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Case Report

Biopsychosocial Rehabilitation of Prone-Induced Brachial Plexus Injury Following COVID-19: A 7-Month Phased Physiotherapy Case Study in a Patient with Multiple Comorbidities

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Abstract

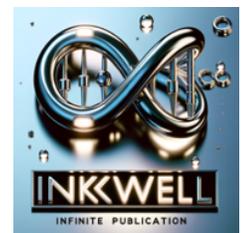
Background: Brachial plexus injury secondary to prolonged prone positioning during COVID-19 hospitalization has emerged as a recognized complication, particularly in patients with metabolic comorbidities such as diabetes mellitus. **Case Presentation:** This case report describes the rehabilitation of a 31-year-old left-handed male with diabetes who developed brachial plexus injury following prolonged prone positioning during COVID-19 hospitalization. The patient underwent intensive physiotherapy over seven months, totaling 38 sessions. Clinical assessment included muscle strength testing, range of motion (ROM) measurement, balance evaluation, psychological distress assessment, the Quick Disabilities of the Arm, Shoulder and Hand (QuickDASH) questionnaire, and the Brachial Assessment Tool (BrAT). At baseline, passive ROM was preserved; however, reduced muscle strength was noted in the shoulder flexors, extensors, abductors, and adductors, as well as in the elbow flexors and extensors. **Intervention and Outcomes:** A structured and progressive physiotherapy program was implemented. Over the rehabilitation period, improvements were observed in shoulder and elbow muscle strength, functional mobility, pain levels, QuickDASH scores, BrAT scores, and psychological status. **Conclusion:** This case highlights the multifactorial nature of neurological and functional recovery following brachial plexus injury associated with prolonged prone positioning. Mechanical factors, metabolic comorbidities, lifestyle influences, and psychological status may collectively affect rehabilitation outcomes. Intensive, structured physiotherapy may facilitate meaningful neurological and functional recovery even in complex clinical presentations.

Keywords: Physiotherapy, exercise, COVID-19, Brachial plexus injury, Rehabilitation, Diabetes mellitus.

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Introduction

Brachial plexus injuries (BPIs) are complex peripheral nerve disorders that can result in profound motor and sensory dysfunction of the upper limb, significantly limiting independence and quality of life (Songcharoen, 2008). Functional recovery following BPI depends on multiple interacting factors, including the severity of neural injury, timing of rehabilitation, metabolic health, and patient engagement in therapy.

Position-related brachial plexus injury has emerged as a recognized complication of prolonged prone positioning during critical care management, particularly following severe COVID-19 infection (Simpson et al., 2020; Mano & Fujimura, 2022). Mechanical compression, sustained traction, and ischemic stress on neural structures during immobilization may lead to neuropraxic or axonotmetic injury patterns that require prolonged rehabilitation.

Comorbidities such as diabetes mellitus further complicate recovery by impairing microvascular circulation, delaying axonal regeneration, and reducing neuromuscular adaptability (Simpson et al., 2020; Genedy et al., 2025). These metabolic influences may alter the rate and extent of reinnervation, contributing to slower and less predictable functional gains.

Although physiotherapy-led rehabilitation is widely accepted as a cornerstone of non-surgical BPI management, there is limited clinical literature describing recovery trajectories in patients presenting with combined mechanical, metabolic, and psychosocial risk factors, particularly following COVID-19 critical illness (de Santana Chagas et al., 2021).

Therefore, documenting rehabilitation outcomes in such multifactorial presentations is essential to better understand how structured physiotherapy may influence neuromuscular recovery despite systemic barriers to nerve healing.

Study Aim

This case study aims to evaluate the longitudinal effects of a structured, intensive physiotherapy program on neuromuscular and functional recovery in a patient with brachial plexus injury complicated by multiple comorbidities, including diabetes mellitus and prior COVID-19 critical illness. Specifically, the study examines progressive changes in muscle strength, range of motion, functional performance (Quick DASH), upper-limb use (Brachial Assessment Tool), pain levels, and psychological status over a seven-month rehabilitation period.

In addition, it seeks to explore how interacting mechanical, metabolic, and psychosocial factors may influence neurological recovery and rehabilitation responsiveness in complex clinical presentations.

Case Presentation

Patient demographics

The patient was a 31-year-old male who was admitted to the intensive care unit (ICU) on 26 October 2024 due to COVID-19 infection and was discharged from the hospital on 27 November 2024. He presented to the physiotherapy clinic for initial assessment on 9 February 2025. He was diagnosed with a right brachial plexus injury. His medical history was significant for diabetes mellitus and recent COVID-19 infection. Diagnostic investigations included magnetic resonance imaging (MRI), nerve conduction studies (NCS), and computed tomography (CT) scanning.

Baseline condition

At baseline, the patient reported severe burning pain in the right upper limb, accompanied by marked reduction in both proximal and distal muscle strength of the same limb. Neurological examination revealed that the cranial nerves were intact, with no evidence of cranial nerve involvement.

Specific neurological deficit

Neuroimaging findings, including magnetic resonance imaging (MRI) and nerve conduction studies (NCS), demonstrated a right-sided upper trunk brachial plexus lesion involving the C5–C6 nerve roots. Clinically, this pattern of involvement corresponded to weakness in shoulder abduction, external rotation, and elbow flexion.

Biopsychosocial model

From a biopsychosocial perspective, several interrelated factors influenced the patient's presentation and recovery. Biologically, he was diagnosed with a right-sided upper trunk brachial plexus injury involving the C5–C6 nerve roots, with a medical history significant for diabetes mellitus and recent critical illness due to COVID-19. Psychologically, he demonstrated moderate psychological distress at baseline, as reflected by a Kessler Psychological Distress Scale (K10) score of 27, with gradual improvement observed throughout the rehabilitation period. Socially, the patient benefited from strong family support, maintained high motivation, demonstrated good adherence to the prescribed physiotherapy program, and was living independently.

Initial assessment

Table 1: MMT at initial assessment.

Muscle Group	MMT (Right Upper Limb, 0–5 scale)
Shoulder Flexion	2-/5
Shoulder Extension	2/5
Shoulder Abduction	2-/5
Shoulder Adduction	2/5
Elbow Flexion	2-/5
Elbow Extension	3-/5
Wrist/Fingers Flexion	4-/5
Wrist/Fingers Extension	4-/5

Range of motion (ROM) assessment revealed that all major joints were within normal limits, with active assistance required for movements of the right upper limb. Balance evaluation demonstrated good static and dynamic sitting

balance, good static standing balance, and fair dynamic standing balance.

Ethical approval

This study was reviewed and approved by the National BioMedical Ethics Committee, King Abdulaziz City for Science and Technology (Approval No. H-02-K-001). Written informed consent was obtained from the patient prior to participation, and all procedures were conducted in accordance with the Declaration of Helsinki. Patient confidentiality and anonymity were strictly maintained throughout data collection and reporting.

Intervention

The rehabilitation program was developed based on principles of motor relearning, progressive mechanical loading, and activity-dependent neuroplasticity. Gradual transition from assisted to resisted movement was implemented to stimulate surviving motor units, promote cortical reorganization, and prevent learned non-use of the affected limb. Exercise dosage and progression were individualized according to pain response, motor control quality, and observed neuromuscular adaptation.

The patient participated in a structured physiotherapy program conducted one to two times per week, with each session lasting approximately one hour, from 9 February 2025 to 14 September 2025. The rehabilitation program was systematically designed to progress from gravity-assisted movements to against-gravity exercises, followed by the introduction of progressive resistance training to improve shoulder and elbow muscle strength. Exercise progression included the use of wrist and elbow weights ranging from 1.8 to 2.2 kg, performed for 20–25 repetitions across two sets. Pain levels, movement quality, and overall safety were closely monitored during each session to ensure appropriate progression and prevent exacerbation of symptoms.

Exercise progression and program design

The rehabilitation program was structured using a progressive, phase-based approach tailored to the patient's neuromuscular recovery status and individual tolerance. Initially, intervention focused on range of motion (ROM) and mobility exercises to preserve joint integrity, prevent stiffness, and facilitate gentle activation of the affected musculature. As voluntary motor control improved, the program advanced to strength training, progressing from gravity-assisted movements to against-gravity exercises with gradual introduction of resistance loading.

Subsequently, the program was organized into distinct contraction-focused phases to optimize neuromuscular re-education and functional endurance. The concentric phase emphasized controlled muscle shortening to enhance lifting and reaching activities. The eccentric phase incorporated controlled lengthening contractions to improve deceleration capacity and joint stability. The isometric phase included sustained static contractions aimed at enhancing joint stabilization and minimizing compensatory movement patterns. Each phase was maintained for approximately 4–6 weeks, with progression guided by clinical indicators including pain reduction, improved movement quality, and measurable strength gains of at least one grade on manual muscle testing (MMT).

This systematic and individualized progression enabled safe loading of the neuromuscular system, minimizing fatigue and pain while facilitating sustained functional recovery and improved motor control.

Stage 1: Identifying the research Question

The research question of this study is “What is known from the existing literature about the impact of traumatic brain injury on women's roles as spouses/partners of people who have had a TBI”. The question was chosen based on the proposal of Arksey and O'Malley (2005), which

stated that a broad question should be adapted to achieve a broad coverage.

By selecting a comprehensive research question, the study can capture a variety of perspectives and experiences regarding the impact of TBI on the role of women as spouses/partners. This method is especially useful for scoping reviews, which seek to provide a comprehensive overview of the existing literature on a specific topic. The broad research question ensures that all relevant literature, even if not explicitly related to the specific research question, is included in the scoping review.

Outcomes and follow-up

Given the single-case design, outcomes were analysed descriptively using repeated clinical measurements rather than inferential statistical testing. This methodological approach is consistent with case report standards, where emphasis is placed on documenting longitudinal changes within the individual rather than establishing population-level generalizability. Serial assessments were used to monitor functional progression, strength recovery, symptom reduction, and psychological improvement over time, thereby providing a structured evaluation of rehabilitation effectiveness at the individual level.

Strength Progression (Right Upper Limb)

Table 2: MMT with comparison in baseline and after 7-months.

Muscle Group	Baseline MMT	7-Month MMT
Hand/Wrist Flexion/Extension	4-/5	4/5
Elbow Flexion	2-/5	3/5
Elbow Extension	3-/5	4-/5
Shoulder Flexion/Abduction	2-/5	4-/5
Shoulder Other Movements	2–3/5	Stable 2–3/5

Timeline for patient progression.

Table 3: The phases of rehabilitation with number of sessions and progression.

Phase 1	Phase 2	Phase 3	Phase 4
Foundation & Stabilization	Major Breakout	Plateau & Consolidation	Finals Gains
Sessions 1-13	Sessions 13-18	Sessions 18-32	Session 32-38
<ul style="list-style-type: none"> • Severe weakness • Mastered program • No regression 	<ul style="list-style-type: none"> • Elbow Flex: 2→3-/5 • Elbow Ext: 3→4-/5 • 40% improvement 	<ul style="list-style-type: none"> • Gains maintained • Strength stabilized 	<ul style="list-style-type: none"> • Elbow Ext: 3→4/5 • Shoulder Rot: 3-/5→3/5

Pain and sensation

During follow-up, the patient reported a marked reduction in burning pain, although residual sensory deficit in the C5–C6 dermatomal distribution persisted. At baseline, the Visual Analogue Scale (VAS) score for pain at the right elbow was 8/10. With ongoing physiotherapy sessions, pain levels progressively decreased, reaching 1/10 by the end of the rehabilitation period.

Psychological outcomes

Psychological status was assessed using the Kessler Psychological Distress Scale (K10). At baseline, the patient obtained a score of 27, indicating a likelihood of moderate psychological distress. After seven months of rehabilitation, reassessment using the same instrument revealed a score of 10, suggesting that the patient was likely to be psychologically well. These findings reflect substantial improvement in psychological status over the course of the rehabilitation program.

Quick DASH score

Upper limb functional status was evaluated using the Quick Disabilities of the Arm, Shoulder and Hand (Quick DASH) questionnaire. At baseline, the patient scored 72.7, indicating severe disability with significant difficulty or inability to perform many daily tasks. After seven months of rehabilitation, reassessment demonstrated a marked reduction in the score to 15.9, reflecting mild disability and only slight difficulty with selected activities. These findings indicate substantial functional improvement over the course of the intervention.

Brachial assessment tool (BrAT) results

At baseline assessment, the patient demonstrated moderate-to-severe functional limitation in the use of the affected upper limb, as reflected by the Brachial Assessment Tool (BrAT) score.

Post-rehabilitation assessment (7 months)

Following seven months of structured rehabilitation, marked improvement was observed across all BrAT subscales, indicating substantial functional recovery and enhanced utilization of the affected arm during daily activities.

Table 4: The Brachial Assessment Tool at the initial assessment and after the physiotherapy program.

Subscale	Baseline	Post-Rehab
Dressing & Grooming (24)	8	21
Arm & Hand Activities (51)	18	44
No-Hand Activities (18)	6	15
Total Score (93)	32	80

Post-rehabilitation assessment (12–14 months)

Long-term follow-up conducted via telehealth at 12 and 14 months’ post-intervention demonstrated sustained improvements across all evaluated clinical indices, including the Brachial Assessment Tool (BrAT), QuickDASH, and the

Kessler Psychological Distress Scale (K10). Additionally, further gains in muscle strength were observed, with elbow flexion improving to Manual Muscle Testing (MMT) grade 3+/5 and elbow extension reaching 5/5. These findings indicate that the functional and psychological improvements achieved during the seven-month intensive rehabilitation program were successfully consolidated and maintained over time.

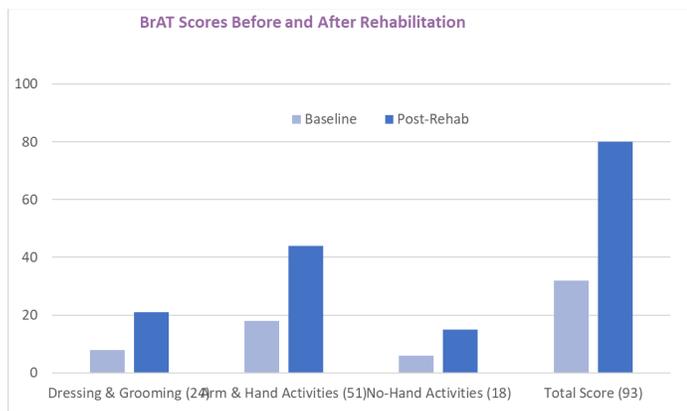


Figure 1. Brachial Assessment Tool at the initial assessment and after the physiotherapy program.

Biopsychosocial Model

From a biopsychosocial perspective, multiple interacting factors influenced the patient's recovery trajectory. Biologically, the severity of the brachial plexus injury and the presence of diabetes mellitus likely constrained the rate and extent of neural regeneration. Psychologically, progressive improvement in emotional well-being appeared to enhance treatment engagement, motor learning, and task performance during rehabilitation. Socially, strong family support and consistent adherence to the prescribed physiotherapy program facilitated sustained participation, thereby contributing to long-term functional recovery.

Facilitators and barriers

Several factors influenced the rehabilitation process. Key facilitators included the patient's high level of motivation, strong family support, and consistent attendance at physiotherapy sessions,

all of which promoted sustained engagement in the rehabilitation program. Conversely, notable barriers included the presence of comorbidities, particularly diabetes mellitus, which may have affected nerve regeneration and recovery potential, as well as the initial severity of muscle weakness, which limited early functional performance and progression.

Key achievements

The rehabilitation program achieved several important outcomes. Exercise intensity was progressed safely and systematically in accordance with the patient's neuromuscular tolerance and recovery status. Regression or secondary complications in the neurologically involved limb were successfully prevented through continuous monitoring and structured loading. Additionally, functional gains were paralleled by measurable improvements in psychological well-being, reflecting the integrated impact of the rehabilitation approach.

Discussion

The observed functional improvements likely reflect a combination of peripheral nerve recovery and central neuroplastic adaptation. Gradual strengthening and task-specific training may have enhanced motor unit recruitment and facilitated collateral sprouting from partially preserved axons, a mechanism commonly described in incomplete plexus injuries. (Mano & Fujimura, 2022; Genedy et al., 2025; de Santana Chagas et al., 2021).

Diabetes mellitus may have contributed to the initially slow progression by impairing microvascular perfusion and axonal transport, both of which are essential for neural regeneration. Despite this biological constraint, progressive loading appears to have provided sufficient stimulus to promote neuromuscular re-education. (Mano & Fujimura, 2022; Vernon Lee et al., 2023).

The role of prolonged prone positioning during COVID-19 hospitalization should also be considered, as sustained compression and traction forces are known to produce position-related plexopathies (Simpson et al., 2020; Mano & Fujimura, 2022). Unlike high-energy traumatic BPIs, these injuries may retain partial neural continuity, explaining the meaningful recovery observed with conservative management. (Mano & Fujimura, 2022; Genedy et al., 2025; de Santana Chagas et al., 2021).

Psychological improvement paralleled physical gains, suggesting an interaction between emotional state and motor performance. Reduced distress may enhance participation, motor learning, and cortical engagement during rehabilitation, reinforcing the biopsychosocial model of recovery.

This case therefore highlights how structured physiotherapy can modulate recovery even when regeneration is biologically compromised, emphasizing the importance of sustained, individualized rehabilitation in medically complex patients. (Sabry et al., 2025).

Conclusion

This case illustrates that intensive, structured physiotherapy over seven months can yield substantial neuromuscular and functional recovery in a right upper trunk brachial plexus injury (C5–C6) following prolonged prone positioning in COVID-19 critical care, despite complicating factors such as diabetes mellitus and initial moderate psychological distress.

Key improvements included enhanced shoulder and elbow strength (MMT gains from 2-/5 to 4-/5 in major groups), near-resolution of pain (VAS 8/10 to 1/10), reduced disability (Quick DASH 72.7 to 15.9), improved upper limb function (BrAT total 32 to 80), and normalized psychological well-being (K10 27 to 10).

These outcomes, achieved through phased progressive loading and activity-dependent

neuroplasticity in an incomplete lesion, highlight the value of holistic management addressing mechanical, metabolic, psychological, and social domains. Early multidisciplinary intervention is recommended for similar complex presentations to optimize conservative rehabilitation potential. This report reinforces the role of tailored physiotherapy in multifactorial post-COVID brachial plexopathies. In addition, further work needs to be done to achieve more objective assessment, these findings cannot be generalized as it is a single case study.

Novelty and Significance

This case presents a rare combination of multiple interacting risk factors, including brachial plexus injury secondary to prolonged prone positioning, diabetes mellitus, and post-COVID-19 critical illness, all of which potentially influence neural recovery. It demonstrates sustained long-term functional and physiological improvements, outcomes that are infrequently documented in similar complex clinical presentations. Furthermore, this case provides a practical framework for examining multifactorial biological, psychological, and social influences on neurological rehabilitation and long-term recovery trajectories.

Limitations

This report describes a single clinical case, which limits the generalizability of the findings to broader patient populations. Objective quantification of muscle strength using handheld dynamometry and follow-up electrodiagnostic assessments were not available, thereby limiting the ability to correlate physiological recovery with clinical improvements. Furthermore, the absence of a comparison or control condition precludes definitive conclusions regarding causal relationships between the intensity of the intervention and the magnitude of observed outcomes.

Recommendations

Early and multidisciplinary rehabilitation is strongly recommended in complex neurological cases. A coordinated team approach involving physiotherapists, neurologists, endocrinologists, and psychologists should be initiated from the acute phase, including during intensive care unit (ICU) admission, to ensure comprehensive management of biological, metabolic, and psychological factors influencing recovery. Additionally, rehabilitation programs should incorporate objective assessment tools, such as handheld dynamometry for quantifying muscle strength and validated patient-reported outcome measures, to enhance the accuracy of progress monitoring and support evidence-based clinical decision-making.

Author Contributions

All authors significantly contributed to the work reported, including conception, study design, data acquisition, analysis, and interpretation. They actively participated in drafting, revising, or critically reviewing the manuscript, provided final approval of the version to be published, agreed on the journal submission, and accepted accountability for all aspects of the work.

Ethical Approval and Patient Consent

Ethical approval was not required for this study, as it is a scoping review based exclusively on previously published and publicly available data.

No human participants were directly involved; therefore, informed consent was not required.

Data Availability Statement

The authors will transparently provide the primary data underpinning the findings or conclusions of this article, without any unjustified reluctance. If need from editorial team.

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Conflicts of Interest

The authors declare no potential conflicts of interest related to the research, writing, or publication of this work.

Declaration of generative AI and AI-assisted technologies

The authors used generative AI tools solely to improve language clarity and correct grammatical issues during manuscript preparation. All content was carefully reviewed and revised by the authors, who take full responsibility for the accuracy, integrity, and originality of the final published work.

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