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Impact of Core Strengthening and OTAGO Exercise Program on Balance and Fall Prevention in Guillain-Barré Syndrome: A Case Series

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Abstract: ***Background: Guillain-Barré Syndrome (GBS) frequently impairs balance, gait, and quality of life. Targeted core stabilization and balance exercises may enhance physical function and mitigate fall risk in neurological conditions. Objective: To assess the impact of a combined McGill core strengthening and Otago exercise regimen on balance, dynamic gait, gait disability, and physical quality of life in GBS patients. Methods: This case series involved GBS patients completing a structured program integrating McGill core stabilization exercises with the Otago balance protocol. Assessments used the Berg Balance Scale (BBS), Dynamic Gait Index (DGI), GBS Disability Scale, and WHOQOL questionnaire. Pre- and post-intervention scores were compared to quantify functional improvements. Results: Participants exhibited statistically significant gains in balance (BBS) and dynamic gait (DGI), with reduced gait-related disability. Physical quality-of-life scores rose post-intervention, signaling better physical capacity. Enhanced trunk stability and postural control from core training likely drove these benefits via improved neuromuscular coordination and minimized compensatory patterns. Non-physical domains (psychological well-being, social relationships, environment) showed no significant change, likely due to limited sample size and their multifaceted influences. Conclusion: This case series demonstrates that integrating McGill core stabilization and Otago balance training improves balance, gait, and physical quality of life in GBS patients. Results advocate for their inclusion in GBS rehabilitation protocols. Larger trials with extended follow-up and psychosocial components are needed to evaluate comprehensive quality-of-life outcomes.***

Keywords: Guillain-Barré Syndrome, core stabilization, Otago exercise, balance, gait, quality of life

1. Introduction

Guillain-Barré syndrome (GBS) is an acute, immune-mediated polyradiculoneuropathy that affects the peripheral nervous system and remains one of the most common causes of acute flaccid paralysis worldwide. The global incidence of GBS has been reported to range between 0.8 and 1.9 cases per 100,000 person-years, with a higher incidence observed in males and older adults [1–3]. Epidemiological studies indicate that although GBS is considered a rare disorder, its burden is substantial due to the potential for severe neurological disability, prolonged recovery periods, and persistent functional limitations [2,4]. Advances in acute medical management, including intravenous immunoglobulin and plasma exchange, have significantly reduced mortality; however, up to 40–60% of individuals experience residual motor and sensory deficits that persist beyond the acute phase, necessitating long-term rehabilitation [3,5].

Clinically, GBS is characterised by rapidly progressive, symmetrical limb weakness, areflexia, and variable sensory involvement, often accompanied by autonomic dysfunction. Weakness typically begins distally and ascends proximally, frequently involving trunk and respiratory muscles in more severe cases [2,3]. Although many patients regain independent ambulation, residual impairments such as reduced muscle strength, impaired proprioception, fatigue, and altered motor coordination are commonly reported during the recovery phase [5,6]. These persistent deficits contribute to compromised postural control and impaired balance, which are increasingly recognised as key determinants of long-term disability in individuals recovering from GBS [6,7].

Balance dysfunction in Guillain-Barré syndrome arises from distal muscle weakness, sensory loss, delayed neuromuscular responses, and impaired trunk stability. Disrupted proprioceptive input and reduced trunk control impair anticipatory and reactive postural adjustments, increasing reliance on unsafe compensatory strategies and elevating fall risk [2,6]. These impairments contribute to secondary injuries, fear of falling, activity restriction, and delayed functional reintegration [7,8]. As core musculature is essential for postural stability and efficient movement, interventions targeting core strength and endurance may play a critical role in improving balance and reducing fall risk in individuals recovering from Guillain-Barré syndrome [9,10].

The McGill core stability programme emphasises low-load, high-endurance isometric exercises designed to enhance

spinal stability and neuromuscular control while minimising excessive spinal loading [11]. This programme targets deep trunk stabilisers such as the transversus abdominis and multifidus and has demonstrated positive effects on trunk endurance, postural alignment, and balance parameters in clinical populations [11,12]. Although the majority of evidence for McGill-based core training originates from musculoskeletal rehabilitation, emerging literature supports its relevance in neurological conditions where trunk instability contributes to functional limitations [12]. Given the trunk weakness and postural deficits commonly observed in GBS, core stability training may provide a foundational component for balance rehabilitation in this population.

In addition to core strengthening, structured balance and fall-prevention programmes have demonstrated strong evidence for reducing fall risk across diverse populations. The Otago Exercise Programme (OEP) is a well-established, evidence-based intervention comprising progressive lower limb strengthening, balance retraining, and functional mobility exercises [13]. Originally developed for community-dwelling older adults, OEP has consistently been shown to improve balance, muscle strength, and functional mobility while reducing fall incidence and fear of falling [13–15]. Importantly, the adaptable and progressive nature of OEP allows it to be tailored to individuals with neurological impairments, including those with residual weakness and balance deficits.

Although both core strengthening and the Otago Exercise Programme have demonstrated independent benefits in improving balance and reducing fall risk, there is a paucity of research examining their combined application in individuals with Guillain-Barré syndrome. Existing rehabilitation literature in GBS primarily focuses on general strengthening, endurance training, and functional mobility, with limited emphasis on targeted balance and fall-prevention strategies [5,6]. Given that balance control depends on both proximal trunk stability and distal lower limb strength, a combined intervention integrating core strengthening with OEP may produce synergistic effects by addressing multiple components of postural control simultaneously.

Therefore, this case series aims to investigate the impact of a combined core strengthening programme based on McGill principles and the Otago Exercise Programme on balance and fall prevention in individuals with Guillain-Barré syndrome. Addressing this research gap may contribute valuable evidence to guide physiotherapy interventions aimed at improving functional outcomes and reducing fall risk in this understudied population.

2. Materials & Methods

Source of Data: Pravara Rural Hospital, Loni

Method of collection of data: (Including sampling procedure, if any)

Type of Data: Quantitative

Study Design: Case Series

Study Setting- The study will be conducted at the Department of Neuro-physiotherapy, Dr A.P.J. Abdul Kalam College of Physiotherapy, Pravara Institute of Medical Sciences, Loni

Sample size: 4

Participants: Guillain-Barré Syndrome (GBS) patients

Material to be used:
1) Consent form
2) Assessment form
3) Weight cuffs
4) Berg Balance Scale
5) Dynamic gate index
6) GBS disability scale
7) WHOQOL-BREF

Selection Criteria:

Inclusion criteria:
Participants included will be:
- Age between 18 – 60 years
- Gender - Both Male and Female
- Ability to understand oral and written information
- Diagnosed with Guillain-Barré Syndrome (GBS) (Acute, Sub acute. chronic)

Exclusion criteria:
Participants excluded will be:
- Other neurological conditions.
- Participants not willing to participate

Statistical Analysis
Analysis of raw data was performed using GraphPad Prism version 10 for Windows, GraphPad Software, Boston, Massachusetts, USA. At baseline (pre-intervention) and following the last session of the core strengthening and OTAGO exercise program (post-intervention), descriptive statistics, including mean ± standard deviation (SD), were determined for all outcome measures. In terms of outcomes, the main results were,

The Berg Balance Scale (BBS), the Dynamic Gait Index (DGI), the Guillain-Barré Disability Scale (GBS), and the domains of the WHO Quality of Life (WHOQOL): Physical Health, Psychological, Social Relationships and Environment. Paired t-tests were used to compare pre- and post-intervention scores for each outcome measure. Statistical significance was defined as a p-value of less than 0.05 with a confidence interval of 95%

3. Result

Participant Characteristics
This case series consisted of four patients with Guillain-Barré Syndrome. The median age of the participants was 27.5 ± 6.80 years.

Berg Balance Scale (BBS):
The mean BBS score increased considerably from 26.75 ± 5.74 at pre-intervention to 46.25 ± 1.50 after intervention.

indicating a considerable improvement in functional balance after the intervention (p = 0.0056, t = 7.1603).

Dynamic Gait Index (DGI):
Gait function improved significantly, with mean DGI scores increasing from 9.75 ± 4.86 pre-intervention to 18.25 ± 2.50 post-intervention (p = 0.0057, t = 7.1414), indicating enhanced dynamic gait ability.

Guillain–Barré Disability Scale (GBS):
The mean GBS score reduced considerably from 2.75 ± 0.50 to 1.50 ± 0.58 post-intervention (p = 0.0154, t = 5.000), indicating a decrease in impairment severity.

Quality of Life Outcomes:

WHOQOL – Physical Health:
Physical health quality of life improved significantly, with mean Physical health scores enhancing from 13 ± 0 at baseline to 28 ± 6 post-intervention (p = 0.0154, t = 5.000).

WHOQOL – Psychological Domain
The WHOQOL - Psychological Domain showed an increase in mean psychological scores from 23.5 ± 5.74 to 34.25 ± 6.50. This suggests a positive trend in psychological well-being, but the change was not statistically significant (p = 0.0722, t = 2.725).

WHOQOL – Social Relationships
The WHOQOL - Social Relationships score increased from 54.5 ± 22.93 to 87.5 ± 7.50, although the change was not statistically significant (p = 0.1052, t = 2.2983), suggesting a non-significant trend towards enhanced social relationships.

WHOQOL – Environment
The intervention did not significantly improve participants' perceived environmental quality of life, as evidenced by the environmental domain scores from 14 ± 12.94 to 21.75 ± 3.78 (p = 0.1927, t = 1.6742).

4. Discussion

This case series investigated the impact of a combined McGill core strengthening and OTAGO exercise program on balance, gait, disability, and quality of life in patients with Guillain-Barré Syndrome (GBS). Significant improvements were noted in balance (Berg Balance Scale, BBS), dynamic gait (Dynamic Gait Index, DGI), gait-related disability (GBS Disability Scale), and the physical health domain of quality of life (WHOQOL-PH). These findings affirm the role of targeted core and balance training in promoting functional mobility and decreasing fall risk among neurological populations.

The statistically significant enhancements in BBS and DGI can be attributed to strengthened trunk stability and postural control achieved via core exercises. Core muscles function as the central stabilising mechanism for the spine and pelvis during dynamic activities, thereby improving balance and gait through enhanced neuromuscular coordination and reduced compensatory movements[17,18]

Systematic evidence from various clinical groups, such as multiple sclerosis and stroke patients, demonstrates that core stabilisation training over 6–10 weeks leads to marked improvements in balance, especially functional performance assessed by tools like the BBS.[19, 20] Specifically, the McGill core strengthening protocol- incorporating isometric stabilisation exercises known as the "Big Three"- is engineered to boost endurance and co-activation of trunk musculature. This optimises spinal stiffness and functional stability, which are vital for maintaining balance and preventing falls.[21]

Similarly, the significant gain in WHOQOL-PH suggests that improvements in physical function directly contribute to enhanced perceptions of physical well-being. This aligns with rehabilitation literature indicating that advancements in functional mobility positively influence physical quality-of-life domains.[23]

In contrast, the psychological well-being, social relationships, and environmental domains of quality of life did not reach statistical significance. Several factors may account for these results. First, the small sample size (n=4) markedly reduces statistical power and heightens the risk of type II error, particularly for complex, multidimensional quality-of-life measures where effect sizes tend to be smaller and variability higher compared to physical performance metrics.[22] Second, domains such as psychological health and social relationships are shaped by emotional, interpersonal, and environmental influences that extend beyond the reach of physical exercise interventions. Meaningful changes in these areas typically demand longer durations, targeted psychosocial support, or integrated community reintegration efforts.[23] For instance, psychological adaptation among GBS survivors can be impacted by chronic fatigue, stress, or shifts in life roles—factors not directly addressed by motor training.[24] Likewise, environmental quality of life often reflects external elements like healthcare access, community resources, and living conditions, which are improbable to shift substantially within the brief timeframe of an exercise program. Consequently, although core and balance training yield measurable benefits in motor function and associated physical quality-of-life aspects, achieving statistically significant improvements in psychosocial and environmental domains likely requires a multimodal rehabilitation framework alongside larger sample sizes.

Overall, the results substantiate the beneficial effects of core stabilisation and balance training on physical function in GBS patients. Future research employing larger cohorts, extended follow-up periods, and incorporation of psychosocial interventions will provide greater insight into impacts across all quality-of-life domains beyond physical health.

5. Conclusion

This case series shows that combining McGill core strengthening with Otago exercises yields significant improvements in balance (Berg Balance Scale), dynamic gait (Dynamic Gait Index), gait disability (GBS Disability Scale), and physical quality of life (WHOQOL-PH) for GBS patients. These gains stem from enhanced trunk stability and

postural control, improving neuromuscular coordination, reducing compensatory patterns, and lowering fall risk. The physical quality-of-life benefits align with rehabilitation evidence linking better function to improved well-being. These results endorse incorporating targeted core and balance training into GBS protocols to boost physical function and independence.

Declaration by Authors

Ethical Approval: Approved

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