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ORIGINAL ARTICLE

Outcome of Nerve Transfers by Posterior Approach for Shoulder Restoration in Upper Brachial Plexus Injuries

Pawan K. Dixit*

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Brachial Plexus Injury, Shoulder Restoration, Nerve Transfers, Posterior Approach

Introduction: Extra-plexus nerve transfers are the mainstay of treatment for return of function in upper brachial plexus injuries. For shoulder restoration, spinal accessory to suprascapular nerve transfer and Somsak transfer is the choice of nerve transfer. Posterior approach for spinal accessory to suprascapular nerve and nerve to medial head of triceps to axillary nerve transfer have gained momentum in recent times. This study reports the outcome of posterior approach of nerve transfers for shoulder restoration.

Methods: Spinal accessory nerve to suprascapular transfer and medical head of triceps to axillary nerve transfer were performed in patients with upper brachial plexus injuries presenting within a year of injury. Postoperative range of motion of shoulder abduction along with external rotation and timing of return of function were recorded.

Results: 11 patients underwent nerve transfers. The mean duration since injury was 7.72 months and mean follow-up period was 11 months ranging from 8 to 18 months. The timing of the return of shoulder function was 26.09 weeks (range from 22 to 28 weeks). Average shoulder abduction and shoulder abduction were 74.3 and 66.6 degrees respectively.

Conclusion: Spinal accessory to suprascapular nerve transfer through the posterior approach is an attractive alternative to anterior approach with early return of function. Nerve to the medial head of triceps to axillary nerve transfer proximal to teres minor branch provides better external rotation.

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INTRODUCTION

Root avulsion injuries are common in upper brachial plexus injuries.[1] Nerve reconstruction using nerve grafts are often not possible and shows poorer results.[2] Extra-plexus nerve transfers are the mainstay of treatment for return of function in upper brachial plexus injuries. Nerve transfers to the suprascapular (SSN) and axillary nerve are commonly performed for shoulder restoration.

Spinal accessory nerve (SAN) is the favored donor for suprascapular nerve transfer as the function of SAN is synergistic to shoulder abduction.[3] SAN is directly co-opted with SSN leaving few branches to upper trapezius (to preserve upper trapezius function) by anterior approach through the same incision used for brachial plexus exploration. Difficulty identifying suprascapular nerve in clavicular fractures[4] and injury to suprascapular nerve at scapular neck, suprascapular and spheno-glenoid notch has been reported in literature.[5] The posterior approach for spinal accessory to suprascapular has been described by Guan[6] and Bahm[7] owing to reports of distal suprascapular nerve injuries.

Somsak[8] described the landmark procedure, which significantly improved shoulder function by

Department of Burns and Plastic Surgery, All India Institute of Medical Sciences, Jodhpur, Rajasthan, India

***Correspondence:** *Pawan K. Dixit, sine.pkd@gmail.com*
Department of Burns and Plastic Surgery, All India Institute of Medical Sciences, Jodhpur, Rajasthan, India

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transferring the nerve to the long head of the triceps to anterior division of axillary nerve. This procedure, along with SAN to SSN transfer, has resulted in an excellent outcome for shoulder restoration. MacKinnon[1] suggested using the nerve to medial head of triceps in place of long head and co-apt with the whole axillary nerve proximal to the branch of teres minor. They further suggested better external restoration of the shoulder by including the branch to teres minor. This study evaluates the outcome of the posterior approach to spinal accessory nerve to suprascapular transfer and nerve to the medial head of triceps to axillary nerve transfer for shoulder restoration.

MATERIAL AND METHODS

The patients with upper brachial plexus injuries who presented to the department of burns and plastic surgery within a year of injury were included in the study. These patients were serially examined, and muscle charting as per MRC grade was done on each occasion. The patients who showed no improvement in shoulder function were considered for spinal accessory to suprascapular nerve transfer and medial head of triceps to axillary nerve transfer by posterior approach for shoulder restoration after consent and relevant approval.

Surgical Technique

All patients were operated on in the prone position with the arm adducted under general anaesthesia. Anatomical landmarks and surgical techniques used are as described by Colbert and Mackinnon.[1]

SAN to SSN Transfer by Posterior Approach

Pre-operatively, SAN is marked at 44% distance from the midline on back on the line joining midline to the acromion process. Suprascapular notch is marked at the midpoint on the line joining the medial border of the scapula and acromion process. Incision marked two cm superior and parallel to the spine of the scapula (Figure 1A). Infiltration was done with adrenaline solution in 1:100000 dilution. Skin and subcutaneous tissue incised and trapezius muscle split. Branches of SAN were identified in the adipose tissue layer below the fascia of the trapezius muscle and confirmed with nerve stimulator. One of the longer branches was dissected for a tension-free anastomosis. Suprascapular notch was palpated at the previously marked position at the superior border of scapula. The suprascapular ligament was dissected by blunt dissection and incised carefully. SSN was identified and traced as proximally towards neck as possible and cut (Figure 1B and C).

Medial Head of Triceps to Axillary Nerve Transfer

Hockey stick incision was marked over arm extending to upper back as shown in figure 1A. Posterior border of deltoid identified and retracted. Sensory branch of axillary nerve identified between deltoid and triceps and carefully traced to axillary nerve in quadrangular space. Anterior and posterior division and branch to teres minor were marked. Long and lateral head of triceps muscle were separated and tendon of teres major identified. Radial nerve and its branches were identified below teres major in triangular space. Nerve to medial head of triceps is usually present atop of radial nerve or very close to it. Nerve to medial head was dissected distally and axillary nerve was cut proximal to teres minor branch (Figure 1D). Nerve coaptation was performed with 10-0 nylon sutures and tissue glue for both transfers.

Assessment Parameters

Post-operatively, arm was immobilised for 3 weeks followed by physiotherapy of all joints and galvanic stimulations. Patients were evaluated in regular follow up for timing of return of shoulder function and range of motion of shoulder abduction and external rotation by clinical and electrophysiological examinations. Muscle power grading was assessed as per MRC grading.

RESULTS

11 patients with upper brachial plexus injuries were undergone SAN to SSN transfer by posterior approach and nerve to medial head of triceps to axillary nerve transfer. Details of patients are provided in 1. All the patients were male with a mean age of 38.9 years. Mean time since injury to procedure was 7.7 months which ranged from 5 to 11 months. Average follow up period was 11 months (range 8 to 15 months).

Mean duration of return of shoulder function was 26.09 weeks which ranged from 24 to 29 weeks which was assessed clinically first and later confirmed by electrophysiological testing.

Mean shoulder abduction was recorded 74.3° ranging from 64° to 80° with power M3 and M4

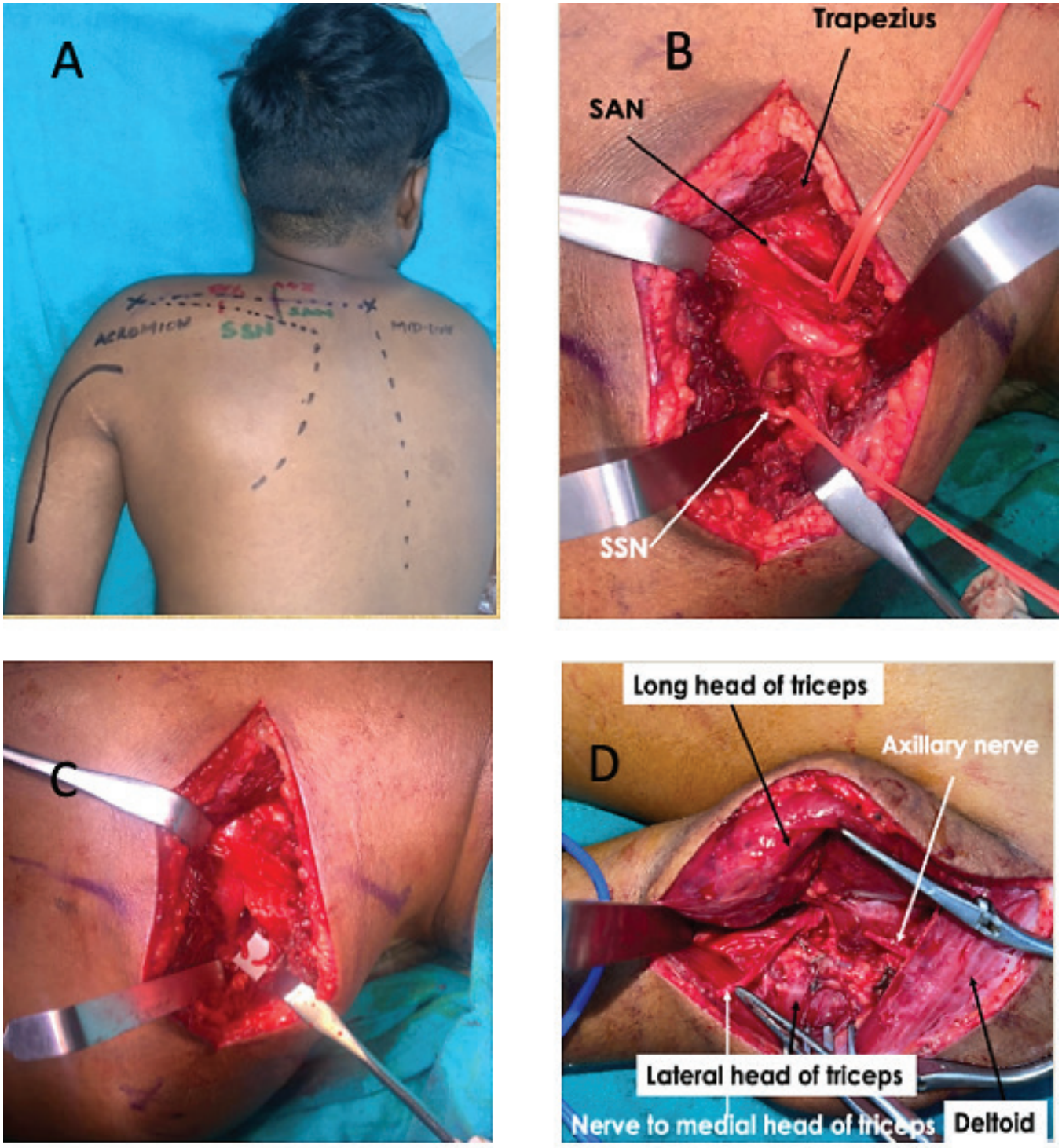

Figure 1: Posterior approach of nerve transfers for shoulder restoration **A)** Incision and landmarks **B)** SAN and SSN identification. **C)** Nerve coaptation between SAN and SSN **D)** showing long, lateral and medial head branches of radial nerve and axillary nerve

MRC grade. External rotation of shoulder achieved in all patients which ranged from 30^0 to 100^o (mean 66.6^o and power M3 and M4). The results of posterior transfer done in a case of upper brachial plexus palsy is shown in Figures 2A to D.

DISCUSSION

The restoration of shoulder function in patients with upper brachial plexus palsy can be challenging. Several nerve transfers have been described to restore

Table 1: Patients Characteristics

S. no.	Age/sex	Time since injury (months)	Follow-up (months)	Return of shoulder function (weeks)	Shoulder abduction ROM (^{0})	External rotation ROM (^{0})
1	24/M	6	12	28	70	60
2	28/M	8	11	26	70	58
3	45/M	7	15	24	80	90
4	31/M	11	8	29	70	50
5	50/M	10	14	28	64	30
6	44/M	7	10	24	80	80
7	36/M	8	14	27	80	100
8	24/M	6	10	24	68	60
9	28/M	5	11	25	80	90
10	60/M	7	10	27	80	55
11	48/M	10	12	25	76	60

ROM – Range of motion

shoulder function. The SAN to SSN and Somsak nerve transfer has been proposed as an effective technique for restoring shoulder function in patients with upper brachial plexus palsy.

Occurrences of distal suprascapular nerve injury has been reported in the literature. Nagano *et al.*[9] reported that double and triple level suprascapular nerve injury is not uncommon and probably results into poor result by nerve transfers by anterior approach. Mikami *et al.*[5] reported the occurrence of distal suprascapular injury in seven of his 22 patients. In cases of distal injury, nerve transfer through anterior approach will not yield satisfactory outcome. Also, in case of extensive injury around clavicle including clavicular fracture, dissection and identification of SSN would be difficult.

In present study, author evaluated the outcomes of the surgery in a group of 11 patients with upper brachial plexus palsy who underwent nerve transfer using the posterior approach. The mean follow-up time was 11 months. The result of present study showed that in terms of shoulder function, mean increase in active range of motion of 74.3 and 66.6 degrees for shoulder abduction and external rotation, respectively.

Bhandari *et al.*[10] reported the outcome of posterior approach of spinal accessory nerve to suprascapular nerve transfer and Somsak transfer in a series of 14 patients. He reported that patients who underwent spinal accessory to suprascapular transfer through posterior approach had early return of shoulder function (28 weeks versus 34 weeks). Mean range of motion of shoulder abduction and external rotation were 125° and 45°. Similar findings were reported by Maurya *et al.*[11] who reported early return of shoulder function by posterior approach, though there was no statistically significant difference in outcome at 18 months follow up when compared to anterior approach.

Advantages of posterior approach includes nerve coaptation is performed closer to the muscle it innervates. So it can provide better results in patient who present with longer duration of denervation(>6 months)[12] as well as in cases of suspected distal injury to SSN (with fractures of clavicle and scapula). Also, distal most branches of SAN is used for transfer which retains function of proximal trapezius.

There are certain limitations with posterior approach. Most of the patients with upper brachial plexus injuries simultaneously require other nerve

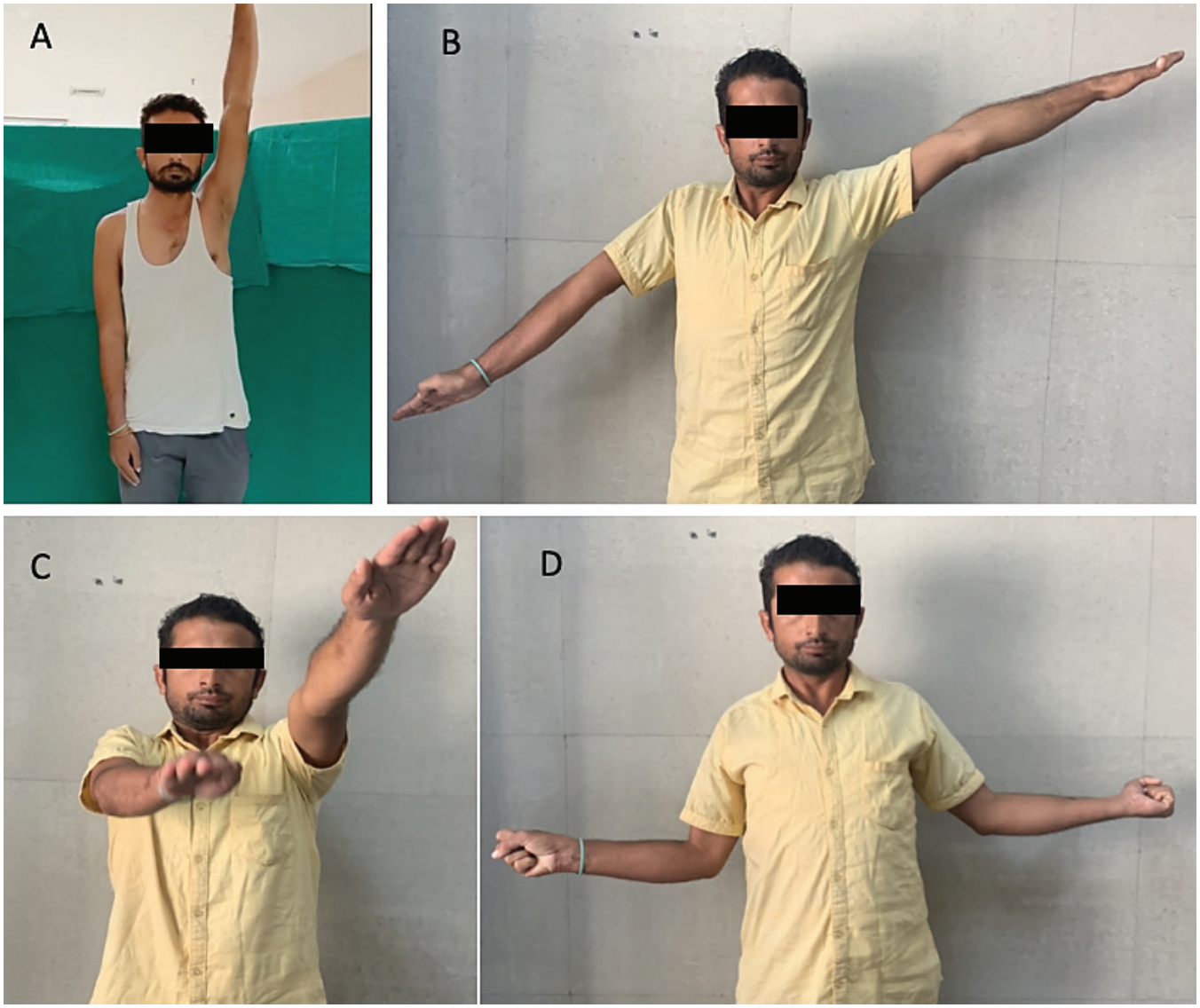

Figure 2: Patient with upper brachial plexus palsy with loss of shoulder abduction **A)** Preoperative **B, C)** Postoperative at eight months showing satisfactory shoulder abduction and flexion. **D)** patient achieved excellent external rotation at eight months follow up

transfers like Oberlin procedure for elbow restoration which is done in supine position with arm abducted. repositioning from prone to supine will cause longer operative time. Also, brachial plexus exploration will not be possible in prone position.

Colbert and McKinnon[1] described the use of nerve of medial head of triceps transfer to axillary nerve. Nerve to medial head of triceps has more length than long head for tension free anastomosis. They also suggested to co-apt with entire axillary nerve, proximal to the branch of teres minor. Including the branch to teres minor would provide better external rotation of shoulder owing to function of teres minor as glenohumeral stabiliser and external rotator of shoulder. Furthermore, Hartrampf *et al.*[13] reported the use of long head of triceps as free flap for different reconstruction. Taking nerve to long head of triceps will preclude its use for other indications. In present study, average external rotation achieved was 66.6 degrees which is better than reported in other studies.[10]

In conclusion, Posterior approach to spinal accessory nerve to suprascapular nerve transfer and nerve to medial head of triceps to axillary nerve transfer is an effective technique which provides early return of shoulder function and restores shoulder abduction and external rotation.

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