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Case Report

Physical Medicine and Rehabilitation Section

Physiotherapy Perspective in the Rehabilitation of Traumatic Brachial Plexus Injury in a Patient with Polytrauma: A Case Report Emphasising an Early Approach

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ABSTRACT

Traumatic peripheral nerve damage from Road Traffic Accidents (RTA) can cause severe impairment and loss of function in the upper and lower limbs. A significant portion of acute peripheral nerve injuries affects the upper limb, particularly the brachial plexus. The treatment for complete brachial plexus injury may involve surgery and intensive physiotherapy to help the nerves regenerate and reinnervate the muscles. A 17-year-old male was referred to the Neurology department from a primary healthcare centre after being involved in RTA that resulted in a fall on the right-side. Investigatory findings revealed a head injury with Subarachnoid Haemorrhage (SAH), fractures of the right tibia shaft, right clavicle lateral shaft, and right lower limb. Following surgery, the patient experienced difficulty in performing movements with the right upper limb, along with pain and tingling sensations. As a result, the patient was referred to physiotherapy. During physiotherapy, the patient received sensory re-education sessions lasting 15-20 minutes each, as well as bilateral training sessions lasting 20 minutes each, for a total of four weeks. Over the course of the treatment, the patient demonstrated overall improvement in hand function, including proper grasp and opposition. This improvement was reflected in the brachial assessment tool, Upper Extremity (UE) functional index, and functional independence measure. These positive outcomes underscore the importance of early neuro-physiotherapeutic rehabilitation for patients with brachial plexus injuries, as it can significantly enhance their overall well-being and quality of life.

Keywords: Bilateral training, Early physiotherapy, Functional electrical stimulation, Muscle re-education, Sensory re-education

CASE REPORT

A 17-year-old male student was referred to the Neurology department from a primary healthcare centre with a chief complaint of difficulty moving his right upper limb and walking independently. He had a RTA and fell on his right-side 14 days ago, losing consciousness for 20 minutes. He sustained multiple abrasions on both hands and legs but had no history of vomiting, seizures, or bleeding from the ear, nose, or throat. Magnetic Resonance Imaging (MRI) of the brain revealed a SAH. Additionally, an X-ray showed a displaced fracture of the right clavicle and right tibia shaft. The right tibia shaft fracture was treated with an interlocking nail, and the limb was immobilised for seven days. For the right clavicle, Open Reduction and Internal Fixation (ORIF) with K-wire fixation was performed. Physiotherapy was initiated on the 8th day, starting with basic bed mobility training. After 14 days, Partial Weight Bearing (PWB) was introduced. Conservative management was continued for the SAH. Gait training commenced on the 15th day and continued for two months, with modified weight bearing using crutches. Passive range of motion exercises were performed for the upper limbs from the 8th day until one month, within a pain-free range.

Following one month of surgery, minimal recovery was observed in the upper limb function. The patient reported difficulty in performing movements of the right upper limb, along with pain and a tingling sensation. The patient was referred to the neurologist, and the investigations revealed non recordable Compound Muscle Action Potential (CMAP) amplitude on the right median, ulnar, radial, axillary, and musculocutaneous nerves. Sensory Nerve Action Potential (SNAP) amplitude was also absent in the right median, ulnar, and radial nerves. F-wave was not recordable on the right median and ulnar nerves. There was no sensory or motor function in the right upper limb. Nerve Conduction Velocity (NCV) revealed right pan-brachial plexopathy, for which nerve grafting was performed. The patient was then referred to physiotherapy after one month. However, due to financial constraints, he reported to physiotherapy two months postsurgery.

Physiotherapy Functional Assessment

The patient was ectomorphic, well-oriented, and cooperative during the evaluation. At the initial assessment, the patient showed inability to move the shoulder, elbow, and wrist on the right-side. All sensations were affected in the right upper limb. Normal movements were observed in the left upper limb, including elbow and wrist flexors and extensors, with a Medical Research Council scale (MRC scale) score of 4/5. However, there was no contraction observed on the right-side, resulting in an MRC scale score of 0/5 [1]. The nerve injury was diagnosed using the Seddon classification as "axonotmesis" with conduction block [2].

Physiotherapy Intervention

When the patient reported for physiotherapy two months after surgery, a physiotherapy programme was planned for the affected upper and lower limbs.

For Lower Limb

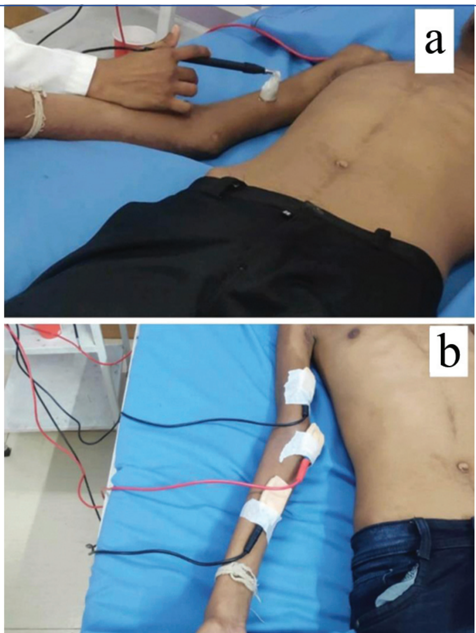
To maintain joint mobility and integrity, the patient was taught range of motion exercises and encouraged to change positions regularly. Exercises were included to improve range of motion, strength, endurance, and coordination of the affected limb and joints. These exercises followed a progressive approach, gradually increasing in intensity and difficulty based on the patient's tolerance and healing status. Initially, 10 repetitions for each exercise were performed twice a day for a duration of one month, progressing to 15 repetitions.

Strength training was conducted according to American College of Sports Medicine (ACSM) guidelines, as part of a 1-hour protocol, 2-3 times a week for four weeks [3].

Manual therapy techniques were applied to mobilise the joints and soft tissues. These techniques included knee joint mobilisations, soft tissue massage, and myofascial release [4]. Proprioception training was provided to enhance joint awareness and stability. This training involved balance exercises, wobble board training, or functional activities [5]. Gait training was implemented to improve walking ability and confidence. This included PWB progressing to Full Weight-Bearing (FWB) from the 20th day of hospitalisation to one month, with the assistance of crutches, for 15 minutes per day [6]. Functional training, such as stair climbing, squatting, and lifting, was incorporated to facilitate activities of daily living and aid in the patient's return to work or sports [7].

For Upper Limb

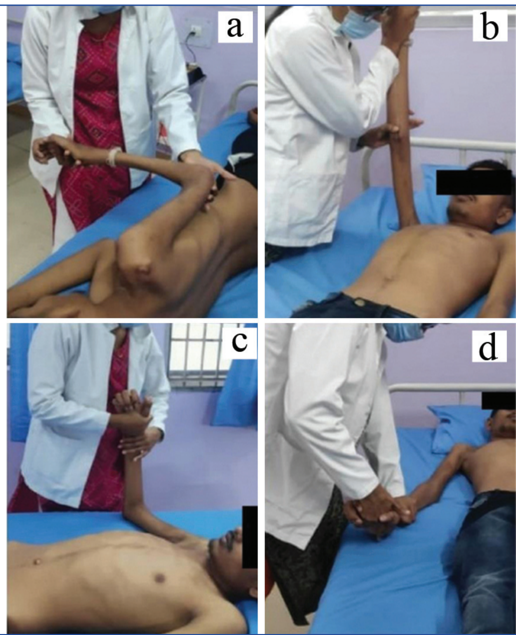
Muscle re-education: Initially, long-duration galvanic currents (30 mS for the biceps [Table/Fig-1a] and 100 mS for the deltoid and supra/infraspinatus) were applied for a duration of 10 minutes daily for 19 days, until a flicker of contraction was observed in the muscle. Based on the results of the SD curve plotted at regular intervals, the duration of Neuromuscular Electrical Stimulation (NMES) [Table/Fig-1b] was further reduced from 15 minutes to 10 minutes. Galvanic currents were discontinued, and faradic currents were introduced once the patient achieved an acceptable contraction within one millisecond. This process continued until the muscle grade reached grade-2.



[Table/Fig-1]: a) Galvanic stimulation on biceps; b) Neuromuscular electrical stimulation.

To prevent its impact on axonal sprouting, a large indifferent electrode was placed at the nape of the neck, a pen electrode was positioned at the motor point for galvanic currents, and a slight distance was maintained from the motor point for faradic currents [Table/Fig-1].

Weak muscles were engaged in appropriate work capacity through assisted-resisted [Table/Fig-2] free or resisted exercises. Objective, recreational, or occupational activities were incorporated to ensure functional use and promote the muscle's return to normal function. Training was conducted for a duration of 10 minutes per day with variable resistance, as tolerated by the patient, for four weeks. Task-oriented training was included to enhance attention, performed twice a day for 10 minutes, over a period of four weeks. According to mechanical principles [8], the rolling frictional force was found to be less than the sliding frictional force. Therefore, the patient was advised to alternate between suspension therapy and roller skating at home. Graduation levels were adjusted in response to progress, raising from grades 1-2 and 2-3, and later weight cuffs were applied to the wrist to facilitate advancement, with 10 repetitions per set for two weeks.

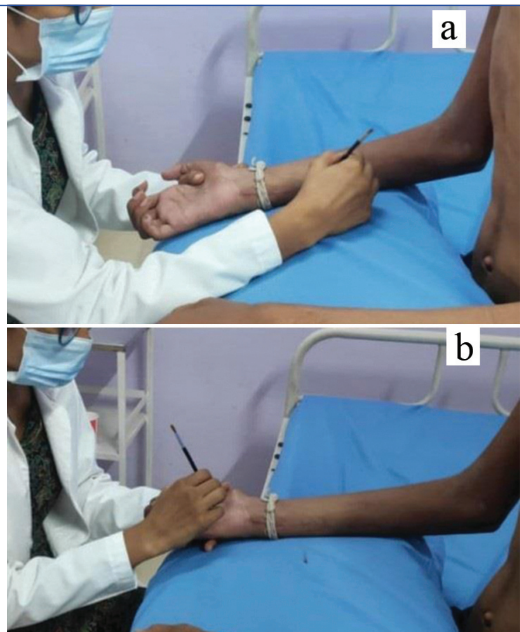


[Table/Fig-2]: Active assisted exercises. a) For shoulder external and internal rotators; b) For shoulder flexors; c) For wrist flexors; d) For wrist extensors.

Sensory Re-education

Sensory re-education was provided to enhance neural activity and initiate a motor response. Sessions lasted for 15-20 minutes and were conducted for three weeks. The following methods were employed to promote mobility from grade-0 to grade-1, which continued until grade-2 was achieved.

A manual brush [Table/Fig-3] or a battery-operated brush, part of Rood's facilitatory approach, was used to apply pressure to the skin. The myotome and dermatome had to match for this procedure, and the skin overlaying the muscle had to share the same root supply. The brush was applied three to five times, followed by a 30-second pause, and then repeated. A brushing duration of up to three seconds was recommended at a time.



[Table/Fig-3]: Sensory re-education via manual brush. a) Over flexor aspect of forearm; b) Over palm.

To encourage a voluntary contraction, a light push (tapping) was manually exerted across a tendon or muscle belly for a duration of five minutes. This tapping was performed on the belly of the muscles and tendons. Rood advised three to five taps over the muscle belly.

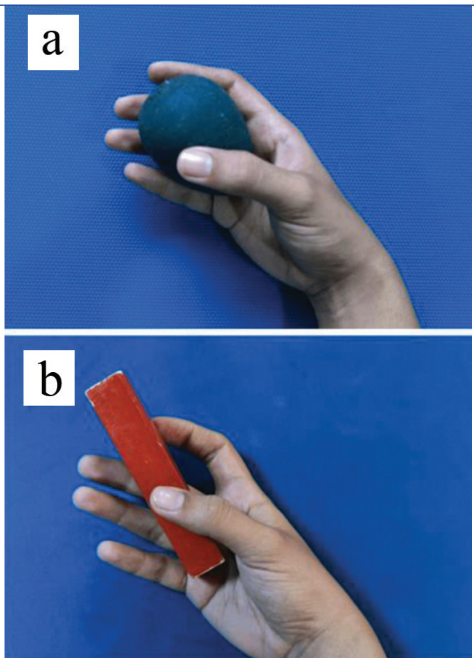
Bilateral Training

Later in the recovery process, the patient was encouraged to participate in self-care, occupational, and recreational activities that required the use of both extremities. This involved introducing functional movements such as horizontal movements, diagonal patterns, chopping Proprioceptive Neuromuscular Facilitation (PNF) patterns, and bilateral arm lifts with a medicine ball for shoulder flexion [9].

Furthermore, wand exercises for shoulder flexion, external rotation, and elbow flexion were incorporated. Bimanual tasks involved both the injured and uninjured arms, enabling the patient to practice normal movement patterns and receive input from the contralateral cerebral region. The regimen consisted of five days a week for six weeks, with 20 minutes of upper-limb activities for the involved side and 20 minutes of strength training for the less affected side [10].

Follow-up and Outcome Measures

After one month, there was an improvement in overall hand function, including proper grasp and opposition [Table/Fig-4]. The right upper limb achieved a Medical Research Council scale (MRC scale) score of 3+/5 following rehabilitation. Additional outcome measures are provided in [Table/Fig-5]. Pre- and post-treatment myotome and dermatome testing results are shown in [Table/Fig-6].



[Table/Fig-4]: Improvement in overall hand function. a) Spherical grasp; b) Opposition via thumb.

Outcome measure	Prerehabilitation	Postrehabilitation
Brachial assessment tool	6	50
Upper Extremity (UE) functional index	12	46
Functional independence measure	Level 1	Level 5

[Table/Fig-5]: Improvement in outcome measures.

Prerehabilitation		Postrehabilitation	
Myotomes	Dermatomes	Myotomes	Dermatomes
Shoulder elevation 0/5	C4 10%	Shoulder elevation 2/5	C4 40%
Shoulder flexion 0/5	C5 10%	Shoulder flexion 3/5	C5 60%
Shoulder abduction 0/5	C6 10%	Shoulder abduction 3/5	C6 60%
Shoulder internal rotation 0/5	C7 10%	Shoulder internal rotation 3/5	C7 40%
Shoulder external rotation 0/5	C8 10%	Shoulder external rotation 3/5	C8 40%
Elbow flexion 0/5	T1 10%	Elbow flexion 3/5	T1 40%
Elbow supination 0/5		Elbow supination 3/5	
Elbow pronation 0/5		Elbow pronation 2/5	

[Table/Fig-6]: Neurological improvement in patient.

DISCUSSION

Neurophysiotherapy for complete brachial plexus injury aims to prevent joint stiffness, muscle atrophy, and contractures, restore range of motion, sensation, and motor function, and enhance quality of life and independence [11]. Traumatic brachial plexus injuries often occur as a result of road traffic crashes, which can be part of a complex polytrauma presentation [12]. Glenohumeral joint fractures and dislocations are common injuries in these cases, and surgical repair may be necessary [13]. Complex injuries require long-term and intensive therapy efforts. Patients often face challenges in performing daily tasks and returning to work, particularly if their job involves manual labour [14].

This case focuses on the management of a young patient who experienced multiple traumas in RTA and had suffered a traumatic brachial plexus injury. Recovering from a brachial plexus injury alone is typically considered challenging. However, this particular case was even more complex due to the presence of other polytrauma injuries.

The most common physical therapy interventions used in this case included range-of-motion exercises, muscular stretching and strengthening, electrothermal and phototherapy, manual therapy, and sensory re-education approaches [15]. Margaret Rood first proposed brushing as a therapeutic preparatory facilitatory treatment to enhance the excitability of motor neurons supplying inhibited muscles, thereby facilitating movement responses [16].

The patient also incorporated regular use of neuromuscular electrical stimulation as a complement to their therapy for strengthening the upper limb. The goal of electrical stimulation was to maintain muscle flexibility, extensibility, irritability, and contractility while delaying muscle atrophy until the muscle's nerves were reinnervated. Electrical stimulation resulted in synchronised firing relative to voluntary contraction, ungraded force of contraction, recruitment of type II fibres before type I fibres, leading to increased fatigue, and recruitment of larger motor units over smaller motor units. Electrical stimulation was discontinued once the muscle reached Grade-2 [17,18].

Slow-rising galvanic currents are preferable over fast-rising galvanic currents in order to minimise unintentional contraction of neighbouring innervated muscles [19]. Additionally, upper-limb exercises and hydrotherapy were important for the patient's recovery. The six months covered in this case study serve as a clear example of the significance of ongoing physical and emotional support during a challenging rehabilitation process. The patient showed significant improvement after rehabilitation, which is also supported by a systematic review [20].

This case study provides positive evidence for the application of NMES in a complex polytrauma patient with brachial plexus injury. It demonstrates a successful rehabilitation approach for managing orthopaedic and neurological disorders [21]. No negative effects were observed, and muscle activation appeared to be highly beneficial. These observations indicate the need for further investigation into the application of NMES in individuals with brachial plexus injury and polytrauma [22].

In a similar case report, patients experienced increasing difficulty in performing daily tasks as Upper Extremity (UE) function decreased. After six weeks of treatment using Proprioceptive Neuromuscular

Facilitation (PNF) and Functional Electrical Stimulation (FES), there was a significant improvement in UE function. Therefore, the combination of PNF and FES can be considered a therapeutically useful strategy for enhancing functional mobility after traumatic brachial plexus injury [23]. Another study demonstrated successful rehabilitation of brachial plexus injuries through a combined therapy of electrical stimulation and PNF, compared to individual therapies alone [24]. An organised rehabilitation protocol, patient motivation, and effective communication among surgeons, physiatrists, and physiotherapists are essential for clinical evaluation, functional grading tests, SD curve execution, adjustment of NMES settings, and modification of exercises based on changes in muscle strength. Following these recommendations can lead to improved patient recovery outcomes [19].

CONCLUSION(S)

Traumatic brachial plexus injury patients who receive early neuro-rehabilitation show improvement in overall well-being and quality of life. Early rehabilitation also helps prevent complications that can arise from immobilisation. Rehabilitation includes patient education, providing feedback about potential secondary complications, maintaining joint range of motion, and regaining strength in the affected muscles. These essential outcomes can be achieved through available neurophysiotherapeutic approaches and recent advances such as FES.

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