

Biceps Neurotization Versus Biceps and Brachialis Neurotization in Brachial Plexus Injury: Comparative Study

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ABSTRACT

Background: Restoration of elbow flexion has a high priority in brachial plexus injury, and many techniques were described to achieve it. Between these techniques fascicular nerve transfer has popularity between reconstructive surgeons. Whether single or double fascicular transfer should be the master technique is a matter of controversy. The purpose of this study is to compare the results for restoration of elbow flexion with single and double fascicular transfer from median and ulnar nerves.

Patients and Method: From June 2009 to December 2015 forty one patients with complete paralysis of elbow flexors after brachial plexus injuries were managed by either Oberlin procedure (Group A) or transfer a fascicle from ulnar nerve to motor branch of biceps muscle and another fascicle from median nerve to brachialis muscle.

Results: Patients underwent the double fascicular transfer showed significant better muscle power according MRC score than who had single transfer. Objectively patients with double fascicular transfer rated their procedures rather than who were under a single transfer, and finally we found that the level of injury did not have a considerable effect on the final results.

Conclusion: Double fascicular transfer is an effective, simple and short time procedure that can be done in non-traumatized tissue near the target muscle and has low morbidity.

Key Words: Nerve transfer – Oberlin's procedure – Brachial plexus palsy – Elbow flexion.

INTRODUCTION

One of the most tragic events occurs after motorcycle accidents is brachial plexus injuries that results in sever upper limb disabilities [1,2]. Supraclavicular lesions (involved C5-7) are considerably more frequent lesions in plexus injury with the incidence ranged from 62% to 80.5% in some series [3-5]. Following the previous injury, patients loss their ability for elbow flexion, shoulder abduction and external rotation [6]. In these patients restoration of elbow flexion has the highest priority, than shoulder movements [7-11]. To achieve this goal many procedures were described according

to type, level and time of injury, and availability of donor nerves and muscles [12]. In 1994 Oberlin and others transferred a motor fascicle from the healthy ulnar nerve to the biceps branch of the musculocutaneous nerve; they got promising results in their study [13] and in subsequent work, where most of their patient had MRC grade 4 or more elbow flexion [14]. Based on the same principals Mackinnon et al., did double fascicular transfer, they transfer a motor fascicle from median nerve to brachialis muscle which is the primary elbow flexor beside Oberlin procedure, again they achieved good result with MRC4+ elbow flexion [15]. The subsequent studies showed superiority of double fascicular transfer over the sole Oberlin procedure [2,16,17]. However this opinion is refused by others, they claimed that single and double nerve transfer had equivalent results [6]. In this study we will present our results after single and double nerve transfer for restoration of elbow flexion.

PATIENTS AND METHODS

This non-randomized retrospective study reviewed the surgical techniques to restore elbow flexion that adopted in Plastic Surgery Unit and Microsurgery Center of Zagazig University and their outcomes. From June 2009 to December 2015 forty one patients (27 males and 14 females) with upper brachial plexus (C5-6 or C5-7) were managed by either single or double nerve transfer to flexor(s) of elbow beside other procedures. In those patients the cause of plexus injury was traumatic in twenty five patients (60%) and obstetrical injury in sixteen patients (40%). The mean age of obstetrical group at time of surgery was 10.9 ± 2.8 months, and in traumatic one it was 27.04 ± 6.29 years. In traumatic group the interval time between time of injuries and surgical interference was 3.8 ± 0.8 months.

There were twenty seven patients (65.9%) had C5-7 injury and fourteen patients (34.1%) with C5, 6 injury. In twenty three patients the lesions were at right side and in eighteen patients it was at left side.

Preoperative evaluation: All patients were subjected to full clinical evaluation including range of motion for all joints of affect limbs, atrophy in shoulder and arm muscles, sensory and motor status of whole limbs (MRC grade was used). CT myelography was done for all patients and EMG was done in seven patients to confirm the diagnosis, and they were not routine investigations.

The Patient-Rated Elbow Evaluation (PREE) is an organ specific score that subjectively measures pain and function of elbow; a higher score is associated with high disability [18]. Adult patients (traumatic cases) were asked to fulfill the functional section of the questionnaire (pain section is irrelevant) preoperatively and they repeat it one year after surgery for comparative purpose.

Surgery. Surgeries were done at mean of 4.12 ± 9.3 after injuries in traumatic patients. In early phase of this study the elected technique for restoration of elbow flexion was Oberlin' procedure. This phase included sixteen patients (Group A) and lasted for two years and four months. During the remaining period of the study the following twenty five patients (Group B) were managed by transfer of a fascicle from ulnar nerve to biceps muscles, and a fascicle from median nerve to brachialis muscles.

Operative technique: The details of surgical techniques are beyond the scope of this paper. In both groups the steps were almost the same. All operations were done under general anesthesia without muscle relaxant so as to the nerve stimulator can be used. Magnification was achieved by 5.5 X loupe (Keeler). Through a longitudinal incision in the medial side of the arm between biceps and triceps muscles median, ulnar and Musclocutaneous (MCN) were exposed. Motor branches to biceps and brachialis were dissected, and isolated with vessel loops. In Group A: The motor fascicles to flexor carpi ulnaris muscles in ulnar nerve were identified by observing contractions of muscles, after stimulation with 2-3 milliamper by nerve stimulator. The identified fascicles were dissected from the main nerves after incision of their epineurium for the longest possible distance; care was taken in order not to damage interfascicular connections. The fascicles were transferred to biceps

after cutting it distally and anastomosed with the distal end of motor branch of MCN to biceps muscle with 9/0 ethilone and/or fibrin glue. Two points were kept in mind during fascicular transfer: First is to do tension free anastomosis and the second one is to keep the anastomosis as near as possible to the target muscle to make the regeneration time as short as possible. In Group B patients the same previous steps were followed and after that motor fascicles to flexor carpi radialis were identified, isolated and transferred to brachialis muscle by the same way adopted for ulnar fascicles transfer. Wounds were closed without drain and arms were kept beside the chest wall for three weeks, in adult elasto-plasts were used and by cast in pediatric group.

Other surgical procedures like plexus explorations and reconstruction in indicated cases and transferring of spinal accessory nerves to suprascapular nerves were done in the same sitting.

Follow-up: Beside postoperative physiotherapy, patients were examined at two months intervals for signs of recovery.

Data were analyzed by SPSS 16. For categorical data (MRC score) chi-square test was used and *t*-test was used for continuous data.

RESULTS

Early postoperative period was uneventful for all patients without any considerable complication. The overall follow-up period was 3.83 ± 1.8 years (from 1.2 to 6.9 years). It was longer in Group A (5.7 ± 0.79) than that of Group B (2.6 ± 0.96).

The mean operative time for Group A was 95.6 ± 7.27 minutes while it was 115 ± 6.92 minutes in Group B, the independent *t*-test showed significant difference in operative time.

All our patients showed progressive improvement in elbow flexor powers whether the single or double neurotization was the elected procedure, these improvements were continued over months until they reached to a plateau levels which were recorded and compared with preoperative values. This comparison showed a significant statistical difference between preoperative and postoperative MRC score in all patients ($\chi^2=0.015$). But when both groups were compared, it was found that there is a significant difference between two groups in favor to Group B double transfer (Table 1) and Fig. (9). We also noticed that the level of injury

(C5-6 & C5-7) did not have a significant effect on the outcome of the procedures ($\chi^2=0.906$).

Our entire patients gratified their surgical procedures whether it was as there was a strong significant difference between their preoperative and postoperative PREE score. But independent *t*-test showed significant difference between Group A and B in favor to Group B (double fascicular). (Table 2 & Fig. 10).

Through the whole postoperative follow-up period we did not noticed either motor or sensory deficit in donor nerves' territories.

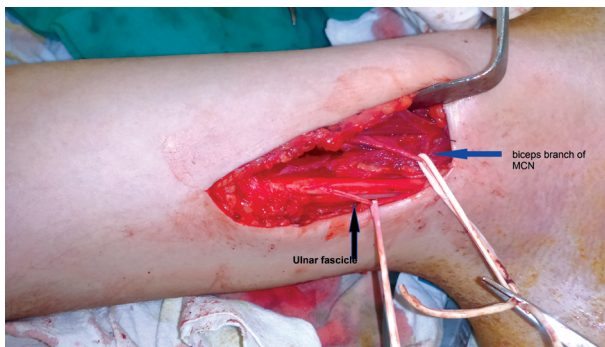


Fig. (1): Shows dissection bicep branch and ulnar fascicle.



Fig. (2): Oberlin procedure.

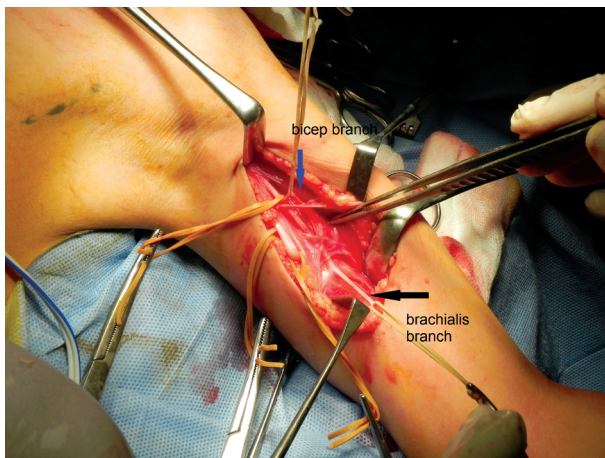


Fig. (3): Dissection of biceps and brachialis branches.

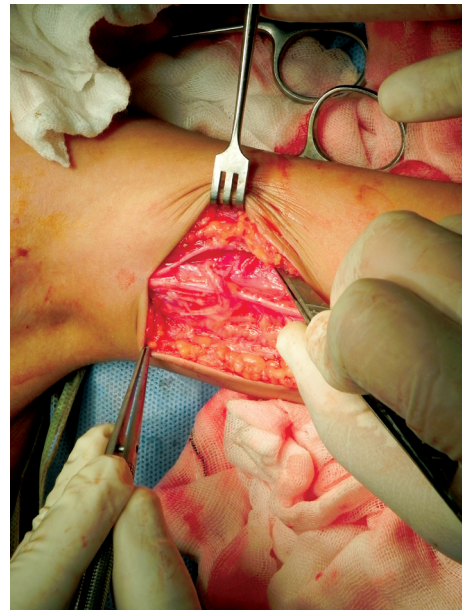


Fig. (4): Double fascicular anastomosis.



Fig. (5): Preoperative obstetric patient.



Fig. (6): Postoperative obstetric patient.



Fig. (7): Preoperative traumatic patient.



Fig. (8): Postoperative traumatic patient.

Table (1): Showed preoperative and postoperative MRC scale in Group A & B.

	Pre-operative MRC		Post-operative MRC					Sig. χ^2
	M0	M1	M1	M2	M3	M4	M5	
Single transfer	14	2	0	2	7	7	0	0.017
Double transfer	22	3	0	1	2	19	3	
Total								

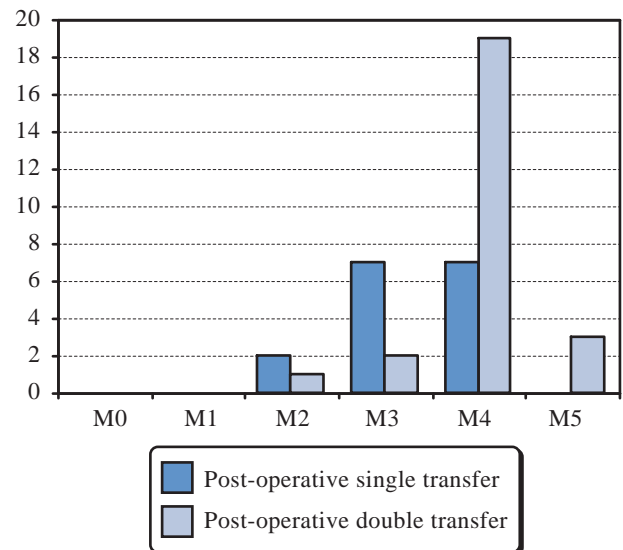


Fig. (9): Represents compares post-operative MRC in A & B groups.

Table (2): Shows preoperative and postoperative PREE scores in both groups.

	Pre-operative PREE	Post-operative PREE	Sig.
Single fascicular	121.7±2.3	52.06±3.9	Independent <i>t</i> -test 0.045
Double fascicular	121.5±2.6	49.5±3.7	
Sig.	Paired <i>t</i> - $t < 0.001$		

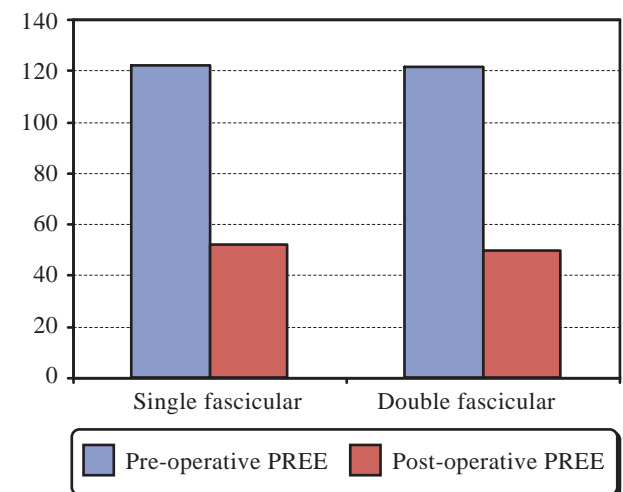


Fig. (10): Represents preoperative and postoperative PREE scores in both groups.

DISCUSSION

Restoration of elbow flexion has the utmost importance in patients with brachial plexus injury [11,19,20]. Although this restoration could be achieved by a variety of muscle transfer [21] but

achieving it through reconstruction of neural pathway is considered more physiological and superior choice [22,23]. Nerve transfer carries several advantages over the classical nerve repair including, short regeneration time as the neural anastomosis is closed to the motor endplate of the target muscle which prevents the unfavorable degeneration and fibrosis of motor endplate, [24,25] a short operative time and exclusion of sensory environment are another valuable advantages [15,26,27]. The elegant Oberlin procedure can donate a nerve supply to biceps muscle and achieve a good flexion, while the brachialis muscle which is a strong elbow flexor did not have its adequate attention [13,14,28,29].

Our entire patient showed significant improvement in their muscle power, most of them had M4 or better results however Group B patient showed a significant better results, and M5 grade was achieved in many patients in this group. Objectively patients with double fascicular transfer rated their procedures rather than who were under a single transfer. Ray and other had a results near similar than that we had, and a near similar results were reported by other studies [2,15,23,30]. Although a double transfer procedure took an longer time than the single one, but we believe that an average of twenty minute longer is a cheap price for brachialis function. To the best of our knowledge there is only one study compared single to double fascicular transfer by Carlsen et al., although they found that the patient underwent double transfer got better results than those underwent single one, but they found that this difference is not statistically significant owing to a small sample size, and many contributing factors that may case bias like level of injury and associated shoulder injury. And finally whey concluded that if no other transfer is appropriate and patient has good median and ulnar function a double fascicular transfer would be a good option [6].

Whatever single or double transfer was done we adopt early surgical intervention strategy and we believe that our good results is partially attributed to early intervention before starting the process of degeneration of motor endplate. Early intervention was recommended by several studies [31,32].

The level of injury in the plexus did not show a considerable difference on the outcome in our patients. This finding was previously stated by Tsai et al., as they found that shoulder and elbow muscles did not show a considerable difference in power when they were re-innervated whether the level of injury was C5-6 or C5-7 while Carlsen

and others found a better muscle power recovery is associated with less sever injuries [6,33].

Safety of any procedure is measured by its drawbacks. A normal power in forearm flexor and intrinsic muscle of the hand as well as absence of sensory deficit after fascicular transfer was stated in other studies and was noticed in our entire patient is another merit of this procedure [2,15,34].

Conclusion:

Double fascicular transfer is an effective, simple and short time procedure that can be done in non-traumatized tissue near the target muscle and can be conjugated with other procedures for shoulder and has low morbidity.

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