Operative reduction and tendon transfer for treatment of posterior dislocation of the glenohumeral joint secondary to obstetric brachial plexus palsy in young children

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Background
The incidence of posterior subluxation/dislocation of the shoulder secondary to obstetric brachial plexus palsy is found to be relatively high with increasing awareness of the condition and advances in radiological imaging. Left untreated, glenohumeral deformation and functional impairment are progressive with increasing age.

Patients and methods
Twelve patients with posterior subluxation (five patients)/dislocation (seven patients) of the shoulder secondary to obstetric brachial plexus palsy were treated by operative reduction with concomitant anterior soft-tissue release and latissimus dorsi and teres major tendon transfers to the rotator cuff. The mean age at surgery was 3 years.

Results
After a mean follow-up of 3 years, the mean aggregate Mallet score improved from 9.5 points preoperatively to 14.4 points postoperatively (increased by 51.6%). Abduction and external rotation improved significantly. Radiologically, the mean percentage of humeral head anterior to the midscapular line improved from 9% preoperatively to 42% postoperatively. All patients except one showed restoration of the dislocation, which was maintained until final follow-up. The mean glenoid version improved from -45.8° preoperatively to -8° at the latest follow-up.

Conclusion
The procedure used results in improved shoulder function and glenohumeral joint remodeling. Postoperative care and rehabilitation programs are mandatory for satisfactory outcome.

Keywords:
brachial plexus birth palsy, obstetric brachial plexus palsy, posterior dislocation of shoulder, tendon transfers to rotator cuff

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Introduction

The incidence of obstetric brachial plexus palsy (OBPP) has been reported as 1–4/1000 live births. Therefore, there is still a significant incidence of the condition [1,2].

The incidence of the posterior subluxation/dislocation of the humeral head secondary to OBPP in young children was thought to be uncommon [2]. Recently, many authors suggested that this condition had been missed or underdiagnosed in early infancy because the accuracy of traditional radiographic studies was impeded by the primarily cartilaginous nature of the shoulder. With advances in radiologic imaging, such as ultrasonography, computed tomography (CT), and MRI scans, this condition has become more commonly reported, with an incidence of up to 40% [3–5].

Such a dislocation probably occurs secondary to persistent muscle imbalance between strong internal rotators and weak or paralyzed external rotators. This imbalance causes an internal rotation contracture, resulting in a posterior dislocation of the shoulder [6].

Dislocation of the humeral head should be considered in any infant or child who has OBPP with rapid loss of passive external rotation between monthly examinations despite physiotherapy, and the condition should be confirmed by CT scanning [1,7].

The principle of treatment is the release of the contracted internal rotators, relocation of the dislocated glenohumeral joint either by closed or open reduction, and tendon transfer to increase the range of active external rotation and abduction [3,6].

The aim of this study was to report the results of operative reduction with concomitant anterior soft-tissue release and tendon transfer to the rotator cuff for treatment of posterior subluxation/dislocation of the humeral head secondary to OBPP in young children.

Patients and methods

During the period from February 2003 to May 2008, 12 children with posterior subluxation or dislocation of the

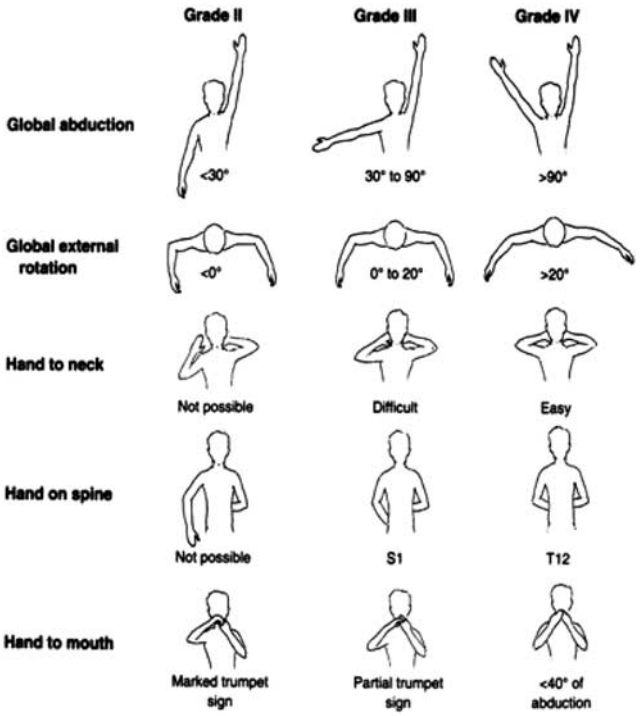
glenohumeral joint secondary to brachial plexus birth palsy were treated at our institution by operative reduction with concomitant anterior soft-tissue release and latissimus dorsi and teres major tendon transfers to the rotator cuff. The mean age at surgery was 3 years (range, 2–5 years). Five patients were girls and seven were boys. The right side was affected in seven patients and the left side in five. All patients had an upper plexus palsy. None of the patients had undergone previous surgery, and they were treated by physiotherapy.

Diagnosis of posterior dislocation of the shoulder was based on [3,6,7] history (rapid loss of passive external rotation between monthly examinations despite physiotherapy), clinical examination (internal rotational contracture, impaired passive external rotation, asymmetry of the shoulder with palpable humeral head posteriorly, decrease in the length of the upper arm, and asymmetry of the skin fold due to telescoping of humerus and axillary asymmetry), and conventional radiography; however, it was difficult to carry out the study accurately with consistency in young children using only CT scans (all patients).

The following clinical parameters were assessed preoperatively and postoperatively: (a) active shoulder movements and function were measured using the modified Mallet scoring system [8]. In this scoring system, five elements (abduction, external rotation, hand–neck, hand–back, and hand–mouth) were assessed (maximum score, 25 points; Fig. 1). (b) Passive range of movements of shoulder was assessed by measuring abduction, external rotation, and internal rotation of the shoulder.

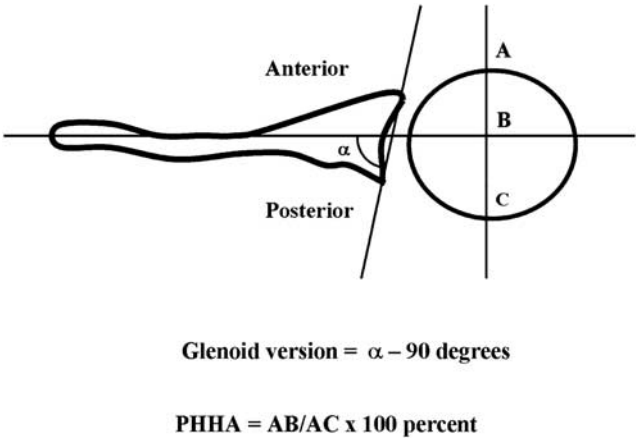
The glenohumeral joint morphology was assessed by CT scanning and was characterized by measuring both the glenoid version and humeral head subluxation using the method adopted by Waters *et al.* [9] (Fig. 2) To measure the glenoid version or the glenoscapular angle, a line is drawn parallel to the scapula and a second line is drawn tangential to the joint. The latter line connects the anterior and posterior margins of the glenoid. The angle in the posterior medial quadrant is measured; 90° is subtracted from this measurement to determine the glenoid version. The percentage of posterior subluxation is measured by defining the percentage of humeral head anterior to the midscapular line (PHHA). The greatest diameter of the humeral head (AC) and the distance from the scapular line to the anterior portion of the head (AB) are measured. This ratio (AB/AC) multiplied by 100 is the PHHA to the midscapular line. Shoulders were classified as dislocated (PHHA 0%), subluxed (PHHA 1–35%), or normally positioned (> 35–50%) [9].

Figure 1



Schematic representation of the modified Mallet classification system of active shoulder function in patients with obstetric brachial plexus palsy. Grade I denotes no active motion and grade V denotes normal function (equal to that on the contralateral side; not shown). Aggregate modified Mallet classification scores are calculated by adding the grades for each of the five individual elements (possible range, 5–25) [8].

Figure 2



Schematic diagram showing the method of measuring the glenoid version and the percentage of posterior subluxation of the humeral head [9].

Surgical technique

When the patient was lying supine, under general anesthesia, an anterior axillary approach of the shoulder was performed. The subscapularis tendon was identified and separated from the underlying capsule using a blunt instrument; thereafter, it was released or lengthened, without opening the capsule (to prevent anterior instability of the shoulder and to decrease adhesions). Sometimes the capsule and subscapularis tendon were blended into each other and both were divided to the extent necessary to allow satisfactory reduction of the humeral head. The pectoralis major tendon was then lengthened by z-plasty, if required. The reduction was then easily accomplished by external rotation of the arm. The latissimus dorsi and teres major tendons were

detached from the humerus and sutured with a stay suture. With the patient turned over on the side and with the patient's arm adducted across the chest, and through a separate posterior incision, these tendons were rerouted posteriorly (with protection of the radial nerve and the contents of the quadrilateral space), where they were subsequently woven into two longitudinal incisions made in the posterior-superior aspect of the rotator cuff and sutured to themselves with a nonabsorbable suture. The lengthened muscles should be sutured in a sufficient length to permit complete external rotation in abduction without undue tension. The wound was closed in the usual manner, and the upper limb was immobilized in a previously prepared, bivalved shoulder spica cast that holds the shoulder in 90° of abduction, 90° of external rotation, and 20° of forward flexion (with the elbow flexed 80–90° and the forearm and hand in a neutral position) to maintain anterior release and joint reduction [10].

Postoperative management

Patients were immobilized in a shoulder spica cast for 6 weeks, followed by an orthosis for further 6 weeks. Physiotherapy was started after removal of the spica cast. The child was weaned from orthosis during therapy sessions and bathing. Weaning from orthosis was gradual. Internal rotation was not begun until 3 months postoperatively.

Results

The mean duration of follow-up was 3 years (range, 2–5 years).

Range of movement

The mean preoperative abduction was 85.9° (range, 60–130°). At the final examination, it increased to a mean of 132° (range, 90–170°). The mean preoperative external rotation was −17° (range, −40 to 15°). At the final examination, it increased to a mean of 60° (range, 40–90°).

According to the modified Mallet scoring system [8], the mean aggregate Mallet score improved from 9.5 points (range, 6–11 points) preoperatively to 14.4 points (range, 11–18 points) postoperatively (increased by 51.6%; Table 1).

Radiologic results

The mean PHHA improved from 9% (range, 0.0–29) preoperatively to 42% (range, 27–49) postoperatively. Preoperatively, five patients had subluxed shoulders and seven patients had dislocated shoulders. Postoperatively, all patients except one showed restoration of the dislocation, which was maintained until final follow-up. Only, one patient showed subluxation.

The mean glenoid version improved from −45.8° (range, −50 to −35°) preoperatively to −8° (range, −16 to −6°) at the latest follow-up.

Comparison of serial CT measurements revealed that the glenoid retroversion in the affected shoulder decreased by a mean of 30% 1 year postoperatively and by about 10% per year thereafter.

Complications

Limited internal rotation: loss of the last 30° of internal rotation occurred in four patients (33.3%). Exercises performed by the parents, by holding the scapula against the ribs while flexing and internally rotating the arm, were generally useful in the treatment of this deformity. However, it took a long time to resolve.

A keloid and an ugly scar were observed in two patients (16.7%).

Infection of the surgical wound: superficial infection occurred in one patient (8.3%); however, it was managed with dressing and antibiotics.

Posterior subluxation of the shoulder occurred in one patient (8.3%). It was dislocated preoperatively.

Clinical evaluation

Two-year follow-up: the aggregate Mallet score improved from 8 points preoperatively to 13 points postoperatively.

Radiologic evaluation

PHHA improved from 0% preoperatively to 49% postoperatively.

The glenoid version improved from −40° preoperatively to −10° postoperatively.

Discussion

The reported incidence of posterior subluxation/dislocation of the shoulder in infants and children secondary to OBPP is found to be relatively high (20–40%) with increasing awareness of the condition and advances in radiologic imaging [3,9,11].

The history of untreated patients with posterior subluxation/dislocation shows progressive glenohumeral deformation and functional impairment with increasing age [9,12].

Diagnosis of such conditions should be early and not delayed to allow for early correction and avoid deformity progression and to provide enough time for remodeling [3,12].

Diagnosis is based on awareness of the condition by childcare providers – including orthopedists, pediatricians, neurologists, and physical therapists [9,12]. All children with OBPP and rapid loss of passive external rotation between monthly examinations despite physiotherapy should be considered at risk and undergo CT scanning as a routine investigation, as performing axillary radiography in infants and young children is usually difficult [7,12,13]. However, other authors rely upon radiography [6], ultrasonography, or MRI [3].

The treatment of posterior subluxation/dislocation is controversial. Torode and Donnan [14] reported satisfactory results after anterior soft-tissue release with open reduction (without tendon transfers), followed by casting

for 6 weeks, orthosis for 6 weeks, and prolonged physiotherapy and added tendon transfers as a secondary procedure if there is persistent defective abduction and external rotation. However, they reported that most children did not show improvement in abduction. Others [3,9,12] performed anterior soft-tissue release and open glenohumeral joint reduction with concomitant latissimus dorsi and teres major tendon transfers to the rotator cuff. The latter method included one session of surgery and casting, release of the latissimus dorsi and teres major, which are deforming forces, augmentation of the already-weakened abductors and external rotators (which have unpredictable recovery), and a short period of physiotherapy. Moreover, this combination helps to optimize short-term and long-term outcomes [1,3,6]. Therefore, this was the method used in the present study.

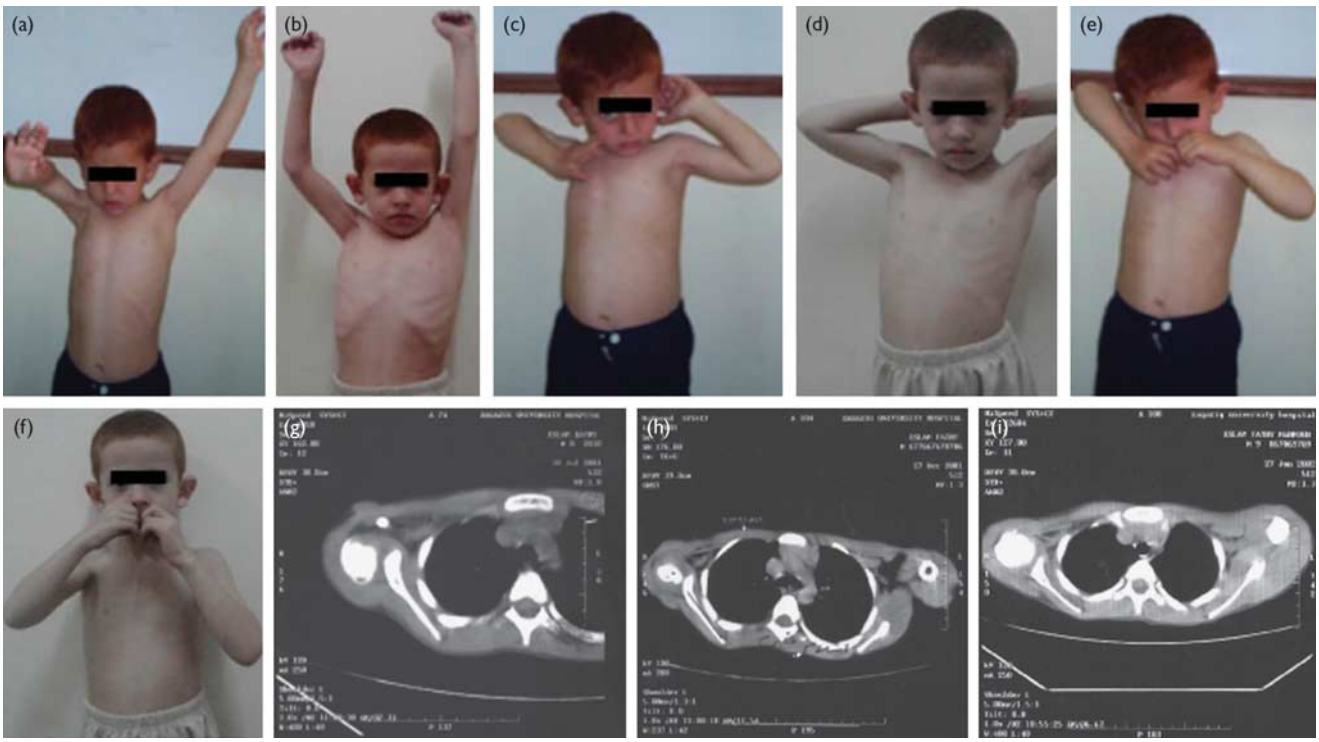
In the study by Hui and Torode [12], 23 young patients with posterior subluxation/dislocation in association with OBPP were treated by open reduction of the glenohumeral joint, accompanied by tendon lengthening and transfers. The mean age was 2 years and 5 months (range, 8 months–6 years and 7 months). The mean follow-up period was 3 years and 7 months. The angle of the glenoid retroversion in the affected shoulders decreased by a mean of 31% after open reduction and continued to improve at 9% per year.

Waters and Bae [3] treated 23 patients by latissimus dorsi and teres major tendon transfers to the rotator cuff combined with musculotendinous lengthening and open glenohumeral joint reduction. The mean age at the time of surgery was 27 months (range, 8–50 months). The mean aggregate Mallet score improved from 10

Table 1 Results according to the modified Mallet score

Score element	Mean preoperative score	Mean postoperative score	% of change
Global abduction	2	3.1	55% increase
Global external rotation	1.4	3.2	128.6% increase
Hand–mouth	2	3	50% increase
Hand–neck	2	3.1	55% increase
Hand–back	2.1	2	4.8% decrease
Aggregate score	9.5	14.4	51.6% increase

Figure 3



A 4-year-old boy with right OBPP and posterior dislocation of the right glenohumeral joint. (a) Preoperative abduction. (b) Postoperative abduction. (c) Preoperative hand to neck. (d) Postoperative hand to neck. (e) Preoperative hand to mouth (marked trumpet sign). (f) Postoperative hand to mouth (negative trumpet sign). (g) Preoperative CT: posterior dislocation of the right shoulder. (h) Six months postoperative CT. (i) Final CT. CT, computed tomography; OBPP, obstetric brachial plexus palsy.

preoperatively to 18 postoperatively. The mean glenoid version improved from −39 to −18° and PHHA improved from 13 to 38%. These improvements were maintained during the follow-up period.

In the present study, the procedure not only improved the shoulder and upper extremity function but also resulted in improved glenohumeral joint morphology in the majority of patients. These improvements were maintained during the follow-up period.

Interestingly, in the study by Waters and Bae [3], improvements in external rotation of the shoulder were not seen at the expense of internal rotation. The mean Mallet hand-to-spine score improved from 1 preoperatively to 2 postoperatively. They suggested that preservation of internal rotation power is critical for midline activities of daily living and bimanual tasks, and the risk of losing internal rotation motion and strength may outweigh the benefits of improved external rotation. This might be attributable to avoiding overzealous soft-tissue release (just to improve passive shoulder external rotation to >90° with the arm abducted and to >30° with the arm adducted) and improved compliance with rehabilitative care. In contrast, in the study by Ozturk *et al*. [15], the mean Mallet hand-to-spine score decreased by 13.9%. The mean Mallet hand-to-back score decreased by 4.8% in the present study. Four patients showed limitation of last degrees of internal rotation, but showed improvement after physiotherapy.

It should be noted that the patients in the present study underwent surgery including tendon transfers relatively early in life. Tendon transfers have been performed at even younger ages by Waters and Bae [3](8–50 months), Hoffer and Phipps [6] (14 months–3 years and 8 months), and Hui and Torode [12] (8 months–6 years and 7 months) with satisfactory results.

Preventing or reversing glenohumeral deformity and normalizing the PHHA to the midscapular line are important surgical goals to optimize shoulder function and quality of life and therefore to warrant this procedure [12].

Conclusion

The incidence of posterior subluxation/dislocation of the shoulder in infants and children secondary to OBPP is relatively high. Diagnosis is based on awareness of the condition by childcare providers. The condition should be diagnosed and treated early without delay, aiming to avoid progressive deformity and allowing enough time for remodeling. Operative reduction with concomitant anterior soft-tissue release and tendon transfer to the rotator cuff results in improved shoulder function and glenohumeral joint remodeling in the majority of patients. Postoperative care including good physiotherapy and rehabilitation programs is mandatory for satisfactory results (Fig. 3).

Acknowledgements

Conflicts of interest

There are no conflicts of interest.

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