Is pronator teres rerouting efficient for correction of pronation deformity in obstetric brachial plexus palsy?

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Background
A forearm pronation deformity is one of the deformities following an obstetric brachial plexus injury that causes functional and cosmetic disability. It is caused by the unrestricted action of the pronator muscles of the forearm in the presence of weak or paralyzed supinators. Surgical intervention by supinator muscle rerouting aims to correct pronation deformity and restore most of the daily function.
Aim
To evaluate the results of pronator teres rerouting for correction of noncontracted pronation deformity in obstetric brachial plexus palsy.
Patients and methods
A prospective study was done over a period of 42 months on 18 children presented with pronation deformity without contraction after obstetric brachial plexus palsy aiming for correction of pronation deformity and restoration of supination motion to get some hand-to-mouth movement by doing pronator teres rerouting. The mean age was 9.3 years (5.8–15 years). The mean follow-up was 23.4 months (8–42 months). All patients complete their follow-up.
Results
The median active supination improved from 5° (0–10°) to 75° (70–80°) with no loss of pronation. All patients were able to get hand-to-mouth movement and brush their teeth and could easily dress themselves.
Conclusion
Pronator tendon rerouting is a very effective procedure for correcting noncontracted forearm pronation deformity in brachial plexus injury.

Keywords:
brachial plexus, forearm, pronation deformity, pronator teres

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Introduction

Obstetrical palsy of the upper limb represents a severe traumatic complication during delivery, which basically involves the brachial plexus and occasionally the osteoarticular structures of the shoulder and its deep periarticular muscles [1]. One of the most common complications of obstetric brachial plexus palsy is loss of pronation or supination of the forearm. Pronation deformity is less common than supination deformity [2]. A pronation contracture is caused by the unrestricted action of the pronator muscles of the forearm in the presence of weak or paralyzed supinators. Although in its early stages a pronation contracture can be corrected passively, once the interosseous membrane contracts, the deformity becomes fixed. It has therefore been suggested that this should be corrected at an early stage [3]. As most of the pronation deformity is usually associated with normal function, the aim of the tendon transfer is to restore some of the supination movement that helps in enabling some hand-to-mouth movement and obtain the hand in most optimal functional position [4]. As a delay in the rebalance of paralytic muscles or the prevention and correction of muscular contractures or ligament retractions usually allows progressiveness of deformities and joint subluxations or dislocations [1], so it is essential to evaluate the condition of the interosseous membrane (elastic or contracted) and the radioulnar joint. In addition, we must take into consideration to correct any deformities in shoulder and elbow before doing rerouting of the pronator teres muscle.

In this study, we tried to evaluate the results and to answer the question, 'is pronator teres rerouting efficient for correction of forearm pronation deformity in obstetric brachial plexus palsy?'

Patients and methods

Between June 2012 and December 2015, 18 patients were done at Suez-Canal University Hospital with

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pronation deformity of the forearm without active supination after obstetric brachial plexus palsy. The study was approved by the institutional ethics committee in the Orthopedic Department of Orthopaedic Surgery, Seuz canal University, Egypt. There were nine boys and nine girls, with a mean age of 9.3 years (5.8–15 years). The right forearm was affected in 10 (55.5%) patients and the left forearm in eight (44.4%) patients. There were 11 (61.1%) C5-6 palsies and seven (38.8%) C5-7 palsies.

The indication for operation in each case was impairment of active supination with full passive supination, and the arm in neutral position with or without a medial rotation contracture of the shoulder. The hand was normal in all cases.

The affected limbs were assessed clinically, both preoperatively and postoperatively, for active and passive pronation and supination of the forearm (Table 1). Particular care was taken to measure forearm rotation in isolation from shoulder movements. The range of supination was measured in degrees using a goniometer. Measurements were done preoperatively and repeated 6 months after surgery. The patient was asked to hold a cylindrical object (e.g. a pen or stick) in a neutral position before pronating and supinating the forearm. The angles between the vertical and the pen were taken to be the range of movement in each direction. The median follow-up was 23.4 months (8–42).

Surgical technique

The surgery was performed under general anesthesia. A single incision was used. The pronator teres muscle was identified deep to the flexor carpi radialis, and its insertion identified, and the tendon was completely removed with its periosteal attachment. The distal part of the tendon was then rerouted dorsally to volarly through a window in the interosseous membrane (Fig. 1). A drill hole was done on the volar side of the radius from volar to dorsal side at which the distal

Figure 1

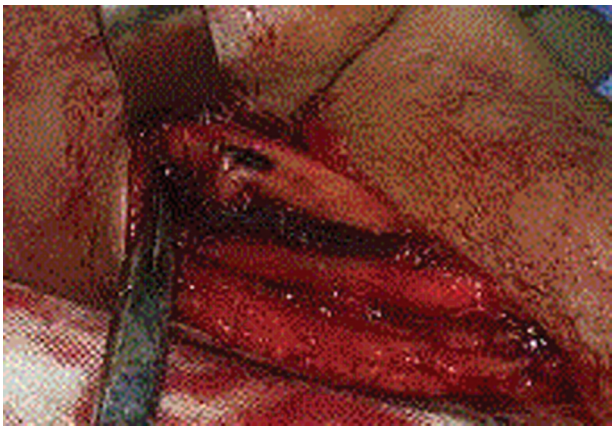
The distal part of the pronator teres muscle rerouted dorsally through the interosseous membrane.

Table 1 Summary of the patients

Case numbers	Age (years)	Sex	Side	Surgery before rerouting	Preoperative supination	Postoperative supination	Follow-up (months)
1	6.4	M	R	None	10	80	42
2	11.1	F	L	Humeral osteotomy	0	70	37
3	5.8	F	R	Shoulder	10	80	36
4	7.6	F	L	None	10	80	34
5	14	M	R	Humeral osteo	0	70	30
6	8.9	M	L	Shoulder	0	80	29
7	6.6	M	R	None	10	80	28
8	13.2	M	L	Humeral osteo	0	70	25
9	12	F	R	Humeral osteo	0	70	25
10	10.9	F	R	Humeral osteo	0	80	23
11	5.9	F	L	None	10	80	22
12	8.9	M	R	Shoulder	0	80	18
13	9	F	L	Shoulder	0	80	17
14	7.8	M	R	shoulder	0	70	14
15	8.5	F	L	Shoulder	0	80	13
16	6.7	M	L	None	10	80	11
17	9.4	F	R	Shoulder	0	70	9
18	15	M	R	Humeral osteo	0	70	8

F, female; L, left, M, male, R, right.

Figure 2



A drill hall on the volar side of the radius where the distal end of the tendon was passed and tightened on itself from volar to dorsal side.

end of the tendon was passed and tightened on itself from volar to dorsal side under slight tension (Fig. 2). This converted the pronator teres to act as a supinator muscle. After the operation, the forearm was placed in full supination in the cast for 6 weeks, and then rehabilitation was gradually introduced.

Results

A total of 18 patients were included in this study, comprising nine (50%) boys and nine (50%) girls. The average age was 9.3 years (5.8–15 years). All patients had forearm pronation deformity with limited passive supination and full active supination. The preoperative median active supination was 3.33° (0–10°). The postoperative supination was 76° (70–80°) after 6 months of follow-up. Perioperatively, all patients were unable to comb hair and brush their teeth and could not use their affected hand in eating. Postoperatively all patients were able to eat, combing hair, and brush their teeth and could easily dressing themselves. Their parents found that there are marked improvements in most of the daily functions and cosmetic appearance.

Discussion

The most common deformities associated with obstetric brachial plexus paralysis is adduction and internal rotation of the shoulder and pronation of the forearm. Deformities of the forearm rotation are an almost universal finding and can be disabling. Limited supination range of motion less than 10° with absence of abduction and flexion of the shoulder makes hand-to-mouth movement very difficult. Surgical intervention by improving supination aims to correct pronation deformity and restore most of the daily function activities.

Savva *et al.* [5] reported that the strength of the supination increases with external rotation of the shoulder. This means that any procedure that improves external rotation of the shoulder influences the rotation of the forearm. Therefore, surgical intervention was done only when shoulder external rotation was neutral. Supination motion is very important as it is required for daily activities such as turning a key or a door knob, receiving change, personal hygiene, or just playing with other children [6–8]. Therefore, procedures that aim to restore forearm function must correct the pronation deformity, produce active supination, and avoid a secondary supination contracture [6,9]. An uncorrected pronation contracture may, with growth, lead to fixed deformities of the radius and ulna that require radial osteotomy to place the forearm in a functional position. Posterior dislocation of the radial head may also occur [10].

The purpose of this study is to report the effect of the pronator teres rerouting procedure and to determine the function results of this procedure for restoration of supination movement. There is, however, little information about treating the pronation contracture. Yang *et al.* [9] reported four patients successfully treated by flexor carpi radialis transfer. Liggio *et al.* [6] reported the outcome of seven children with pronation contractures treated surgically by transfers of flexor carpi ulnaris, pronator teres, and flexor carpi radialis with success.

Pronator teres rerouting procedures were performed on five fresh-frozen above-elbow cadaver specimens mounted in a forearm rotation mounting frame. The results of this study show that placement of the pronator teres through the interosseous membrane, around the radius, with reinsertion on the volar surface produced the greatest amount of forearm supination [11].

In 2009, Amrani *et al.* [12] did the same procedure on 18 patients with obstetric forearm pronation deformities and showed postoperative active supination improvement with average of 75°. In this study, all children reach an average active supination of 76° after operation with good improvement of the most of daily functional activities and cosmetic appearance of the forearm.

Conclusion

Pronator tendon rerouting is a very effective procedure for correcting noncontracted forearm pronation deformity in brachial plexus palsy. The dynamic

nature of the procedure ensures that the deforming forces are converted to corrective forces.

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Conflicts of interest
There are no conflicts of interest.

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