Surgical Technique The Journal of Hand Surgery (Asian-Pacific Volume) 2025;30 • DOI: 10.1142/S2424835525970021

Contralateral Lower Trapezius to Triceps Transfer for Restoring Elbow Extension in Patients with Brachial Plexus Palsy – A Technical Note

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Restoration of elbow extension is seldom considered in the reconstructive plan for patients with extensive brachial plexus injury because of the scarcity of the nerve and tendon transfer options. However, restoring elbow extension could increase the outreach of hand and give better control of the elbow flexion. We propose a new technique for restoring elbow extension using the readily available contralateral lower trapezius (CLT). By extending the CLT with a fascia lata graft and transferring it to the triceps, we were able to restore elbow extension. In all four patients who underwent this procedure, anti-gravity (Grade-3) elbow extension was reliably achieved. Patients reported improved ability to reach for objects below shoulder level and expressed greater stability while handling a two-wheeler. This technique offers an effective method of restoring elbow extension in instances where the conventional ipsilateral donor muscles are not available for transfer.

Level of Evidence: Level V (Therapeutic)

Keywords: *Brachial plexus, Triceps, Elbow extension, Lower trapezius, Tendon transfer*

INTRODUCTION

Brachial plexus injuries (BPI) are debilitating. The degree of disability is variable depending on the nerves involved at the time of injury and the resultant paralysis. Lack of elbow extension power would be observed in patients with extended upper BPI (involving C5, C6 and C7 roots) or those with total palsy involving C5–C8 and T1 roots. When it comes to the order of preference for functional reconstruction, loss of elbow extension takes a back seat, as elbow flexion and shoulder abduction are extremely essential for basic upper limb function. Nevertheless, for those patients who recover good elbow and shoulder function, and also have a moderate hand function, elbow extension can be very rewarding. This, however, is challenging as the conventional secondary reconstruction options of deltoid to triceps or ipsilateral lower trapezius to triceps are not available. The former being paralysed because of the injury and latter due to denervation, secondary to the use of the spinal accessory nerve for the nerve transfer to the suprascapular nerve in the primary nerve surgery. In such complex situations, we have used contralateral lower trapezius (CLT) to triceps transfer and have found it be effective and with no clinically appreciable donor deficit. We are hereby presenting the technical details and outcome of this technique.

Received: Mar. 14, 2025; Accepted: Jun. 18, 2025
Published online: MMM. DD, YYYY
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SURGICAL TECHNIQUE

Illustrative Case: A 26-year-old male presented with left sided post traumatic global BPI, sustained in a road traffic accident. While his finger flexion recovered spontaneously, the other functions of his upper limb did not improve. He underwent exploration of left brachial plexus and neurotisation of musculocutaneous nerve with spinal accessary nerve (SAN) using a sural nerve graft in stage-1, followed by wrist arthrodesis and ipsilateral upper trapezius to deltoid transfer in the second stage. After these two stages, 2-years postoperatively, patient achieved Medical Research Council (MRC) Grade-3 elbow flexion and shoulder abduction improved to 60°. Patient was satisfied with the outcome, but he desired improvement of elbow extension. Without a functional triceps, the patient felt that his elbow always got flexed when attempting shoulder abduction, and that his hold on the two-wheeler handle was less secure. None of the known donors for restoring elbow extension were available. Deltoid, latissimus dorsi and brachioradialis were paralysed as part of the BPI and ipsilateral lower trapezius was not available as the spinal accessory had been used for the nerve transfer in the initial surgery. Having prior experience with ipsilateral lower trapezius to triceps transfers, we conceptualised that the CLT, once harvested and mobilised, could similarly be flipped proximally to reach the triceps when extended with a fascia lata graft. Based on this rationale, we proceeded with the planned procedure after a detailed discussion with the patient.

Surgical Technique: The surgery was performed in right lateral position with the patient under general anaesthesia. An incision was made 1-inch towards the right side of the midline extending from upper medial scapula-to-L4 vertebra. The lower outer border of the trapezius muscle was identified and then the muscle was elevated. Distally, it was elevated in continuity with the para-vertebral fascia for a length of about 5 cm in order to have a tissue for attachment of the fascia lata graft. The muscle was then elevated proximally by dividing its attachment on the spinous processes. In the proximal part of the dissection, the transversely oriented rhomboid muscles must be identified and left in place and not included along with the trapezius muscle. Also, the trapezius muscle neurovascular bundle lying on the under-surface of the muscle (midway between spinous process and medial scapular border) must be identified and preserved.[1] The trapezius muscle was mobilised till the level of the spine of the scapula (Figs. 1 and 2). Then, a vertical incision was made over the posterior aspect of the affected arm, and the triceps tendon was exposed. A 25 × 4 cm strip of fascia lata was harvested from the ipsilateral thigh. The fascia lata was sutured to lower trapezius, with an overlap of about 8 cm, to provide a strong repair junction, allowing early mobilisation. The fascia lata with the attached trapezius was tunnelled to the distal arm incision via a liberal subcutaneous tunnel to allow free gliding of the muscle facilitated by an intervening incision over the posterior axillary fold (Figs. 1 and 3). The distal end of the fascia lata was attached to the triceps tendon by Pulvertaft weave using

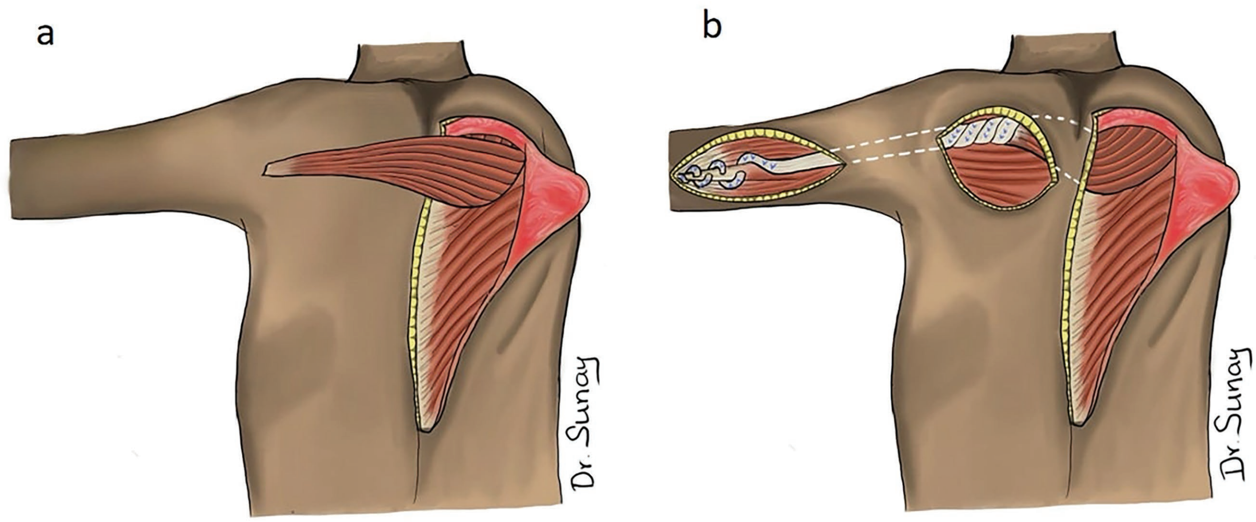

Fig. 1.
A. Descriptive diagram showing the contralateral trapezius harvested and flipped on to the effected arm.
B. Descriptive diagram showing the trapezius extended with fascia lata transferred to the triceps.

Fig. 2. Intraoperative picture with the flipped contralateral trapezius on to the extended arm.

Fig. 3. Intraoperative picture with CLT extended with fascia lata graft is tunnelled subcutaneously through an intermediate incision to the triceps.

polypropylene 3–0 suture, while keeping the arm in 90° abduction and elbow in full extension. Tension adjustment in 90° of shoulder abduction provides a straighter line of pull of the tendon and easier tension adjustment (Figs. 1 and 3). Appropriate tension was confirmed by performing passive elbow flexion after the first weave; one should be able to passively flex the elbow to 90° with the shoulder abducted to 90°. With tension confirmed, additional two to three weaves were placed. The patient was later immobilised for 4 weeks in a customised abduction and elbow extension splint.

Postoperative Protocol: Early protected mobilisation of the elbow was started on the second postoperative day to prevent adhesion of the fascia lata in the long subcutaneous tunnel. Patient was instructed to perform active elbow flexion in the abduction splint with an aim to flex the elbow till about 80° and avoid flexion beyond 90° to protect the repair sites. The lower trapezius can be voluntarily contracted by doing retropulsion of the scapula. This movement was taught to the patient in order to power the transfer. He was instructed to perform retropulsion of the contralateral scapula and try to extend the ipsilateral elbow. These exercises were continued for 4 weeks. After 4 weeks, the shoulder splint was removed and patient was provided with an elbow extension splint and he was instructed to remove the splint five times daily and perform gravity eliminated active flexion and extension till 90° of flexion. The range of flexion was gradually increased, and elbow extension was progressively increased to the antigravity extension. At 8 weeks post surgery, all splints were discarded, and patient was encouraged to use the hand for activities of daily living. By 6 months postoperatively, patient demonstrated improved elbow extension up to MRC grade-3. At his last follow-up, 18 months after surgery, he was comfortably able to perform active anti-gravity elbow extension (Fig. 4 and Video 1).

Fig. 4. Post operative 1-year follow up showing antigravity elbow extension when the arm was supported. The arrow points to the prominence of the contracting transfer.

DISCUSSION

Patients with extensive BPI unfortunately have a dire paucity of donor nerves for reconstruction. While the best available reparable/donor nerves are utilised for elbow flexion and shoulder abduction, tendon transfers remain a viable option for restoring elbow extension during secondary reconstruction. Restoring elbow extension is often underestimated and patients are left to use the gravity aided extension, but active elbow extension could be very useful in improving the reach of the hand for various activities especially the overhead activities. It has been found that patients without elbow extension tend to overshoot the targeted flexion.

Various options exist for providing elbow extension. Latissimus dorsi, posterior deltoid, brachioradialis and biceps have all been described previously, mostly in tetraplegics.[2] Lower trapezius to triceps transfer was described by Bertelli et al.[3,4] In a patient with extensive BPI, the deltoid, latissimus dorsi and brachioradialis may be non-functional, and one would be apprehensive in using the recovered biceps after the nerve surgery. In a resource depleted limb, for a supportive function like elbow extension, a donor from the contralateral side is a reasonable undertaking. CLT has been used for restoring external-rotation and correct winging of scapula.[5–7] It has been shown to be efficacious without donor site functional morbidity. According to studies by Holtermann et al., lower trapezius has been found to have independent control in an EMG study done in healthy volunteers.[8] Thus, lower trapezius transfer can be trained and functions independently when used for elbow extension. Our patient demonstrated a strong gravity eliminated active elbow extension and maintained full elbow flexion range. He could easily perform elbow extension against gravity with terminal 20° of extension lag (Fig. 4 and Video 1). However, the antigravity elbow extension was possible only when the arm was supported (as is also seen in Fig. 4 and Video 1). Despite this limitation, he was satisfied with the outcome and reported improved reach during daily activities, improved control of the shoulder abduction and elbow flexion and increased confidence while riding a two-wheeler, owing to improved stability in holding the bike handle. He did not experience any donor deficit on the contralateral side and was satisfied as the operation improved his upper limb function.

CLT to triceps transfer provides a novel and effective method for restoring elbow extension in patients with limited donor options for secondary reconstruction following extensive BPI. In carefully selected patients, it could improve the overall functionality of the upper limb with increased patient satisfaction. This new tendon transfer option provides surgeons with an additional, valuable option in the reanimation of the paralysed upper limb – helping patients take an extra mile towards regaining independence and improving their quality of life.

DECLARATIONS

Conflict of Interest: The authors do NOT have any potential conflicts of interest with respect to this manuscript.

Funding: The authors received NO financial support for the preparation, research, authorship and/or publication of this manuscript.

Ethical Approval: This study was exempt from institutional board review per our institutional policy on small case reports.

Informed Consent: Written informed consent was obtained from the patient before the study. He has provided his consent to share his photographs and clinical information.

Use of AI and AI-Assisted Technologies AI and AI-assisted technologies were NOT used in writing this manuscript.

Acknowledgements: None.

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Supplementary Files: The supplementary files for this manuscript (listed as follows) are online only and can be accessed at http://www.worldscientific.com/doi/suppl/10.1142/S2424835525970021

Supplementary Video 1: A video showing the anti-gravity elbow extension possible. The contraction of the lower trapezius is notable as the patient performs active elbow extension.