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Case Report

Conservative management of traumatic brachial plexus injury: a case report

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ABSTRACT

Brachial plexus injury (BPI) is one of the devastating conditions for patients, which has a negative impact on patients' quality of life. It renders patients with an inability to achieve functional independence. With advancements in surgeries and rehabilitation, improvement in these domains is possible. This case report describes the rehabilitation of a 28-year-old male patient. Being a driver by occupation and the only earning member in the family, upper limb function was essential for functional independence and resume work. After examination, problems were identified, goals were set, and intervention was planned. The patient took 2 months of inpatient rehabilitation six days a week. After completion of treatment, the patient was independent in basic and instrumental activities of daily living. The study concludes that structured, evidence-based physiotherapy treatment is effective in achieving functional independence and reducing disability in patients with traumatic BPI.

Keywords: Traumatic, Disability, Rehabilitation, Physiotherapy, Brachial plexus injury

INTRODUCTION

One of the most devastating injuries from the patient's perspective is a brachial plexus injury (BPI). BPI occurs most commonly in young adults following a road traffic accident.[1] BPI rarely occurs after clavicle fractures; there are very few case reports of this condition occurring due to it.[2] Even while BPIs are prevalent, every patient is different. A typical brachial plexus patient does not exist. Depending on the type and extent of the injury, BPIs vary and are frequently linked to polytrauma.[3]

Most injuries have a significant effect on physical functioning, including long-term paralysis and neuropathic pain. It has life-changing consequences for individuals and their families. People with BPIs report significant challenges while going back to work.[4] These issues are made worse by body image, social anxiety, and financial uncertainty. For several reasons, the prognosis for individuals with BPIs is uncertain.[5]

After trauma, rehabilitation is essential to recovery, and early intervention is typically recommended to reduce the risk of consequences. Patients with BPI now have a better prognosis for their functional motor recovery due to recent microsurgical procedure advancements. When treated within 6 months, the outcomes favor restoring essential shoulder and elbow function. It is a long-lasting treatment as improvements after surgery may take 3-4 years.[1]

Furthermore, although physical therapy treatment after traumatic BPI is recognized as an essential intervention that should be started early and requires a prolonged treatment period. Rehabilitation of patient with traumatic BPI remains a challenging and relatively unexplored field, in contrast with the evident progress of

microsurgical techniques.[2,6] The importance of performance and functional expectations of patients with traumatic BPI reinforces the need for a physical therapeutic approach focused not only on the structural level but also on components of activities and participation in their personal and environmental contexts. Moreover, patients' cooperation is crucial to ensure the best outcome.

Here, we presented a case with a detailed evaluation and structured, evidence-based treatment protocol for achieving functional recovery and independence in ADLs in patients with BPI.

CASE REPORT

A young 28-year-old male, driver by occupation with right-hand dominance, presented with a history of road traffic accidents resulting in a fall on his left shoulder four months back. The patient had pain in the left shoulder joint and was having difficulty in moving the left upper limb (UL). The patient was prescribed pain medication and a shoulder sling. He continued his activities of daily living independently but with difficulty. One and half months back, he fell from stairs and again sustained a fall on his left shoulder; after that, he had a tingling sensation in his left hand; he was unable to perform overhead activities and to hold his wrist in a neutral position. The patient was advised to physiotherapy treatment.

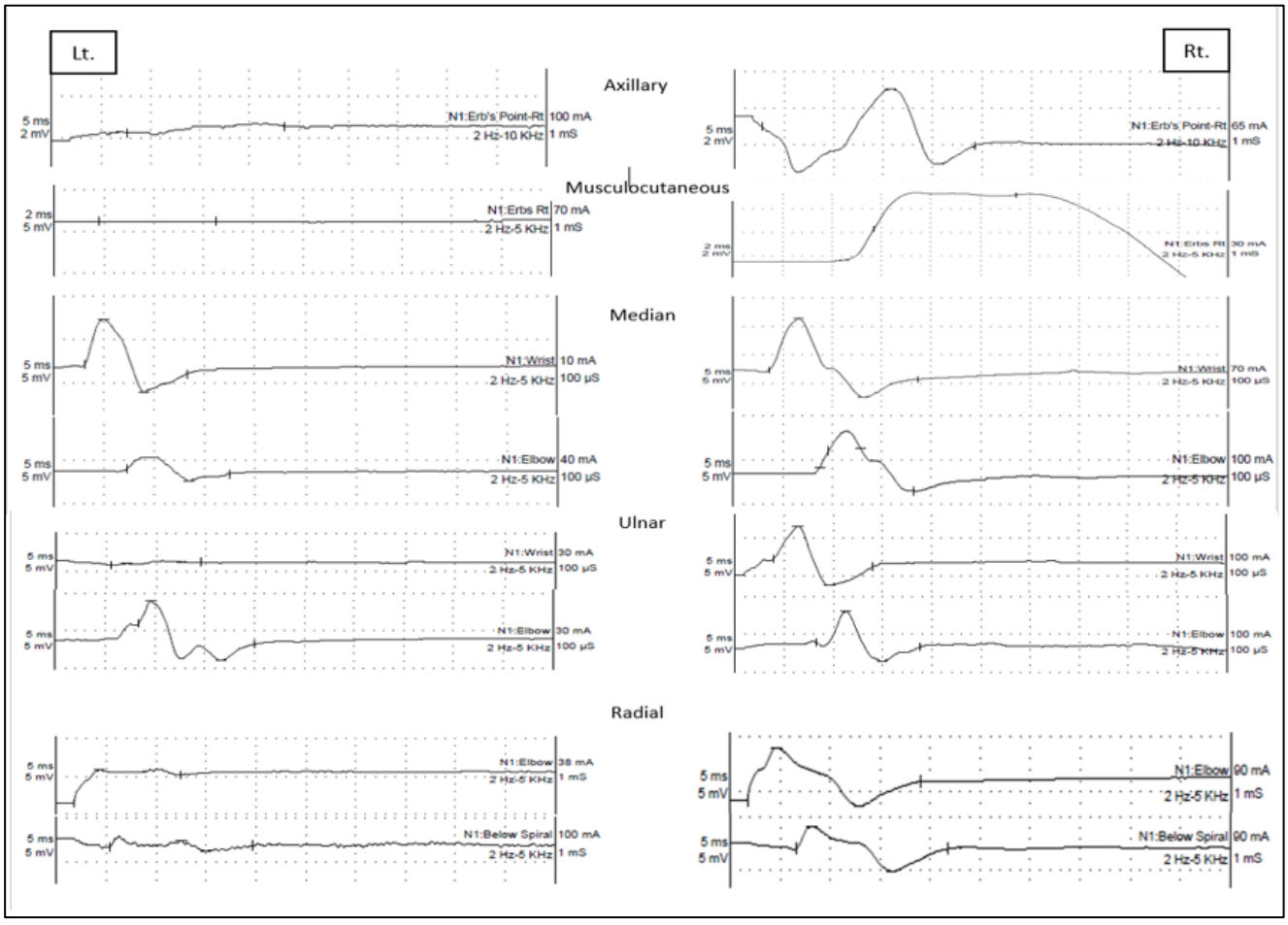

Figure 1: NCS for B/L axillary, musculocutaneous, median ulnar and radial nerve.

Clinical findings

On observation, visible muscle atrophy was present in the deltoid, arm, and forearm muscles, and the left shoulder appeared slightly depressed compared to the right. On examination, all superficial and deep sensations were intact; all muscles had normal tone except left wrist flexors and extensors were flaccid; deep tendon reflex, left biceps ++, triceps +, and supinator was absent. All passive range of motion (ROM) was complete and pain-free; active ROM was restricted in all left UL joints secondary to muscle weakness. Muscle strength was grade 2 for all the scapular muscles except latissimus dorsi, which was 1/5, all shoulder muscles 2-/5, elbow flexors 3/5, elbow extensors 1/5, wrist and finger flexors

3/5, wrist and finger extensors 1/5, lumbricals and interosseous muscles were poor. Functional assessment of hand functions showed an inability to hold objects with the left hand; all power and precision grasps were affected and poor. Strength duration curve (SD) curve of triceps was that of partial denervation with kink, SD curve obtained for ECRL and ECU was that of slight reinnervation, kink present but graph shifted to right side mostly, curve of ED was typical curve for denervation with no response for impulse of shorter duration.

Figure 2: Shoulder abduction at admission (left) and at discharge (right).

Figure 3: Shoulder flexion at time of admission (left) and at discharge (right).

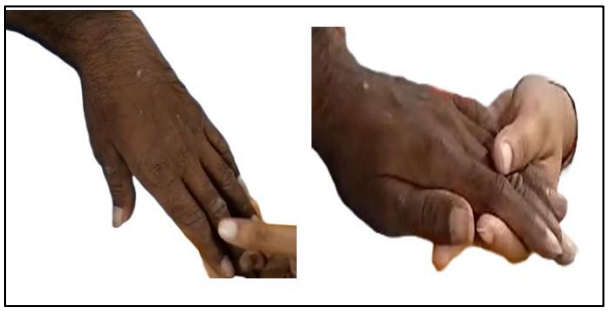

Figure 4: Wrist position at the time of admission, day 1.

Diagnostic assessment

A radiological imaging X-ray scan was done for the left clavicle and shoulder joint on 25 April 2023, which showed a displaced middle third fracture of the left clavicle (Robinson classification type 2 B1). X-ray scan was done for the left clavicle, shoulder, and wrist joint on 7 August 2023; no significant findings were present. Electrodiagnostic studies [electromyography and nerve conduction studies (EMG and NCV) were done on 10 August 2023. It showed reduced amplitude and reduced conduction velocity for left axillary, musculocutaneous, median, ulnar, and radial nerve. radial was the most affected of all. the study suggested motor polyneuropathy proximal>distal point (C5-T1). MRI scan of brachial plexus and cervical spine was done on 15 August 2023; it showed evidence of chronic non-united type 1 fracture of C2 vertebrae; changes of myelomalacia at upper spinal cord (C1-C2); displaced fracture of the mid clavicle with callus formation, edema around C8-T1 nerve roots, lower trunk and posterior as well as medial cord of brachial plexus, suggestive of BPI.

Figure 5: Wrist position at the time of discharge, (day 61).

Therapeutic intervention

Goals

The primary goal was to normalize muscle tone of the shoulder, elbow, and wrist muscles. The next goal was to increase the contraction strength of the left-side scapular and upper limb muscles. The functional goal was to achieve overhead activities, lifting a bucket filled with water, driving a car, holding a glass of water, and reaching the back pocket.

Physiotherapy interventions

Week 1-2

Scapular strengthening exercises were given to improve the strength of the scapular muscles. Proprioceptive neuromuscular facilitation technique (PNF) technique based on the principle of irradiation was used to initiate contraction in the scapular muscles of the left side, and the patient was instructed to perform active movement scapular retraction, shoulder extension, and medial rotation of the right side, respectively, against the manual resistance provided in the opposing direction. The patient was asked to use efforts bilaterally. Dosage: 7 rps with 10 sec holds for each muscle was given for the first 5 days;

for consecutive 10 days, 10 rps with 20 sec holds were given.[7]

Table 1: Timeline of events.

Dates	Events
25-04-2023	RTA
26-04-2023	1st X-ray investigation, (clavicle fracture)
28-04-2023	Conservative management
06-08-2023	Fall from stairs
07-08-2023	2nd X-ray investigation.
10-08-2023	EMG, NCV
15-08-2023	MRI, brachial plexus, and cervical spine were done.
19-08-2023	Reported for physiotherapy treatment

PNF techniques were utilized to improve shoulder muscle strength, with the therapist providing according to patient tolerance. For wrist and finger extensor muscles, facilitation techniques were given with repeated stretches. Electrical muscle stimulation was also given for wrist extensor and triceps muscles. Inter-galvanic current with a pulse width of 300 ms and 100 ms, respectively, and strength according to patients' tolerance, 3 sets of 45 contractions were given for the first week. After the attainment of grade 1 for wrist extensors and triceps, the progression from grade 1 to 2 was done with the help of faradic stimulation pulse width of 100 ms and 30 ms, and strength according to tolerance of patients, 3 sets of 45 contractions were given.[8] For normalizing muscle tone, joint approximation for the wrist was given at 2 hours daily. Tapping was done using a light force applied manually 3-5 times over a tendon or muscle belly of wrist extensors.[9]

Week 3-5

Goal

The primary goal was to increase the muscle strength of the left-side scapular muscles and upper limb muscles. The next goal was to increase the strength of the hand muscles. The functional goal was to perform the movement with moderate difficulty in combing hair, lifting a bucket, reaching back pocket, and lifting a glass of water.

Physiotherapy interventions

The principle of irradiation was used to improve scapular muscle strength; the patient remained sitting, the therapist stood at the back of the patient, and the patient was instructed to perform active movement. The therapist opposed the movement at mid-range on the left side.[9] Strengthening exercises were utilized to improve muscle strength of shoulder muscles. The therapist provided manual resistance at different ranges as the patient could perform movement and assisted minimally when the patient's efforts were insufficient. To increase the strength of wrist and finger extensor muscles and hand intrinsic muscles.

The therapist provides resistance with a yellow theraband and manual resistance to finger extensors, lumbricals, and interossei. Dosage reps with 10-sec hold for each muscle were given for the first 5 days; for consecutive 10 days, 10 reps with 20-sec holds were given.

During muscle re-education from grades 2-3, sliding first progressed with the help of a soft towel and then to skate roller on a table, and it was given as part of a home exercise program. During muscle re-education from grade 2-3 sliding first was progressed with the help of soft towel and then to skate roller both on a table and it was given as part of home exercise program.

Week 6-8

Goal

The primary goal was to increase the muscle strength of the left side scapular and upper limb muscles; the next goal was to increase the strength of the hand muscles to normal. The functional goal was to perform the movement with minimum to moderate difficulty in combing hair, lifting a bucket, reaching back pocket, and lifting a glass of water.

Physiotherapy interventions

Cross-therapy was used to improve the strength of the scapular muscles; the therapist applied moderate pressure to the arm in the opposite direction, and the patient was asked to hold the contraction. The principle of irradiation was used for strengthening contraction in the left side's scapular muscles only for progression, where movements were then performed at mid-range to terminal range.[7,10]

To improve the strength of shoulder, wrist, and finger extensor muscles. Strengthening exercises were utilized with therabands at different ranges. Wand exercises were also prescribed. Strengthening exercises for intrinsic muscles were used with therabands in progression and putty for lumbricals and interossei, and the patient then attempted movement.

Dosage

7 rps with 15 sec holds for each muscle was given for the first 5 days; for consecutive 10 days, 10 rps with 20 sec holds were given.

Wand exercises were also added for shoulder abduction, flexion, external rotation, and elbow flexion, incorporating the use of both affected and unaffected arm and hand for 10 reps with 10-sec hold and progressing it to 15 sec holds for 10 reps.[11]

Table 2: Limb girth value in upper limb before and after treatment.

Segments		Pre-treatment			Post-treatment	
		Right side (cm)	Left side (cm)	Difference (cm)	Left side (cm)	Difference (cm)
Arm	Proximal 1/3rd	34	28	6	32	2
	Middle 1/3rd	30	25	5	29	1
Forearm	Proximal 1/3rd	28	23	5	27	1
	Middle 1/3rd	24	21	3	24	0

Table 3. Muscle strength of Upper Limb Muscles before, midway, and after treatment.

Muscle groups		Pre	Midway	Post
Scapular	Supraspinatus	1/5	2+/5	4+/5
	Infraspinatus	1/5	2+/5	4+/5
	Teres major	0/5	1/5	3/5
	Teres minor	1/5	2+/5	3+/5
	Deltoid	2/5	3+/5	4+/5
	Serratus anterior	2/5	3+/5	4+/5
Shoulder	Flexor	2-/5	3+/5	4+/5
	Extensors	2-/5	3+/5	4+/5
	Abductors	2-/5	3+/5	4+/5
	Adductors	2-/5	3+/5	4+/5
Elbow	Flexor	3/5	4+/5	5/5
	Extensor	1/5	3/5	4/5
Wrist	Flexor	3/5	4+/5	5/5
	Extensor	0/5	2+/5	4-/5
Hand	Lumbricals	Poor	Fair	Good
	Palmar interosseous	Poor	Fair	Good
	Dorsal interosseous	Poor	Fair	Good

Table 4: Outcome measures follow-up at baseline, midway, and at termination of treatment.

Outcome measures		Initial evaluation	Progression (midway)	Termination
BPOM (brachial plexus outcome measure)[12]		14/55	25/55	45/55
DASH (disabilities of the arm, shoulder, and hand questionnaire)[13]	Total score	95.6 %	48.4 %	15.8 %
	Work module	66 %	34.4 %	12.5 %
ARAT (action research arm test)[14]	Grasp	12/18	12/18	18/18
	Grip	6/12	6/12	10/12
	Pinch	8/18	8/18	15/18
	Grossmt	8/12	8/12	11/12
PSFS (patient specific functional scale)[15]		1.6/10	2.4/10	7/10

DISCUSSION

There needs to be more evidence on the effectiveness of physiotherapy management on BPI. The present case study was projected toward rehabilitating a patient with brachial plexus injury by conservative management.

Mechanism and type of injury

Several factors guide treatment options for injured brachial plexus. Determinants of treatment and prognosis are the time from injury, the mechanism of injury, the type of injury (pre vs. postganglionic), and the concomitant injuries of soft tissue, bone, or vasculature.[16] In the present study, there are some positive factors as well as some negative factors. One of the vital is the time from injury, as the patient has been advised in the late stage; the patient reported four and half months after the injury for physiotherapy rehabilitation. It was well documented in the literature that the longer the target muscle was denervated, the lower the likelihood of successful reinnervation. If there is no evidence of

recovery until six months after injury, a reconstructive plan must be formulated.[3,16]

In traction injury, the injury is usually diffused from nerve roots through terminal branches, and the brachial plexus can be disrupted at more than one site.[16] The patient had multiple concomitant injuries along with the BPI. The middle third fracture of the left clavicle, fracture of C2 vertebrae, and changes of myelomalacia at the upper spinal cord (C1-C2) were also present, which is usually associated with poor prognosis.[17] An interesting finding was that no sensory involvement was present in the patient, and it was pure motor palsy despite being the postganglionic type of injury. Studies have shown that the high rate of impairment leading to disability following an injury impacts patients' quality of life.[18]

Electrodiagnostic tests

A Faradic Galvanic test was done; there was no response to faradic current and sluggish response to galvanic current for wrist extensors. There was reduced contraction strength compared to the unaffected side to faradic current and a slightly sluggish response to galvanic current for the triceps muscle. This indicated that triceps was partially innervated and wrist extensors were denervated.

The strength duration curve was plotted for the triceps, extensor carpi radialis longus, extensor carpi ulnaris, and extensor digitorum (ECRL, ECU). The curve obtained for triceps was that of partial denervation with kink; the curve obtained for ECRL and ECU was that of slight reinnervation, with kink present, but the graph restricted to the right side mostly; the curve obtained for ED was the typical curve for denervation with no response for the impulse of shorter duration. Chronaxie and rheobase were calculated, and based on that, the pulse width for NMES was decided. SD curves were plotted at regular intervals, and based on these results, the pulse duration was reduced to a shorter duration.

Nerve conduction studies showed reduced conduction velocity with reduced amplitude for the left axillary, musculocutaneous, radial, median, and ulnar nerves than the right. Latency was near average for all the nerves.

EMG studies revealed severely reduced MUP amplitude and duration for the left triceps, ECRL and ECRU, ED, abductor digiti minimi, and abductor pollicis. There were no signs of any abnormal spontaneous activities.

Intervention

Electrical stimulation

Electrical stimulation was given to prevent muscular atrophy until the nerve re-innervates the muscle, used to retain the qualities of muscle, including elasticity, extensibility, irritability, and contractility.[9] Another potential outcome is that it facilitates and promotes the growth of nerve regeneration itself.[19]

Muscle re-education

Facilitation techniques aimed to boost neural activity and initiate a motor response. Techniques used to progress from grade 0 to 1. Quick stretch, with the brief instruction and addition of quick stretch prior to the movement, it can be powerfully volitional and reach its maximum strength. The stretch results in a relatively brief contraction of the agonist muscle and a brief inhibition of the antagonist muscle. It has an impact by stimulating the primary endings of muscle spindles, which results in monosynaptic reflex facilitation of the muscle. Tapping, a tendon or muscle belly is tapped light to encourage a voluntary contraction. It was done over the belly of the muscles. Rood suggested facilitating the muscle belly with three to five taps. Margeret Rood proposed this idea to make motor neurons supplying inhibited muscle more excitable, facilitating movement responses.[20] Cross-over Therapy was done simultaneously for this subject, wherein there is an emphasis on the contraction of the muscle of the contralateral unaffected side to facilitate relearning on the affected side. Based on Sherrington's theory, studies have demonstrated that it functions via irradiation.[10]

PNF

PNF was given from the early phase (isometric techniques) to the final stage of rehabilitation (diagonal movement with high resistance) to improve the movement's strength and control. This approach is based on neurophysiological principles of motor learning and control, emphasizing functional movement.[7]

Progressive resisted exercise

Resistance during training was increased by using different thera-bands and putty and increasing leverage of resistance and speed. For concentric work, an increase or reduction in movement speed is a progression, whereas a drop in speed is a progression for eccentric labor and eccentric output. The contraction period is lengthened as a progression for holding static.[9]

Functional training

Later on in the rehabilitation process, the patient was encouraged to engage in activities that involved using both extremities for self-care, employment, and leisure; as a result, functional motions were introduced, such as bilateral arm lifting with a medicine ball for shoulder flexion, diagonal patterns, chopping (PNF) patterns and horizontal movements. Additionally, wand exercises for elbow flexion, external rotation, shoulder flexion, and abduction were added. Bimanual tasks incorporate both the affected and unaffected arms and provide the

opportunity for input from the contralateral cortical region and to input standard movement patterns.[19]

Outcomes

The patient significantly improved objective (MMT, muscle girth, ROM, ARAT) and functional (BPOM, ARAT, PSFS) outcomes. There was also improvement in Activity limitation and participation restriction, and the patient was completely functionally independent by the end of physiotherapy rehabilitation (DASH). Previously, studies have shown that full recovery can be achieved in 8 months. This study achieved full functional recovery within 2 months of physiotherapy treatment. However, as the patient reported for treatment four months after the injury, the duration since the injury becomes 6 months.

Due to a lack of awareness and education about the condition, it was observed that this patient could not get the appropriate rehabilitation in the acute stage of injury. The multidisciplinary approach adaptation in the rural setup should be utilized effectively with the role of all the medical professionals at the proper time.

CONCLUSION

The study concludes that structured, evidence-based physiotherapy treatment has been found effective in achieving functional independence and reducing disability in patients with traumatic BPI. Professionals must perform regular clinical evaluations, including regular FG and SD curve testing and updating protocol at regular intervals.

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