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Cross pectoral nerve transfer following free gracilis muscle transplantation for chronic brachial plexus palsy: A case series

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ABSTRACT

In an eight year period, 12 patients were treated by the contra-lateral medial pectoral nerve as motor nerve innervation of the transplanted free gracilis muscle to the paralytic upper limb. The gracilis muscle was used for both elbow and digital flexion. Results were assessed by the MRC grading system and success was defined as muscle strength of M4 and M3 which was observed in seven patients (58%). The motor level of the muscle in two patients was M0 and in two it was M1 to M2. The donor pectoral muscle of these 12 patients showed no deficit in motor and sensory functions. This method can be used for treatment of brachial plexus palsy, regaining useful function of the reconstructed limb.

1. Introduction

The majority of closed injuries to the brachial plexus in the adult population are preganglionic root injuries.[1] Generally total root avulsion of the nerve root from the spinal cord cannot be repaired.[2,3] The prognosis for return of useful hand function is very poor and the measurement of upper limb function has two distinct phases: Function without adaptation and function with adaptation and patients will naturally adapt in order to cope whether we encourage them or not.[7,11] Acute cases of total root avulsion with a denervation period of less than one year can be treated with nerve transfer techniques such as the phrenic, spinal accessory, intercostals, motor nerve of the cervical plexus and the contra-lateral C7 transfer.[4–12] In a flail upper extremity because of chronic brachial plexus palsy for more than a two year period, nerve transfer cannot be useful. An alternative technique for these cases is nerve transfer as donor nerve followed by free muscle transplantation which can be useful for elbow or for simultaneous elbow and digital flexion.[5–7]

Otherwise in patients with no effective results, one year after other nerve transfer operations this technique would be useful.[13,14,16] Gilbert[15] was the first who used the normal contra-lateral limb nerve for reconstruction of elbow flexion. Hosseinian[14] used this method for elbow and finger flexion by free gracilis muscle.[13,15,19]

2. Materials and methods

From January 1993 to March 2001, 16 patients with flail upper extrimities that more than two years was passed from their injury to the brachial plexus were evaluated and underwent our treatment. All these patients were operated for nerve transfer before 6 months by other surgeons with no functional improvement. So the donor nerves such as ipsilateral intercostals or the accessory nerve were used and these nerves and the ipsilateral pectoral nerve were useless. These patients underwent a two stage surgery: in stage one we performed the

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Table 1 – British Medical Research Council Standards

MRC 0: no contraction
MRC 1: flicker or trace of contraction
MRC 2: active movement with gravity eliminated
MRC 3: active movement against gravity
MRC 4: active movement against gravity and resistance
MRC 5: normal power

cross pectoral nerve transfer and in stage two the free gracilis muscle transplantation.

Results were assessed after three years based on the standards of British Medical Research Council (Table 1).

2.1. *Technique*

To innervate a paralytic limb in adults, a 35–45 cm nerve graft between the contra-lateral pectoral nerve of the normal limb and the recipient limb is required (Fig. 1).

The sural nerve was used in all patients as nerve graft. An approximately 5 cm incision was made 1 in. below the clavicle of the normal side between 2/3 of the medial and 1/3 of the lateral side of the clavicle. The medial pectoral nerve of the normal limb was found at the upper portion of the pectoral major muscle. The proximal end of the sural nerve was sutured to the end of the medial pectoral nerve.

The nerve graft was then passed from a subcutaneous tunnel to the medial side of the contra-lateral arm. Nerve regeneration was evaluated by the presence of Tinel's sign. The postoperative time between stage I and stage II ranged from 12 to 14 months.

The second stage of the operation which consisted of a gracilis myocutaneous free flap was used for both elbow and digits flexion. The proximal muscle end was wired to the very proximal humerus. The muscle was fixed over the arm and its long tendon was sutured to the medial four flexor digitorum profundus tendons over the forearm (Fig. 2). Arthrodesis was done in the thumb joints for permanent opposition.

End to side anastomosis was performed between the artery of the gracilis muscle and the brachial artery. For the vein of muscle an end to end anastomosis was performed to basilica vein. The distal sural nerve stump neuroma was resected and the nerve coapted with a 10/0 Prolene suture to the motor nerve of the transferred muscle. The native brachioradialis muscle was detached distally, rotated over the transferred gracilis muscle at the elbow, and fixed to the medial epicondyle of the humerus, to act as a pulley. Postoperative splinting of the limb was used for 6 weeks.

Fig. 1 – Sural nerve between the contra-lateral and the injured limb.

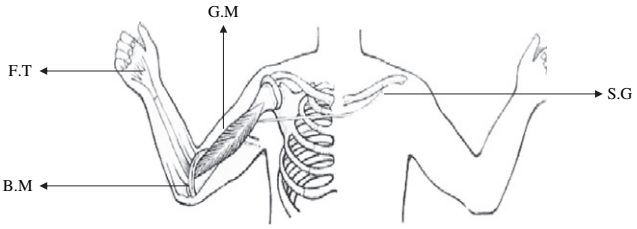

Fig. 2 – Distal tendon of the gracilis was sutured to the flexor digital tendons. G.M: Gracilis muscle; B.M: Brachioradialis muscle; S.G: Sural Graft and F.T: Flexor tendons.

3. Findings

The age of patients ranged from 15 to 35 years with the average being 25 (±4). Two patients did not return for evaluation and two of them did not return for the second stage of the operation and were excluded from the study. The remaining 12 patients underwent the second stage of the operation after 12–14 months (Table 2).

Regeneration rate of the sural nerve graft was at least 1 mm per day and after 12–14 months the end of the sural nerve showed neuroma formation.

In the second stage operation, the sural nerve graft was grafted to the gracilis muscle nerve. In 10 patients after 5–15 months the muscle force was M1 (in the MRC grading). In seven patients progression of muscle force from M1 to M4 developed during 10–21 months. Successful treatment was defined as M4 muscle force, holding and flexion of elbow against gravity which was seen in seven patients. They could hold a 4–9 kg weight with their hand and elbow flexion ranged from 10 to 45 deg. We had two unsuccessful treatments with no motor function of the gracilis muscle (M0) (Table 2).

In seven patients, we had satisfactory flexion in the fingers (Fig. 3).

4. Discussion

In chronic brachial plexus palsy, with more than one year of denervation, the denervated muscle becomes significantly degenerated and atrophic. In these patients nerve transfer or repair would not be effective. The flail limb can be treated by nerve transfer followed by free muscle transplantation in the second stage. When donor nerves such as ipsilateral accessory, intercostals pectoral and contra-lateral C7 cannot be used, the flail limb can be treated by cross pectoral nerve transfer from contra-lateral as a donor nerve with low morbidity rates. One year after medial pectoral nerve transfer from the normal side to the injured limb, the second stage of the treatment with free muscle transfer and repair of the nerve of the free muscle with the transferred nerve can be