A comprehensive road map for early rehabilitation techniques in diffuse axonal injury is provided in Navigating Neural Recovery

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A comprehensive road map for early rehabilitation techniques in diffuse axonal injury is provided in Navigating Neural Recovery.

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Abstract

A condition known as diffuse axonal injury (DAI) causes little axonal damage. The most frequent type of fast event that causes shear stresses in the white matter of the brain is acceleration/deceleration. Axons in the brain sustain severe damage at the intersection of grey and white matter. The most frequent cause of diffuse axonal injury is high-speed auto accidents. The most common technique is an accelerating and decelerating motion that applies shearing pressures to the white matter pathways in the brain. The brainstem and corpus callosum white matter pathways are commonly impacted by diffuse axonal injury. Building organizational capacity, adopting evidence-based best practices, and enhancing the effectiveness of physical therapy all depend on clinical management. A 26-year-old man who had fallen from his bike and suffered head injuries was sent to the hospital right away. Brain CT imaging revealed the possibility of extensive axonal damage. Consistency of care is essential since physical therapy is utilized to promote functional independence. Passive stretching, task-based methods, and sensory integration are a few examples of integrative physiotherapy treatment methods that have been given. Patients' progress was evaluated using the Glasgow Coma Scale (GCS), Rancho Los Amigos Scale (RLAS), Modified Ashworth Scale (MAS), and Functional Independence Measure (FIM). As a result, we draw the conclusion that patients can optimize their functional independence and enhance their quality of life by engaging in regular exercise.

Key words: Cognitive function, functional independence measure, diffuse axonal damage, traumatic brain injury

Introduction

Traumatic brain injury (TBI) caused by brain impact includes diffuse axonal damage (DAI). The leading cause of death and disability among children and adolescents in the US is brain injuries. High-energy head trauma causes accelerative-decelerative pressures that result in shearing forces acting at various densities and compliances inside the brain. These forces cause DAI (1). One of the most common and harmful types of TBI is diffuse axonal injury , which is also a major factor in the maintenance of autonomic dysfunction. The patient's health and degree of awareness change after a serious brain injury. Diffuse

axonal injury is a significant form of brain damage that can arise from non-missile head injuries. It can be challenging to detect this condition after death unless the pathologist is highly skilled in identifying symptoms (2). Primary axonal injury might be considered the same as internal axonal disturbances since its origins, whether traumatic or nontraumatic, entail a disruption inside the axon. Whether traumatic or nontraumatic, secondary axonal injury can be seen as an external, as opposed to an internal, effect on the axon (3). External forces, including acceleration and deceleration forces, have an immediate impact as opposed to later changes like hypoxia, neurological damage, or elevated intracranial pressure. DAI primarily damages the white matter of the brain. Patients with DAI may present with a variety of neurological issues. After a minor head injury, some individuals with normal head CT results show indications of diffuse axonal damage on MR. The pathologic basis for the post-concussion syndrome, which affects a large number of individuals with moderate to severe head injuries, may be represented by these abnormalities (4).

However, most DAI patients are categorized as severe, with a GCS of 8. Diffuse axonal damage is most frequently caused by a high-speed motor accident. A grade of 1 was assigned to the cerebral cortex, corpus callosum, and brainstem due to slight diffuse axonal injury and little white matter alterations. Mild diffuse axonal damage was given a grade of 2, with the corpus luteum receiving considerable focal involvement. Brainstem lesions were assessed as 3, whereas significant diffuse axonal lesions were scored as 2. Lesions of grades 2 and 3 are additionally rare (5). Rostral brainstem lesions are more frequent in the dorsolateral quadrant, whereas corpus luteum lesions are more frequent in the lower half and on one side of the midline. enlarged axonal. The adjacent neurons become dysfunctional and cortical and subcortical regions become dissociated as a result of cerebral microbleeds. CT or traditional MRI cannot provide a clear enough image of these minute alterations (1). On microscopic examination, swollen axonal varices and axonal bulbs should be categorized as diffuse axonal lesions. Numerous methods, such as routine postmortem neuropathology and advanced imaging that can now identify the signatures of traumatically induced axonal injury in a range of traumatically brain-injured individuals, have confirmed the significance of this widespread axonal damage (6).

We discuss the case of a 26-year-old male survivor of diffuse axonal damage who required extensive physical therapy to avoid or address postoperative problems and speed recovery through rehabilitation and support. Consciousness recovery, normalization of muscle tone, early commencement of physical exercise, adequate muscular strength, and quality of life are all key symptoms. Physical therapists have utilized a range of ways to assist patients in recovering from traumatic brain injury, with an emphasis on rehabilitation ideas supported by independent physical therapists (7). The primary aims of therapy are frequently the restoration of cognitive and sensorimotor vision as well as the prevention of sequelae. Injuries such as pneumonia or muscular spasms and stiffness are examples of injuries. The ultimate objective is to gain maximal mobility and self-confidence (8). Physical therapy rehabilitation needs to be thorough, ongoing, and methodically organized, with specific goals for each survivor. Positive results have been shown with early mobilization, sensory stimulation, chest physiotherapy, contracture avoidance, and simple functional exercises.

CASE PRESENTATION

Patient information

On 17th March 2023, a 26-year-old male meet with a road traffic accident due to fall from bike at 12:30am. There was a history of loss of consciousness, oral bleed and bleeding from right ear. The patient was taken to a government hospital in Chandrapur from there he was referred to Nagpur Coal hospital, where he was admitted for two days and in the hospital, he underwent a Computed Tomography (CT) scan, which revealed that he had diffuse axonal injury with IC bleed (Figure 1) and also X-ray that diagnosed with bi-cortical fracture of proximal shaft of right clavicle with associated soft tissue swelling.

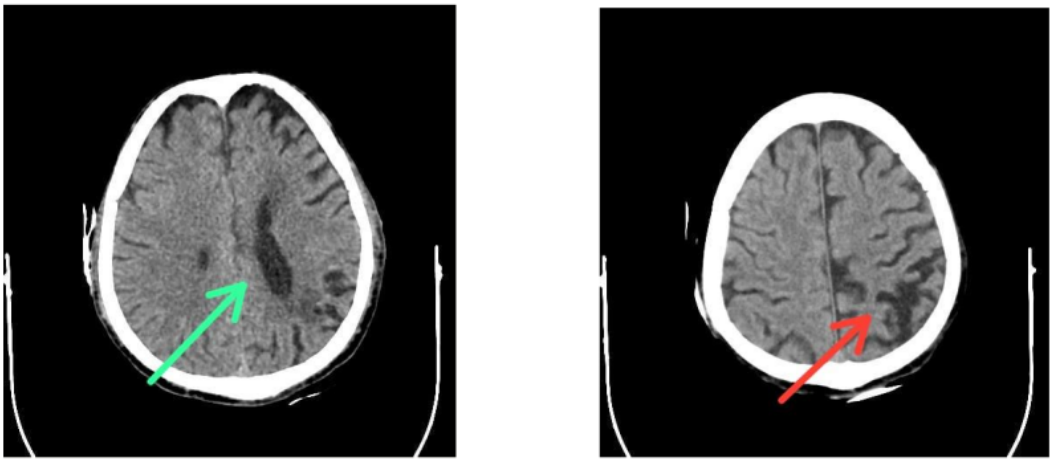
Due to economic problems and the need for improved care, the patient came to our tertiary health care. The patient was intubated (tracheostomized), admitted to the ICU, and referred for further care to neuro-physiotherapy.

Clinical findings

A clinical evaluation was undertaken once the patient had been vitally stabilized. On the day of testing, the Glasgow Coma Scale (GCS) score was 6/15 (E1 VT M4). He had a

blood pressure of 155/89 mm Hg. He had 98 beats per minute of heart rate, 17 breaths per minute of respiratory rate, afebrile, and 99% oxygen saturation. The patient was supine, aware, bewildered, and unresponsive to spoken directions.

The patient was treated conservatively, using medications, physiotherapy, and other supportive treatments. On palpation, the right side had grade 1 spasticity, the left upper limb had grade 0 spasticity, and the left lower limb had degree 1 spasticity. (As measured by the Modified Ashworth scale). The examination of reflexes indicated changes in both superficial and deep reflexes.



(a) (b)

Figure 1(a) CT showing Intracranial bleeding, (b) CT scan that shows Diffuse axonal injury.

Interventional therapy

Antibiotics (the medications lowered the frequency of wound infection and so averted any problems), analgesics, and other supportive therapies were now being administered to the patient. The fundamental objective of physiotherapy rehabilitation was to re-establish the patient's functional independence and allow him to resume his normal activities.

The description of the patient's neuro-rehabilitation is provided in table 1.

Table 1: Neuro-rehabilitation of patient

Serial no.	Physical Therapy Objectives	Rehabilitation Methods
1.	To make them aware of the patient's situation and to secure the participation and consent of carers and relatives.	Guidance as well as counseling for family and carers on the importance of sticking to a fitness routine.
2.	To restore normal muscular tone in the right upper and lower limbs.	Techniques for Facilitation: 1) Rapid Icing 2) Squeezing 3) Rapid Stretch
3.	To maintain joint function and mobility while avoiding joint stiffness.	Upper and lower extremity bilateral PROM exercises.
4.	To help in the cleansing of the airways.	1) Manual Chest Vibrations and Percussions. 2) Suctioning using oral and ET tubes. 3) PNF for the chest - End expiratory pressure.
5.	To avoid pressure sores caused by extended immobilization.	1)Every 2 hours, manual positioning. 2) An air bed is offered.
6.	Stop the advancement of contracture.	1)Long-term stretching positions and 2)ROM Exercises.
7.	To prevent muscle atrophy while increasing physical strength and endurance.	Quadriceps and hamstrings static and isometric workouts
8.	To maintain chest movement while increasing lung capacity and volume.	Exercises for thoracic expansion include shoulder flexion with a deep intake and exhale with extension.

9.	To encourage the patient's mobility and raise his or her degree of attentiveness.	Using a wheelchair to get out of bed. (Figure 2)
10.	Improved sensory integration	Various stimuli, including gentle touch, deep pressure, tactile kinesthesia, and visual exposure, were used during task-oriented workouts.

Figure 2: Wheelchair mobilization

Follow up and outcomes:

Table 2, 3 and 4 depicts the improvement in muscle tone, reflexes and outcome measures.

Table 2: Muscle tone measurements before and after therapy.

	Pre-rehabilitation		Post-rehabilitation	
	Right	Left	Right	Left
Shoulder	1	1	NA	0
Elbow	1+	1+	1+	0
Wrist	1	1	1	0
Hip	1+	1+	1	0
Knee	1+	1+	1	1+
Ankle	1	1	1+	0

Table 3: Results of reflexes before and after rehabilitation.

	Pre-rehabilitation		Post-rehabilitation	
Superficial/deeper reflex	Right	Left	Right	Left
Biceps jerk	3+	3+	NA	2+
Triceps jerk	2+	2+	NA	2+
Knee jerk	3+	2+	3+	2+
Plantar jerk	2+	2+	2+	2+
Plantar reflex	Extensor	Extensor	Absent	Absent

Table 3: Outcome measures

Serial. no.	Outcomes measured	Pre-physical therapy rehabilitation result	Post-physical therapy rehabilitation result
1.	Glasgow Coma Scale	6/15	9/15
2.	Rancho Los Amigos level of cognitive functioning scale	3/10	7/10
3.	Modified Ashworth Scale	1/4	0/4

4.	Manual Muscle Testing of shoulder muscles	Score (On a scale of 5)	Score (On a scale of 5)
	Abductors	1	4
	Adductors	1	4
	Flexors	1	4
	Extensors	1	4
5.	Manual Muscle Testing (Hip muscles)	Score (On a scale of 5)	Score (On a scale of 5)
	Flexors	1	4
	Extensors	1	4
	Abductors	1	4
	Adductors	1	4
6.	Functional Independence Measure	1/7	5/7

Discussion

The patient in this case had significant diffuse axonal damage, which was treated conservatively with appropriate medicines, physiotherapy, and other complementary treatments. Compared to TBI patients without DAI, those with DAI had a three times greater chance of an unfavorable outcome, and this risk rose threefold with each rise in DAI grade. Patients with lesions in the corpus callosum were more likely to experience an unfavorable result; however, this relationship was not consistently observed for lesions in other areas (9). The goals of the rehabilitation process were originally created by clearly discussing the patient's disease and the necessity for physical therapy for recovery to the patient and family. There are several outcome scales such as the Glasgow Coma Scale (10) and Functional Independence Scale (11) Scale results were very favorable with significant improvements on each scale. It is important for physical therapists to address early muscle relaxation by developing a plan to improve motor learning and maximize rehabilitation success (12). Much of what physical therapists do in the treatment of severe TBI is functional skill development. Functional motor skills including standing, walking,

climbing stairs, shifting positions, and reaching and grabbing should be re-learnt by people with brain injuries.

Physical therapists should make this a top focus. Through proper sensory event creation and organization, rehabilitation aims to direct the nervous system toward adaptive neuroplasticity. The International Classification of Functioning, Disability, and Health (ICF) further states that rehabilitation should take an individual patient's goals, needs, resources, and impairments into account. Early treatment for patients may yield better outcomes.

Conclusion

In managing diffuse axonal damage, physical therapy rehabilitation is crucial. The five primary elements of Neuro-physiotherapy for DAI are passive stretching, at-home exercise, cryotherapy, sensory integration, and range of motion. Along with this, it emphasizes enhancing the patient's quality of life and cognitive abilities in order to enhance respiratory and musculoskeletal functions. According to the intended regimen, the patient's functional activities, outcome measures, and quality of life all significantly improved. As a result, treating the patient with diffuse axonal damage involves a significant amount of physical intervention.

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