them (44%) were males and the remaining 14 cases (66%) were females. These cases had a mean age of 40.6 months (range, 2 - 12 years). Of note, 15 cases (60%) had an age below 3 years while two of them (8%) were above 10 years old. Right arm was affected in twenty-two patients (88%). All these cases (100%) were delivered via the vaginal route; moreover, nineteen of them (76%) were the 1st child to their mothers (**Table 3**).

Eighteen patients (72%) were not previously operated while seven patients (28%) underwent previous microsurgical exploration and repair with limited shoulder improvement. Seventeen patients (68%) had a total palsy whereas eight patients (32%) had an upper palsy. All our patients showed improvement of their shoulder power and range of movement.

Table 4 shows a comparison between preoperative and postoperative shoulder function according to Modified Gilbert shoulder evaluation scale in these children. The majority of children the preoperative group sixteen (64%) was of GII and GI while in postoperative group eighteen (72%) was of GIV and GV.

Table 3. Demographic and clinical data.

<i>Variable</i>	<i>Data</i>
Age (years)	3.38 (2 - 12)
Gender	
-Male	11 (44%)
-Female	14 (56%)
Affected side	
-Right	22 (88%)
-Left	3 (12%)
Mode of delivery	
-Vaginal	25 (100%)
-Caesarian section	0 (0%)
Previous microsurgery	7 (28%)
Type of palsy	
-Upper trunk	8 (32%)
-Total palsy	17 (68%)
Blood transfusion	3 (12%)
Surgical site infection	1 (4%)
Pressure scores	2 (8%)

Table 4. Comparing preoperative and postoperative Gilbert shoulder scale.

<i>Grade</i>	<i>Preoperatively</i>	<i>Postoperatively</i>	<i>P value</i>
0	0 (0%)	0 (0%)	
I	4 (16%)	0 (0%)	
II	12 (48%)	1 (4%)	
III	9 (36%)	6 (24%)	P < 0.001
IV	0 (0%)	13 (52%)	
V	0 (0%)	5 (20%)	
VI	0 (0%)	0 (0%)	

As illustrated in **Table 4** there is clear improvement of shoulder function evaluated using Modified Gilbert shoulder evaluation scale as there were 73% of postoperative group between GIV and GV while about 84% of preoperative group were between GII and GIII.

3.1. Complications

Three of our patients (12%) required blood transfusion, and all of them were less than three years old. One patient (4%) had superficial surgical site infection which improved by medical treatment and dressing. One patient had a stich sinus at the shoulder which was treated with antibiotics with recurrent attacks of infection. After six weeks, the cast was removed, the wound was explored, and the prolene stitches were removed. The tendons were firmly healed and the patient was allowed to continue his physiotherapeutic program after that.

Another girl, who was known to have Attention Deficit Hyperactivity Disorder (ADHD), broke the plaster cast and thus, we instructed the parents to fix the cast with a Crip bandage and they came to our facility in the next day and we changed it. Two patients (8%) had small superficial pressure sores one on the elbow and one on the scapula which healed by dressing. **Figure 3** & **Figure 4** show two of our patients and demonstrates shoulder improvement postoperatively.



Figure 3. (a) Preoperative; (b) Before cast removal; (c) Six months postoperative; (d) Twelve months postoperative.

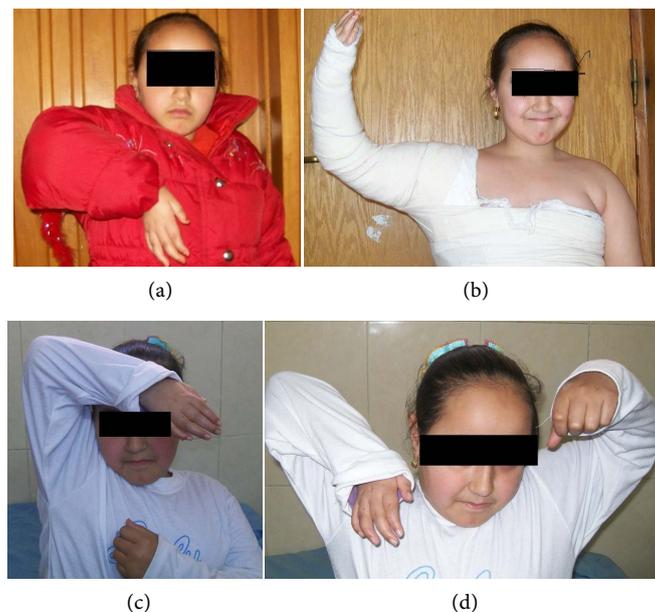


Figure 4. (a) Preoperative; (b) Before cast removal; (c) & (d) Six months postoperative.

4. Discussion

Generally, brachial plexus palsy due to obstetric trauma affects about 0.1% to 0.4% of births. Surprisingly, about 50% of these children show spontaneously accepted outcome. However, other children will experience significant shoulder function impairment due to both external rotation and abduction deficits. Additionally, such failure of muscle recovery may cause deformity of the glenohumeral joint. The traumatic process during labour itself may result in myostatic contracture [13].

Some limitation with glenohumeral movement as well as increased scapular winging will be noticed in such cases even if the child has a mild form of chronic brachial palsy. Only infants who will have their antigravity biceps recovered at first 1.5 months of life will not experience shoulder girdle asymmetry on the long-term follow up [14].

The effect of surgery on the glenohumeral joint impairment is still considered a matter of debate. It has been reported that there is a satisfactory improvement of the shoulder mobility as well as correction of the osseocartilaginous deformity [15] [16]. On the other hand, others found no such effects on performing post-operative MR scans [17].

Adducted internally rotated shoulder and glenohumeral deformities were our main concern in this study. In our experience, transfer of latissimus dorsi and teres major muscles accompanied with subscapularis release improved shoulder active motion and decrease passive resistance.

The average age of our patients at the time of surgery was 40.6 months (range 2 - 12 years). This was slightly more as compared to that quoted in western literature. In a series by Waters *et al.*, the average age at the time of tendon transfers was 27 months [18] while that in a series by Hoffer *et al.*, it was 28 months [19]. On the other hand, our results are much nearer to this study coming from Bombay Hospital & Medical Research Centre in India at which the average age at the time of surgery was 44 months (range 18 months to 7 years) and this mostly due to the similar cultural circumstances [20].

In our study, we included 11 boys (44%) and 14 girls (56%). Moreover, the right upper limb was the commonest to be affected when compared to the left one (22 vs. 3 cases).

Another study handling the same perspective included 32 cases; of whom 18 (56.25%) were boys, and 14 (43.75%) were girls. Additionally, the right shoulder was affected in 15 cases (46.87%) while the remaining 17 cases (53.13%) had their left shoulder affected [21].

Cohen *et al.* found very clear functional and clinical improvement provided by subscapularis muscle release with latissimus dorsi and teres major transfer [21]. These previous results are similar to our results which revealed highly favorable outcome after subscapularis release combined with tendons transfer. More than 70% of patients included in our study reached G IV and G V shoulder function according to Modified Gilbert shoulder evaluation scale.

An Indian study was conducted to evaluate the clinical outcome of shoulder muscle transfer for shoulder abnormalities in obstetric brachial plexus palsy. Using modified Mallet score, both shoulder movement and functions were significantly improved after the surgical procedure after a mean follow up of 4 years (range 2.5 - 8 years). The pre-operative Mallet score ranged from 8 to 13 with a mean of 11.2 ± 1.41 , and that score has improved to a mean of 19.2 ± 1.66 (range 15 - 20). Moreover, no patient had worsening of shoulder function [20].

Another Egyptian study that was conducted to compare the outcome of subscapularis sliding combined with either latissimus dorsi transfer (group A) or combined latissimus dorsi and teres major transfer (group B) in cases of obstetric brachial palsies. Like this study, they used the modified Gilbert shoulder grading system for assessment. All patients showed statistically significant improvement of active shoulder abduction and external rotation without significant differences between the two groups. On the other hand, Significant external rotation contracture of the shoulder was experienced in 66.67% of cases but it was more noticed in group B cases. It was concluded that corrective surgery should be restricted to latissimus dorsi transfer without teres major transfer to avoid external rotation contractures [22].

Although many surgeons have advocated the satisfactory results after managing such patients with subscapularis release, latissimus dorsi and teres major tendon transfer, others have noticed a decrease in the post-operative gain on 10-year follow up. However, the end points reached were still higher than untreated patients [23].

A recent study has published that the short-term results of latissimus dorsi transfer and subscapularis release are encouraging. However, these advantages deteriorated over the long follow-up period. Abduction was maintained over the long-term, but external rotation deteriorated. Internal rotation deteriorated over a long-term longitudinal follow-up, leading to functional impairment [24].

Our study has some limitations; it is retrospective single center study that may induce a referral bias. Moreover, the number of included cases was relatively small. Additionally, this study lacks the radiological follow up during the post-operative period and that is because it is our center policy to depend on clinical examination for postoperative evaluation. The short follow up periods can't make us form a solid consensus about this deterioration of shoulder function after long time of surgery.

5. Conclusion

Tendon transfer is a valid easy procedure for correction of shoulder deformities in patients with obstetrical brachial plexus palsy. It is considered a very good option for patients who missed the chance of microsurgical repair or patients with poor shoulder recovery after surgery. Although some authors reported deterioration of shoulder function with long time follow up after tendon transfer it is still better than those who were not operated.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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