Preventing Deltoid Dysfunction after Axillary Nerve Injury: Results of Partial Radial to Axillary Nerve Transfer as the Index Procedure

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INTRODUCTION:

Axillary nerve injuries, whether traumatic or iatrogenic, are catastrophic for patients, producing profound functional deficits and disability secondary to deltoid dysfunction. Even when the best micro-surgical repairs are performed in a timely manner, either via direct coaptation or with a nerve graft, a patient typically fails to regain normal function. Accordingly, surgeons routinely recommend expectant conservative care with the hope that the axillary nerve injury is a neuropraxia-type injury and will spontaneously resolve. Instead, significant time routinely passes, allowing for motor endplate (MEP) degeneration, and often leaves the patient with permanent sequelae from the injury. Here we present the results of a novel concept of performing a partial ra-dial nerve to axillary nerve transfer as the index procedure for treatment of isolated axillary nerve injury (Fig. 1).

METHODS: We present an IRB approved retrospective single surgeon (RG) case series of patients with an isolated axillary nerve injury that was confirmed with electromyography (EMG) and treated with partial radial nerve to axillary nerve transfer between 2014-2022. The donor nerve branch was chosen using intraoperative nerve stimulation to identify a branch of the radial nerve that ONLY provided innervation for triceps extension AND did not initiate wrist or digit extension. Shoulder range of motion (forward flexion, abduction, external rotation) and Medical Research Council (MRC) scores (deltoid, triceps, wrist and digit extension) were recorded pre-op and at final follow-up. Patients with brachial plexus injuries (BPI) who received this nerve transfer were not included
in the analysis of pre- and post-operative changes in ROM and strength, but were evaluated for any post-operative donor nerve defect.

RESULTS:

14 patients met the inclusion criteria of an isolated axillary nerve injury—13 male and 1 female (Table 1); an additional 17 patients received this nerve transfer as part of the treatment for their BPI (31 patients total). All patients had confirmed axillary nerve injury with presence of readily detectable fibrillation potentials on EMG. These EMG studies also provided data of other electrophysiological abnormalities including: 10 patients with significant reduction in motor unit recruitment, one patient with zero motor unit recruitment, 7 patients with long duration, high amplitude motor unit potential, and 3 patients with zero motor unit potential.

The mean patient age at time of surgery was 50 years old (range 22-66) with the mean time from the injury to the surgical intervention being 19.1 months (range 3-120). In 13/14 patients, an appropriate branch of the radial nerve that only innervated triceps extension was identified via an intraoperative nerve stimulator within 60 minutes from anesthesia induction. In one patient, a suitable donor radial nerve branch was not identified that only provided triceps activation and accordingly, the nerve transfer was not performed. No patient had any donor site defect as measured by weakness in triceps, wrist or digit extension in the immediate post-operative period or in any subsequent follow-up visits. 9 patients underwent additional sequential surgeries (under the same anesthetic) following nerve transfer. Mean follow-up was 27.2 months (range 6.5-63).

Mean pre-op shoulder ROM was forward flexion: 44° +/- 27°, abduction: 47° +/-22°, and external rotation: 19° +/- 25°. Mean post-op ROM was forward flexion: 148° +/- 35°, abduction: 132° +/- 32°and external rotation: 51° +/- 11°. Mean improvement in ROM was forward flexion: 94° +/- 46° ($p < 0.01$), abduction: 85° ($p < 0.01$), and external rotation: 28° +/- 25° ($p < 0.01$) (Fig. 2). Mean pre-op deltoid MRC score was 2. Mean post-op MRC score was 4+.

DISCUSSION AND CONCLUSION:

Previous reports in literature have detailed that axillary nerve repair routinely only produces a recovery to M3/4 strength, and most often leaves the patients with significant functional deficits. In contrast, we have shown here that the partial radial nerve to axillary nerve transfer offers the possibility of M5 with nearly normal ROM without any measurable donor site morbidity. In this cohort, all patients had significantly abnormal preoperative EMG findings consistent with axillary nerve injury, without evidence of meaningful reinnervation or recovery.

All patients who received nerve transfers had an appropriate donor nerve selected using intraoperative neural monitoring. No patient experienced postoperative donor site weakness. We observed significant gain in average ROM and MRC scores, even for patients who underwent nerve transfer more than 6 months after nerve injury.

Conclusion: When an appropriate donor radial nerve branch can be identified in patients with an isolated axillary nerve injury, surgeons should strongly consider a partial radial nerve to axillary nerve transfer for the index procedure.

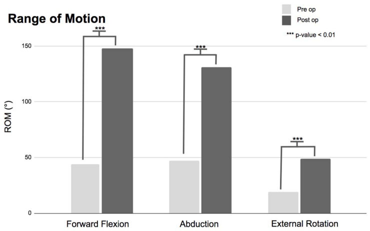

Figure 2: Mean pre and post-operative range of motion

Study ID	Age	Gender (M=0, F=1)	time from injury to surgery (months)
1	53	0	7
2	61	0	3
3	55	0	14
4	26	0	5
5	37	0	3
6	22	0	73
7	51	0	7.5
8	61	0	120
9	42	0	5
10	66	1	12
11	57	0	4
12	54	0	7
13	61	0	4
14	54	0	4

Table 1: Patient demographics

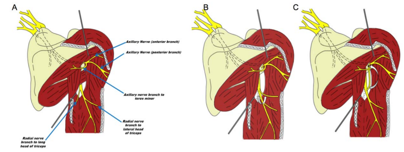

*Figure 1: (**A**) normal anatomy of radial and axillary nerve. (**B**) identifying correct radial nerve donor branch. (**C**) coaptation of donor branch to axillary nerve.*