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Rehabilitation Program from the Minimally Conscious State to the Recovery of Mobility Following Severe Traumatic Brain Injury Due to a Road Traffic Accident: A Case Report

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Disclosure statement

I have no actual or potential conflict of interest in relation to this program/presentation.

TBI and Diffuse Axonal Injury

- Traumatic brain injury (TBI) is a leading cause of mortality and long-term disability, particularly in young individuals, with significant neurological and functional consequences.
- Diffuse axonal injury (DAI) represents a severe form of TBI, caused by acceleration–deceleration and rotational forces that produce widespread shearing of axons at the microscopic level.
- This results in disruption of white matter tracts and impaired connectivity between cortical and subcortical structures, affecting multiple neural networks.
- Clinically, DAI is strongly associated with prolonged disorders of consciousness, severe cognitive impairment, and a slow, often incomplete recovery trajectory.[1]

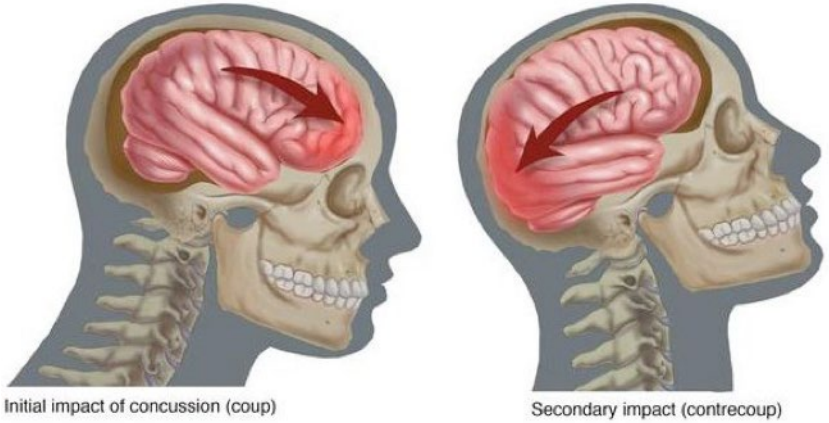


Figure 1. Coup–contrecoup injury pattern in traumatic brain injury caused by acceleration–deceleration forces.

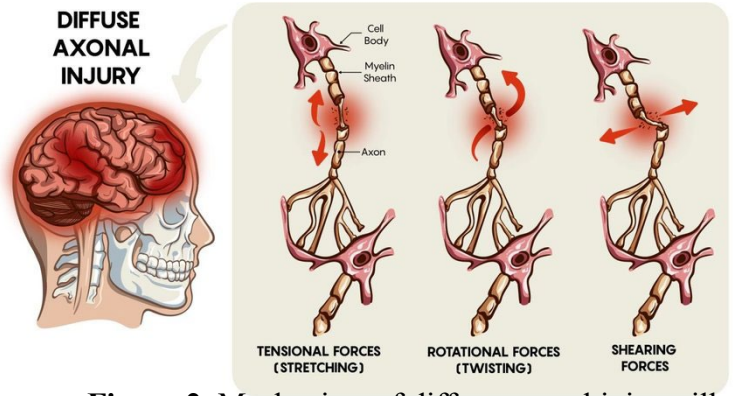


Figure 2. Mechanism of diffuse axonal injury, illustrating axonal damage caused by tensile, rotational, and shearing forces leading to disruption of neural connectivity.

[1] Johnson VE, Stewart W, Smith DH. Diffuse axonal injury in traumatic brain injury. *The Lancet Neurology*. 2013;12(2):157–166.

Clinical Impact of Severe TBI

- Severe traumatic brain injury with diffuse axonal injury results in widespread disruption of neural networks, leading to significant impairment of consciousness, cognition, and functional abilities.
- Clinically, patients often evolve from acute neurological instability to prolonged states of reduced responsiveness and severe dependence in daily activities.
- Recovery is typically slow and heterogeneous, with a substantial risk of long-term disability.[2]

[2] Maas AIR, Menon DK, Adelson PD, et al. Traumatic brain injury: integrated approaches to improve prevention, clinical care, and research. *The Lancet Neurology*. 2017;16(12):987–1048.

Age as a Prognostic Factor in TBI Recovery

- Young age is a key prognostic factor in traumatic brain injury, being associated with enhanced neuroplasticity and a greater capacity for functional reorganization.[3]
- This biological advantage supports more efficient neural recovery processes, contributing to improved motor and cognitive outcomes.
- As a result, younger patients have a higher likelihood of achieving functional gains and partial recovery of independence compared to older individuals.[3]

[3] Hukkelhoven CWPM, Steyerberg EW, Rampen AJJ, et al. Patient age and outcome following severe traumatic brain injury: an analysis of 5600 patients. *Journal of Neurosurgery*. 2003;99(4):666–673.

Acute Phase – Initial Presentation

- A 19-year-old female patient was admitted following a severe traumatic brain injury sustained in a road traffic accident.
- At presentation, the patient had a **Glasgow Coma Scale score of 4**, indicating a severe impairment of consciousness.
- She required **endotracheal intubation, mechanical ventilation, and intensive care support** due to the critical neurological condition.



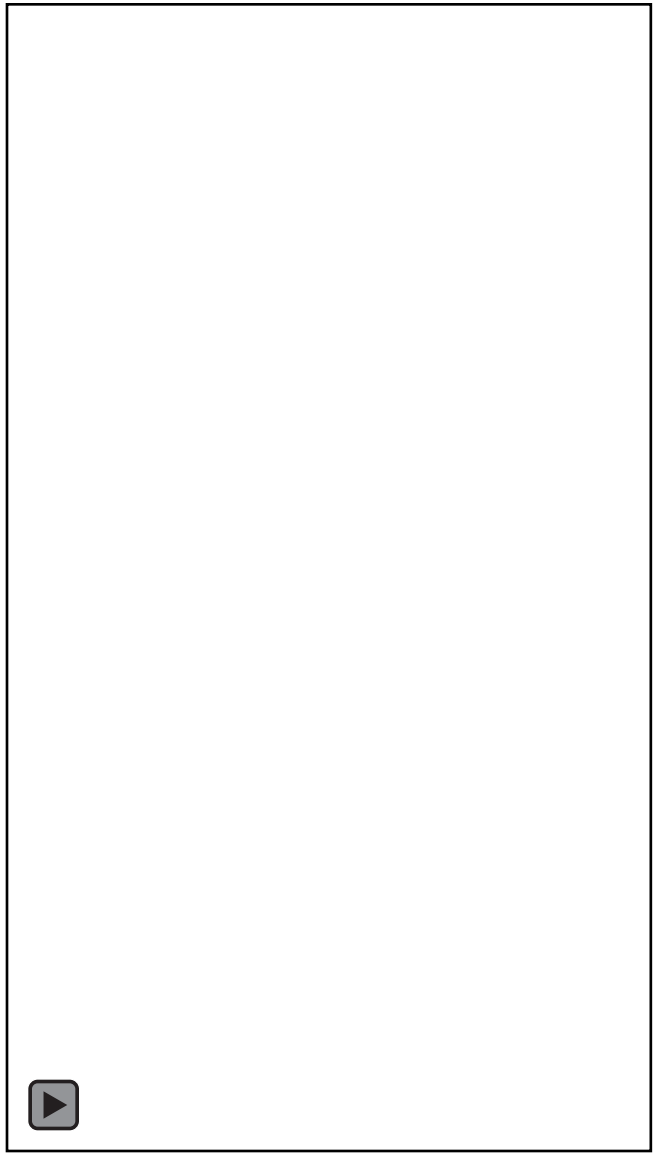


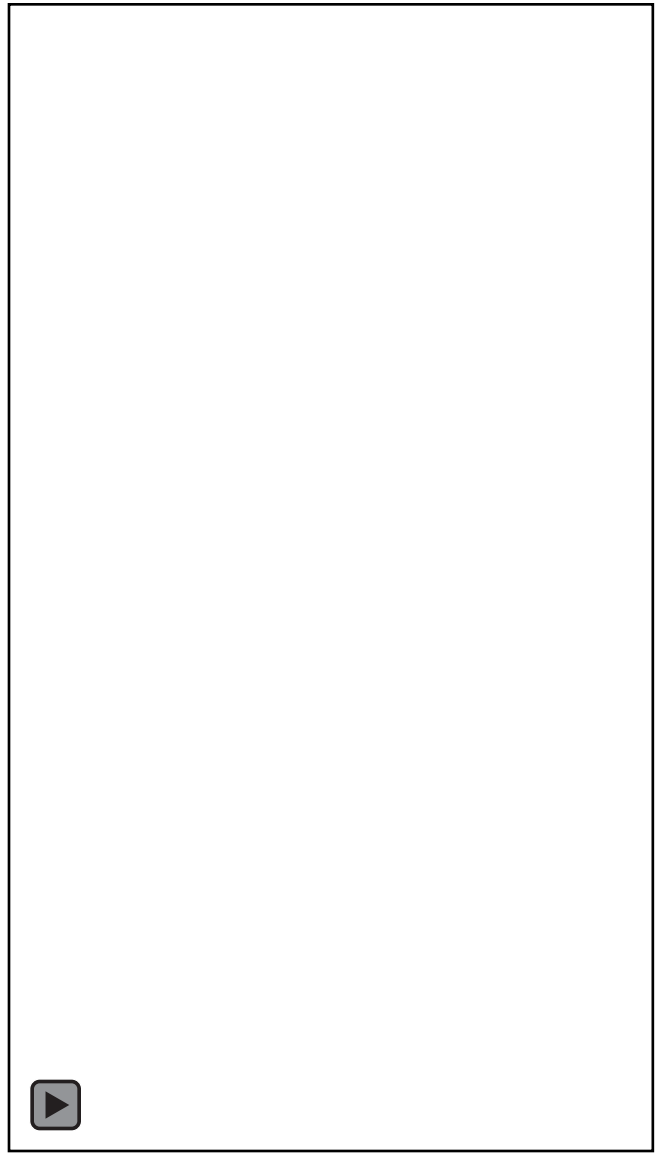
Figures 3&4. Acute phase of severe traumatic brain injury, illustrating initial clinical presentation with craniofacial trauma and subsequent intensive care management requiring airway protection and invasive mechanical ventilation.

Neuroimaging Findings

Cranial computed tomography revealed multiple traumatic brain lesions, including:

- **Subdural hematoma**
- **Subarachnoid hemorrhage (SAH)**
- **Diffuse axonal injury (DAI)**
- **Midline shift**, suggestive of significant cerebral edema





Videos 1–2. Serial cranial CT scans performed on June 1 and June 15, demonstrating the evolution of traumatic brain injury, including right subdural hematoma and subarachnoid hemorrhage.

ICU Evolution

- During the intensive care unit stay, the patient showed gradual neurological improvement following the reduction of sedation.
- The level of consciousness improved from a **Glasgow Coma Scale score of 4 to approximately 7–8**, with the emergence of spontaneous eye opening and partial motor responses.
- This evolution indicated the beginning of neurological recovery, although the patient remained in a critical condition requiring intensive medical support.

Supportive Interventions

Due to the severity of the neurological condition, the patient required **advanced supportive care** during the acute phase:

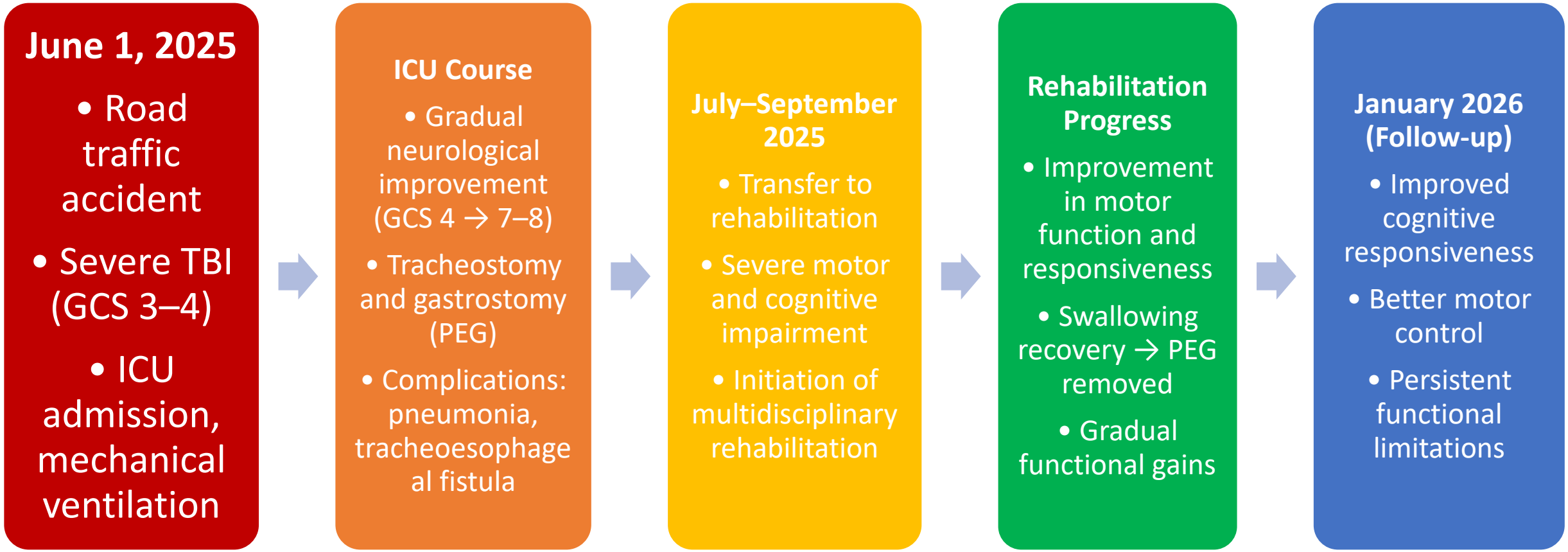
- **Mechanical ventilation** for respiratory support
- **Tracheostomy** for prolonged airway management
- **Gastrostomy (PEG)** for enteral nutritional support

Acute Phase Complications

- The clinical course was complicated by **severe respiratory infection with *Klebsiella pneumoniae***, which required targeted antibiotic therapy.
- The patient also developed a **tracheoesophageal fistula**, which was managed through **endoscopic closure using clips**, with subsequent favorable evolution.

Transition to Rehabilitation

- At the time of transfer, the patient was **clinically stable**, following the acute phase of severe traumatic brain injury.
- Despite neurological improvement, she remained **significantly functionally impaired**, requiring a structured rehabilitation program.


June 1, 2025
• Road traffic accident
• Severe TBI (GCS 3–4)
• ICU admission, mechanical ventilation
ICU Course
• Gradual neurological improvement (GCS 4 → 7–8)
• Tracheostomy and gastrostomy (PEG)
• Complications: pneumonia, tracheoesophageal fistula
July–September 2025
• Transfer to rehabilitation
• Severe motor and cognitive impairment
• Initiation of multidisciplinary rehabilitation
Rehabilitation Progress
• Improvement in motor function and responsiveness
• Swallowing recovery → PEG removed
• Gradual functional gains
January 2026 (Follow-up)
• Improved cognitive responsiveness
• Better motor control
• Persistent functional limitations

Clinical Status at Admission

- At admission, the patient presented with **spastic tetraparesis**, resulting in significant motor impairment and limited functional mobility.
- Cognitive function was affected, with **reduced verbal output and slowed responses**, consistent with residual post-traumatic cognitive dysfunction.
- Functionally, the patient was **dependent for most activities of daily living and required assistance for mobility**.

Functional Assessment

- **Barthel Index: 0 → total dependence**
- **Modified Rankin Scale: 5 → severe disability**
- **Functional Independence Measure: consistent with complete dependence**
- **Functional Ambulation Category: 0 → non-ambulatory**

Rehabilitation Program

The patient underwent a **multidisciplinary rehabilitation program**, tailored to her neurological deficits:

- **Physical therapy (kinesiotherapy)** focused on improving mobility, muscle strength, and postural control
- **Speech and language therapy** aimed at restoring verbal communication and cognitive-linguistic function
- **Cognitive rehabilitation** targeting attention, orientation, and executive functions

Motor Rehabilitation

- Motor rehabilitation was progressively structured, according to the patient's neurological recovery.
- Initially, therapy focused on **basic mobilization and postural control**, aiming to prevent complications and maintain joint mobility.
- Subsequently, the patient progressed to **assisted sitting and verticalization**, followed by **gait training**, achieving short-distance ambulation with support.

Cognitive Recovery

- At admission, the patient presented with **severely impaired communication**, characterized by minimal verbal output and reduced responsiveness.
- During rehabilitation, progressive improvement was observed, with the patient becoming able to provide **short, monosyllabic responses** and engage in basic interaction.
- This evolution reflects a significant recovery of **cognitive and language functions** following severe traumatic brain injury.

Swallowing Recovery

- At admission, the patient required enteral feeding through gastrostomy.
- With progressive improvement of swallowing, oral feeding was successfully reintroduced.
- **The gastrostomy was subsequently removed, representing a key step toward functional recovery and independence.**

Clinical Evolution (Overview)

• Across consecutive rehabilitation admissions, the patient showed a progressive consolidation of neurological recovery.

• Improvements were observed in postural control, interaction, and participation in structured rehabilitation activities.

• The clinical course was characterized by a steady transition from a severely impaired state toward increased responsiveness and engagement.

Functional Outcome

- At discharge, the patient showed clear functional improvement compared to the initial rehabilitation admission.
- Motor function improved, reflected by higher segmental strength scores.
- Spasticity remained moderate but better controlled.
- Functional ambulation improved, with progression from non-functional to assisted walking.
- Overall outcome: significant functional recovery, although not fully independent.

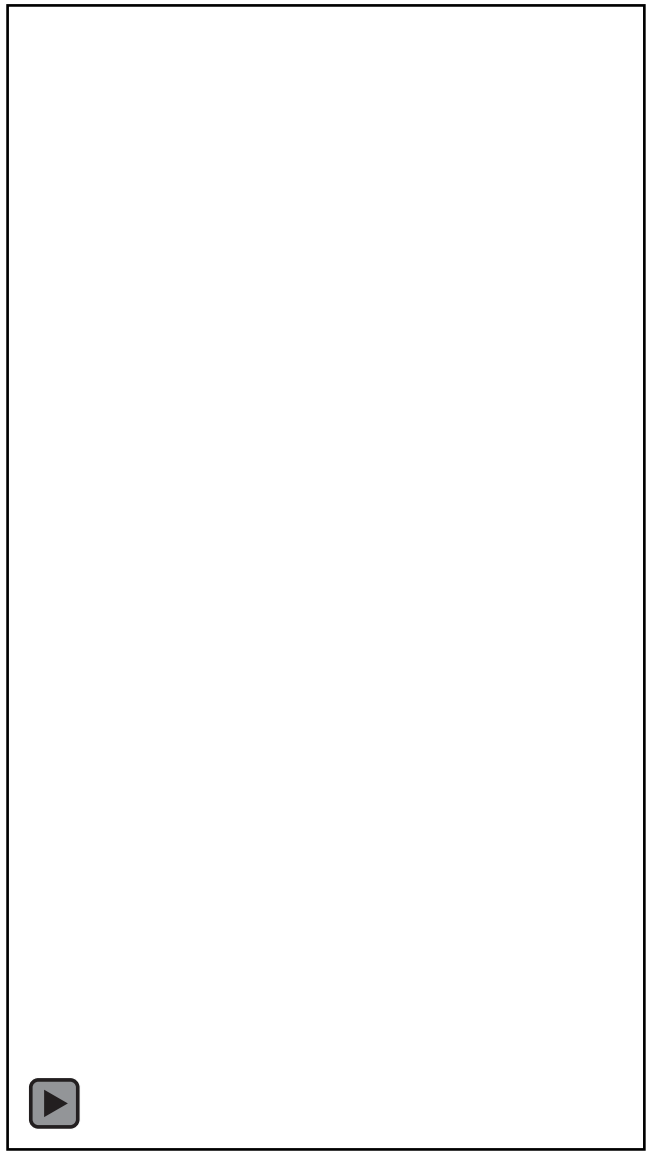
Functional Progress — Comparative Assessment

Scale	Admission	Discharge
Motor Score (Total)	60	80
MRC (segmental)	3	4
Ashworth	0	2
Penn Spasm Frequency	0	2
FAC	0	1
GOS-E	3	4
Modified Rankin Scale	5	4
Barthel Index	0	15

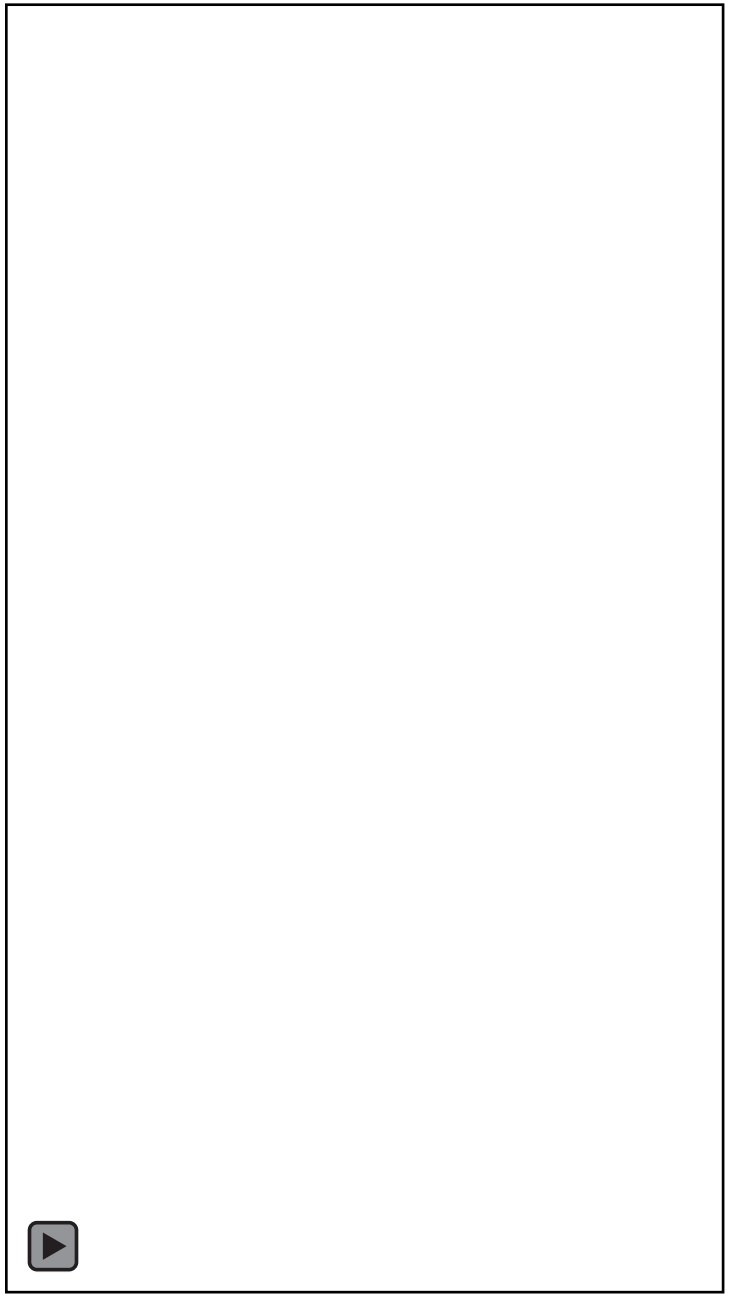
- At the end of the rehabilitation period, the patient achieved partial functional recovery, with significant neurological and functional improvement.
- Motor strength increased, enabling assisted mobility and improved performance in basic activities of daily living.
- This progress was accompanied by the development of moderate spasticity, a common feature in the recovery phase after severe brain injury.
- Despite these gains, the patient remained partially dependent and required ongoing support.

Follow-up (January 2026)

- At follow-up evaluation, the patient presented with a consolidated neurological status following severe traumatic brain injury with diffuse axonal injury.
- Cognitive function showed further improvement, with increased responsiveness, better interaction, and the ability to sustain simple communication.
- Motor recovery progressed toward improved voluntary control and coordination, although residual spastic tetraparesis remained evident.
- The resolution of acute complications, including tracheostomy and gastrostomy removal, supported the transition to a more stable clinical phase.
- Despite these advances, functional independence remained limited, with the patient still requiring assistance for mobility and activities of daily living, reflecting the prolonged and incomplete recovery trajectory typical of severe TBI.



Video 3. Patient performing assisted ambulation using wall support during the rehabilitation phase, illustrating partial recovery of motor function and initiation of functional mobility.



Video 4. Advanced stage of rehabilitation, showing assisted ambulation with minimal support from another person, reflecting progression toward functional independence.

Particularity of the Case

- This case is notable due to the young age of the patient and the extreme severity of the initial brain injury, characterized by severe traumatic brain injury with diffuse axonal injury and a very low initial Glasgow Coma Scale score.
- Despite an initially poor prognosis, with a high risk of persistent disability, the patient demonstrated a meaningful degree of neurological recovery over time.
- The clinical course highlights the capacity for neuroplasticity in young individuals, as well as the critical role of early stabilization and structured multidisciplinary rehabilitation in supporting recovery.
- Although the outcome remained functionally limited, the observed improvements in motor, cognitive, and swallowing functions underline the potential for gradual but significant recovery even in severe cases.

Discussion

- Severe traumatic brain injury with diffuse axonal injury is associated with a prolonged and often incomplete recovery due to widespread disruption of neural networks.
- However, this case illustrates that younger patients may exhibit significant recovery potential, likely related to enhanced neuroplasticity.
- The observed evolution highlights the critical role of sustained multidisciplinary rehabilitation in facilitating functional improvement, even when initial impairment is severe.

Conclusions

- Severe TBI does not preclude meaningful recovery
- Early and continuous rehabilitation is essential
- Functional gains may occur despite severe initial impairment

Figure 5. Follow-up clinical status showing substantial neurological recovery, with improved facial expression, interaction, and functional independence compared to the acute phase.



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Thank you for your attention!