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CASE REPORT

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Restoration of Elbow Flexion for a C5-C6 Brachial Plexus Injury Using a Double Nerve Transfer

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BACKGROUND INFORMATION

Many peripheral nerve injuries were previously repaired by direct means at the site of injury.[1] In contrast, the concept of nerve transfers to address peripheral nerve injuries that are not repairable by direct means is relatively new. In general, nerve injuries that have a long distance to regenerate to their respect target (that usually fail) or have a poor prognosis for recovery are lesions that may be considered for nerve transfers. This case demonstrates the concept of peripheral nerve transfers to reinnervate the biceps and brachialis using less critical nerves to restore elbow flexion.

CASE REPORT

A 28-year-old right-hand dominant male was involved in a motorcycle accident and sustained multiple injuries which included: C7-T1 cervicothoracic subluxation with contusion of the spinal cord and associatedleft lower extremity weakness, multiple rib fractures, pulmonary contusions, a grade III AC separation of the left shoulder and a left C5-C6 brachial plexus injury. In his evaluation, an MRI was performed with findings ofbilateral C7 and T1 facet dislocation. He subsequently underwent cervicothoracic fusion to stabilize the spine from C6 to T2 vertebra for vertebral injuries associated with a left lower extremity neurologic impairment. In addition to these findings,he was found to have concomitant left C5-C6 brachial plexopathy with the typical findings of absence of active elbow flexors and dynamic shoulder stabilizers.

Approximately one year post-motorcycle accident, nerve conduction and needle electromyographic studies clearly demonstrated the affected muscles including those following the superior trunk of left brachial plexus: infraspinatus, supraspinatus, biceps, brachioradialis, teres major, teres minor, and deltoid muscles. This study also found absence of sensory conduction in the thumb indicating lesion distal to dorsal root ganglion and absence of denervation of rhomboid muscles indicating lesion distal to branching of dorsal scapular nerve.About 1 year 4 ½ months later, operative interventions for restoration of upper extremity functions via nerve transfers was undertaken.

Surgical approach of the peripheral nerves was carried out using a medial approach. The median and ulnar nerves were identified in the arm (figure 1.). Vessel loops were placed about the nerves for gentle retraction and further dissection was made for proximal exposure of the nerves. Careful and meticulous dissection to free the ulnar and median nerves was used. A disposable nerve stimulator was used intraoperatively to identify the portion(s) of the nerves suitable for transfer. The nerve fibers located on the posteriomedial aspect of the ulnar nerve which innervates the flexor carpi ulnaris was chosen to transfer. On the median nerve, fibers located on the anterolateral portion of the nerve which controls the FDS to the digits was determined suitable transfer.

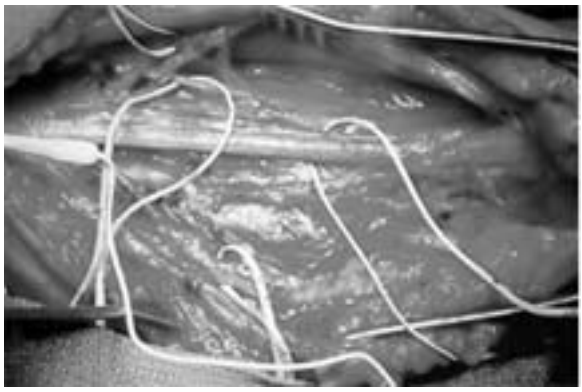

Figure 1: Exposure of left brachial plexus

Next, identification of biceps branch of the musculocutaneous nerve was undertaken and secured with 9-0 Nylyon suture, fibrin glue and a Neurogen wrap in an end-to-end repair to the ulnar branch of the FCU. Then an end-to-end repair of the median nerve fibers to the brachialis was performed. The wound was closed in a layered fashion using 2-0 Vicryl for the deep tissues and staples for the skin. A sterile soft dressing, followed by a long-arm posterior splint was placed.

OUTCOME

Patient has been followed for twelve months status post double nerve transfer of the left upper extremity brachial plexus. There were no pre-, intra-, or post-operative complications. Incision healed successfully as seen in Figure 2.

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Figure 2: Left upper extremity

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Figure 3: Left Elbow Flexion

Further post-operative testing demonstrated the ulnar and median nerves function to be essentially intact despite the fibers taken from these nerves for the transfers. The patient demonstrated very good hand function(Figure 4, 5 & 6).

Figure 4: Left-Hand: Finger Abduction

Figure 5: Left Hand: Fist

Figure 6: Wrist extension and finger flexion

DISCUSSION

Devastating and debilitating brachial plexus injuries can render dramatic changes in the lives of these patients to loss of upper extremity functions. Management is holistic, multidisciplinary and extensive in order to return the patient back to- or close to their baseline functions in society. Initial evaluation includes: a thorough history, physical examination with adjunctive imaging and electrophysiological studies. Primary goal in treatment should create efforts to return and maintain as much function of the upper extremity as possible. It is important to consider timing of restoration procedure implemented due to irreversible changes to the motor endplate and intraneural fibrosis that produces muscle resistance to neuronal stimuli that may occur 18 to 24 months post-injury negating use of nerve reconstruction and late type interventions.[9] Early interventions include procedures in nerve repair or reconstruction using direct repair, neurolysis for scar compression, nerve grafting, and nerve transfers; or late interventions consisting of tendon transfers or pedicled muscle transfers of functioning muscles (ie, bipolar pectoralis muscle transfer or latissimus dorsi muscle transfer) to maintain shoulder function and stability along with elbow flexion.[9]

Successful nerve transfers to improve elbow flexion first began with Oberlin as a single nerve transfer to innervate the biceps.[3-5] Unfortunately, some patients did not achieve the elbow flexion strength required for activities of daily living with this transfer. Later, the Oberlin transfer was modified by Mackinnon by adding

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a second nerve transfer to reinnervate the brachialis muscle achieving double nerve transfers.[6-8] Thereafter, many studies undertaken have provided supportive evidence in promising nerve transfers in returning shoulder function, elbow flexion, and sensation to upper extremites using a variety of methods and donor/receipient nerves for transfers.[3-8,10,13-16] As in this patient, this mode of repair has improved elbow flexion. Moreover, double nerve transfers have been indicated above single transfers in achieving better strength in flexion.[12] Nerve transfers have offered benefits above nerve coaptation in proximal nerve lesions[2] which risks tension due to approximation in the cords increasing gap defect and/or elongated timing to repair that promotes risk of nerve retraction, also contributing to gap defect.[1] Additional nerve transfers that have been described to augment Oberlin-Mackinnon transfer include: the distal accessory nerve to the suprascapular nerve transfer and the branch to the lateral head of the triceps to the anterior branch of the axillary nerve to help provide reinnervation to the shoulder stabilizers.[9]

Nerve transfers offer a new approach to difficult peripheral nerve injuries. The double nerve transfer to reinnervate the biceps and brachialis is a reasonable approach for a C5-C6 brachial plexus inury and is now considered the treatment of choice for this lesion. Other nerve transfers are currently being developed to restore muscle and sensory function using less critical or expendable nerves.

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