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CASE REPORT

Therapeutics laser and ultrasound effects on peripheral polyneuropathy in Guillain-Barré Syndrome: case study

Efeitos do laser e ultrassom terapêuticos combinados na polineuropatia periférica na síndrome de Guillain–Barré: estudo de caso

Efectos de la terapia por láser y ultrasonido sobre la polineuropatía periférica en el síndrome de Guillain–Barré: análisis de caso

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ABSTRACT | Guillain-Barré Syndrome (GBS) is a rare autoimmune disease that affects the nervous system, causing muscle weakness, paralysis, and lack of sensitivity. In addition to drug treatment, physical therapy assists in early recovery and prevention of comorbidities from paralysis. This article aims to evaluate the effectiveness of laser and ultrasound combination therapy in the recovery of superficial and deep sensitivity and muscle neuromotor control with GBS. This study analyzes a case report of a patient diagnosed with GBS and referred to physical therapy. We collected data on demographic characteristics, functionality, pain scale, score for muscle strength, and the quality of life via the SF-36. Among the final outcomes, we achieved the recovery of superficial and deep analgesia sensitivity to normal in the post-intervention period, improvement of functioning from 16 and to 68 points after combination therapy, total pre-intervention value was 210 and post was 780 points SF-36. Strength tests scored four and five points were observed in all muscle groups evaluated, before and after therapy, respectively. Romberg test was not performed before the intervention due to trunk instability; after treatment participants presented minimal balance changes. Finally, the protocol used was efficient to improve functioning, quality of life, and recovery of superficial and deep sensitivity of the upper and lower limbs, resulting in the return of the individual to activities of daily living with 20 sessions of physical therapy.

Keywords | Guillain-Barré Syndrome, Physical Therapy, Therapeutic Laser, Therapeutic Ultrasound

RESUMO | A síndrome de Guillain-Barré (SGB), doença autoimune rara que acomete o sistema nervoso, provoca fraqueza muscular, paralisia, falta de sensibilidade, e a fisioterapia auxilia na recuperação precoce e na prevenção de comorbidades provenientes da paralisia. Este artigo tem como objetivo avaliar a efetividade da combinação entre laser e ultrassom terapêuticos na recuperação da sensibilidade superficial e profunda e do controle neuromotor muscular com SGB. O estudo traz um relato de caso de um indivíduo diagnosticado com SGB e encaminhado para fisioterapia. Foram coletados dados acerca das características demográficas, da capacidade funcional, da escala de dor, da força muscular, além da aplicação do questionário de qualidade de vida SF-36. Entre os resultados, o teste de sensibilidade superficial e profunda, realizado com analgesia pré e normal no período pós-intervenção, demonstrou melhora da capacidade funcional. Na avaliação da qualidade de vida, o valor pré-intervenção foi de 210 pontos, e o de pós-intervenção, 780. O teste de *Romberg* não pôde ser realizado, dada a instabilidade de tronco para manter o corpo do paciente em equilíbrio. Concluiu-se que o protocolo foi eficiente para a melhora da capacidade funcional, da qualidade de vida e da recuperação da sensibilidade superficial e profunda dos membros superiores e inferiores, acarretando o retorno do indivíduo às atividades de vida diária com 20 sessões de fisioterapia.

Descritores | Síndrome de Guillain-Barré; Fisioterapia; Laser terapêutico; Ultrassom terapêutico.

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RESUMEN | El síndrome de Guillain-Barré (SGB) es una afección autoinmune rara que afecta el sistema nervioso causando debilidad muscular, parálisis y falta de sensibilidad; en este caso, la fisioterapia ayuda en la recuperación temprana y en la prevención de comorbilidades derivadas de la parálisis. Este artículo tiene como objetivo evaluar la efectividad de la combinación de la terapia por láser y ultrasonido en la recuperación de la sensibilidad superficial y profunda y del control neuromotor muscular con SGB. El estudio trata de un informe de caso de una persona diagnosticada con SGB y remitida para fisioterapia. Se recopilaron datos sobre las características demográficas, la capacidad funcional, la escala del dolor, la fuerza muscular y la aplicación del cuestionario de calidad de vida SF-36. Los resultados destacan que la prueba de sensibilidad superficial y profunda, realizada con analgesia pre y normal en el período posterior a la intervención, mostró una mejora en la capacidad funcional. En la evaluación de la calidad de vida, el valor previo a la intervención fue de 210 puntos; y el valor posterior a la intervención, 780. No se pudo realizar la prueba de *Romberg* dada la inestabilidad del tronco para mantener el cuerpo del paciente en equilibrio. Se concluyó que el protocolo fue eficiente en la mejora de la capacidad funcional de individuo, de la calidad de vida y de la recuperación de la sensibilidad superficial y profunda de los miembros superiores e inferiores al poder reincorporarlo a las actividades de la vida diaria con 20 sesiones de fisioterapia.
Palabras clave | Síndrome de Guillain-Barré; Fisioterapia; Terapia por Láser; Terapia por ultrasonido.

INTRODUCTION

Guillain-Barré Syndrome (GBS) stands as one of the most common subtypes of acute polyneuropathy, affecting two out of 100,000 individuals annually. Some estimates indicate a greater occurrence of the disease among males and people aged from 50 to 74 years old, however, it can affect individuals of all age groups, of both sexes and of any ethnicity[1]. Notably, 4–15% of patients with GBS die during treatment, and about 20% will have some disability[2].

In the acute phase of GBS, the most common symptoms include muscle weakness, paralysis, lack of sensitivity, tingling, pain that starts in the legs and affects the whole body, and decreased reflexes. Weakness in the torso and upper limbs can affect the muscles related to breathing, making the use of mechanical ventilation necessary. Involvement of the autonomic system is frequent and can cause urine retention, tachycardia, hypertension, postural hypotension, and arrhythmia[3]. Other complications associated with the acute GBS are insomnia, pressure ulcers, impaired communication, nutritional deficiency, immobility, and venous thrombosis[4].

Physical therapy is recommended for the rehabilitation of individuals with after-effect of GBS, and one of the methods consists of the application of therapeutic ultrasound or low-intensity laser therapy, which enable the potentiation of its anti-inflammatory effects, trophic, and regenerative analgesics. Also, such protocol enhances ATP production, favoring tissue regeneration, which stimulates microcirculation and increases the contribution of nutritional elements, associated with increased mitotic velocity, facilitating the multiplication of cells and the formation of new vessels from preexisting ones, in the whole system[-8].

A novel Brazilian equipment matches **ultrasound** and **laser**. This is the newest technology used for physical therapy procedures and has been showing promising results in the treatment of chronic diseases such as osteoarthritis, temporomandibular disorder, and fibromyalgia[7-8]. Although the literature on the benefits of this synergy between different physical agents is still quite scarce, theoretically, it is possible to achieve good analgesic and healing effects since the combination of ultrasound and laser in the same equipment yields a different mode of action[8].

Studies on the use of irradiation with therapeutic ultrasound concomitant with laser as a means of stimulating the regeneration of injured peripheral nerves are relatively scarce, given that the technology of the device is current and surviving GBS cases are rare. Thus this study aimed to evaluate the effectiveness of combination therapy with the use of ultrasound and laser in a single device in the recovery of superficial and deep sensitivity and control neuromotor disease of patients diagnosed with GBS.

METHODOLOGY

This is a case study on a 64-year-old male, smoker, sedentary, and with mitral valve regurgitation. To walk, he needed the help of a walking stick or wheelchair,

the presence of an enlarged base and the absence of waist dissociation, with a consequent increase in the support polygon. The individual was included in the research after seeking physical therapy treatment for rehabilitation of GBS after-effects and prevention of complications. The patient was diagnosed with GBS in September 2021, after performing cerebrospinal fluid protein tests, which showed values above normal (169mg/dl), and electroneuromyography, which indicated a moderate degree of demyelinating polyneuropathy in all four limbs. The former was suggested acute phase (15 days of evolution) on sensory and motor aspects, with greater sensory and distal severity, with moderate distal degeneration of sensory nerve fibers of upper and lower limbs, mild degeneration in the proximal region of the lower limbs and distal upper limbs, in addition to a moderate degree of distal degeneration of the lower limbs. The study was developed in a private physical therapy clinic by the responsible researchers linked to the Federal University of Alfenas.

The proposed clinical treatment was the administration of corticosteroids and daily gabapentin, and the patient did not need hospitalization.

Therapeutic protocol

The device that combines ultrasound and laser (Recupero brand, MMO company, Brazil, 2020) was used in 20 physical therapy sessions lasting 40 to 50 minutes, twice per week.

The following settings were used:

- Ultrasound: pulse.
- Frequency: 1MHz.
- Intensity: 0.8w/cm² (minimum nerve dose).
- Time: one minute per point
- Laser Mode: 660/808nm (with the two wavelengths linked).
- Time: one minute per point

The application of the head of the device followed the guidelines for the use of therapeutic ultrasound, placing a layer of conductive gel directly on the affected area and then attaching it to the head of the equipment, making slow and circular movements.

The main points of application were through the path of the median nerve at the elbows and hands height. For the lower limbs, the points of application of the device followed the innervation of the fibular nerve of the lower half of the legs and feet. Figures 1 and 2 show the application points of the appliance.

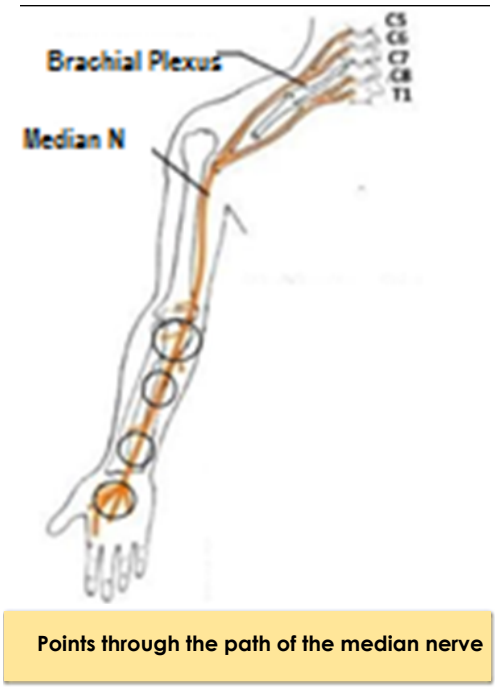


Figure 1. Application points on the upper limbs

Source: [????].

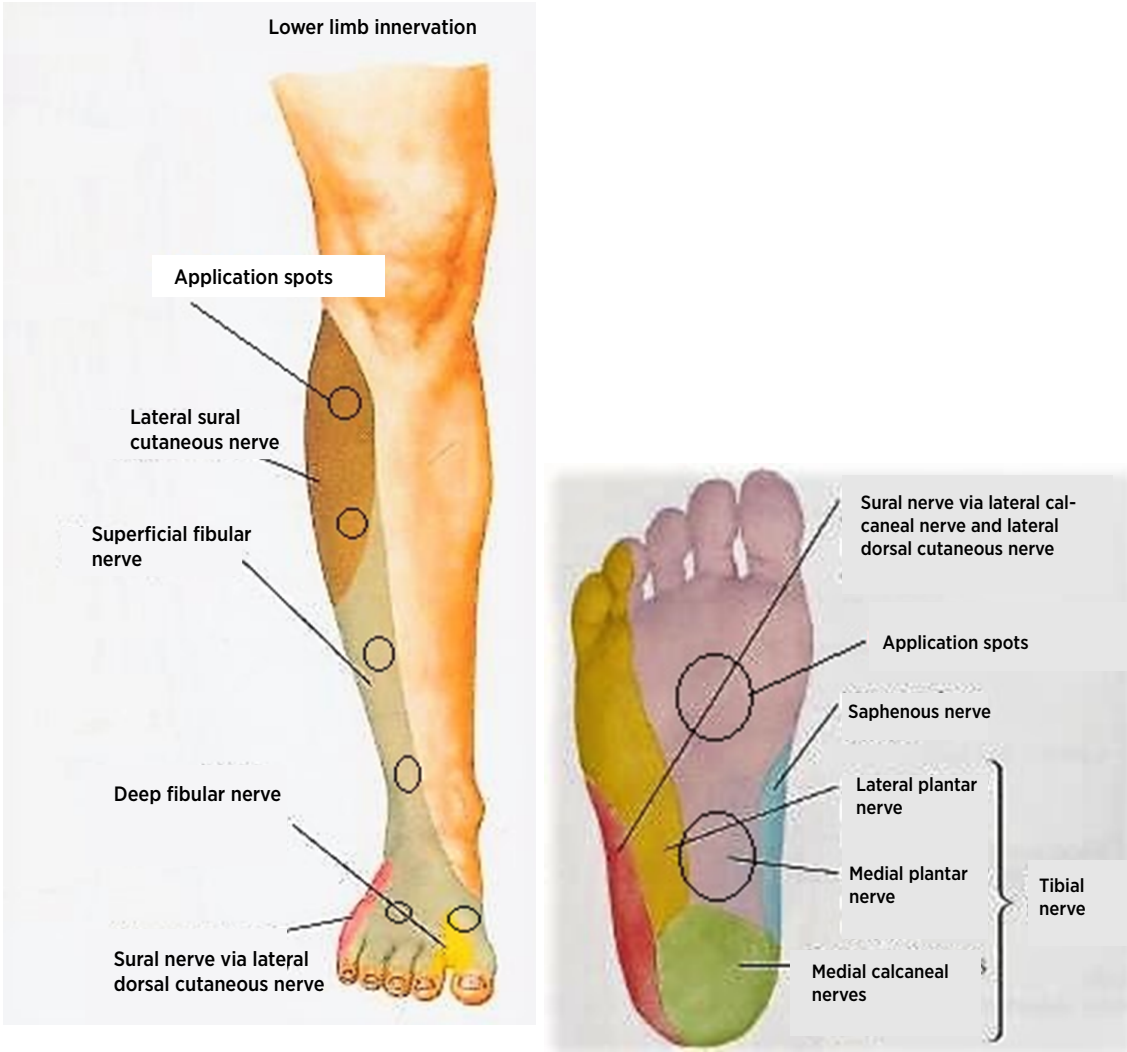
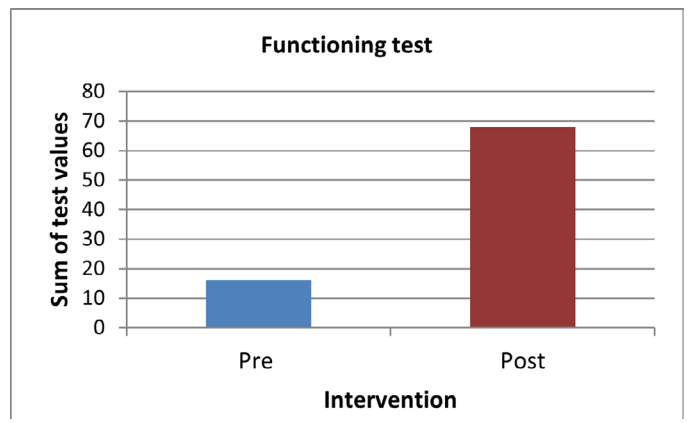


Figure 2. Application protocol of lower limbs

Source: [????].

In addition to the combination therapy with laser and ultrasound, stretching exercises of the upper and lower limbs, strengthening of the quadriceps, glutes, hip abductors, biceps, deltoid, and latissimus dorsi muscles were performed with the use of light intensity elastic bands (two sets of five repetitions, with one minute of rest) and a stationary bike for five minutes.

The evaluation included the collection of vital signs, such as blood pressure, heart and respiratory rate, and peripheral oxygen saturation, all within normal physiological parameters. For the evaluation of functioning, the adapted version—validated for the Brazilian population—of the lower extremity functional scale (LEFS) was used[9], which enabled observing an improvement in functioning after the sessions, with 16 points in the pre-intervention period and 68 points in the post-intervention period (Graph 1).



Graph 1. Comparison of the functional capacity test at the pre- and post-intervention moments

The Medical Research Council (MRC) score for upper and lower limb evaluation[10] indicated gains in muscle strength in the evaluated groups of upper and lower

limbs in the post-intervention period, compared to the pre-intervention period.

Superficial tactile, thermal and pain sensitivity tests, and evaluation of proprioception were performed. Recovery of the sensitivity of legs, feet, and hands was observed after the intervention. To evaluate tactile sensitivity, cotton was used on the extremities of the feet and hands for comparison. Tactile discrimination, in turn, was evaluated by means of the two-point test, with the use of tweezers. To test pain sensitivity, the fingers and toes, the backs of the hands and feet, the soles of the feet, and the palms of the hands were scratched with the tip of a pen cap[11].

The thermal sensitivity test was performed with test tubes containing hot water (40 to 45°C) and cold (5 to 10°C), which were alternately touched against the skin of the distal part of the legs, feet, and hands[11].

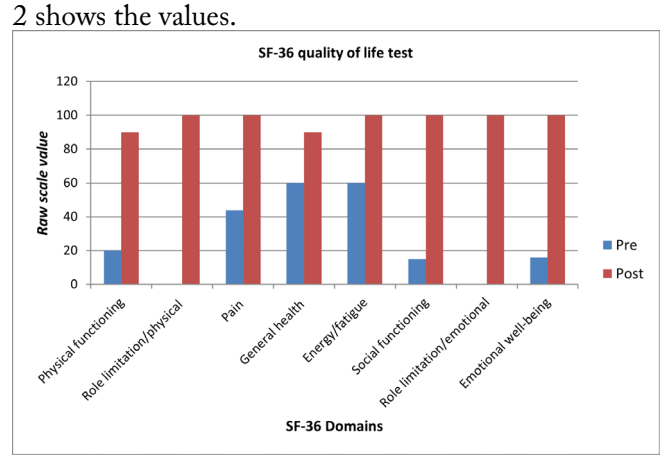
To evaluate deep sensitivity, specifically kinetic-postural, the hallux was moved down and up through the lateral portions, so that the patient could mark the position assumed at the end of the movement[11].

Reported pain remained at zero, according to the patient's report, both before and after the intervention. Table 1 shows the variables.

Table 1. Comparison between muscle strength, tactile, painful, thermal, and profound sensitivity variables Monte Belo, Minas Gerais, Brazil 2021

Parameter Stage	Pre-intervention	Post-intervention
Muscle strength	4	5
Shoulder abduction	4	5
Elbow flexion	4	5
Handle extension	4	5
Hip flexion	4	5
Knee extension	3	5
Ankle dorsiflexion		
Tactile sensitivity:		
Cotton		
HANDS	Analgesia	Normal
FEET	Analgesia	Normal
Colon		
HANDS	Analgesia	Normal
FEET	Analgesia	Normal
Painful tenderness		
Pen bridge		
HANDS	Hypoalgesia	Normal
FEET	Analgesia	Normal
Thermal Sensitivity		
Cold and Hot		
HANDS	Hypoalgesia	Normal
FEET	Hypoalgesia	Normal
Deep sensitivity **Proprioception**	Does not recognize	Normal

Quality of life was evaluated using the SF-36 questionnaire (Medical Outcomes Study 36 – Item Short – Form Health Survey)[12], composed of eight domains of the individual's life. The total value of the pre-intervention period was 210 points, and that of the post-intervention period, 780 points. By comparing these values, it was detected that the patient achieved the maximum score in the quality of life test with the physical therapeutic protocol, denoted by the increase in physical functioning, the decrease in physical limitations and symptoms of analgesia in the feet and hands, the improvement of general health and emotional well-being, the increase in energy, the less impairment of social functioning, and, finally, by the reduction of limitations arising from the patient's emotional state because of the disease. Graph 2 shows the values.



Graph 2. Comparison of the domains evaluated in the SF-36 quality of life test in the pre- and post-intervention

During the evaluation of possible changes in static balance of patients with neurological impairment by the Romberg test[13], the patient was unable to keep the feet close and aligned when closing the eyes to start the test, as he could not stabilize the torso in the pre-intervention period. Therefore, the test could not be conducted. In the post-intervention period, it was possible to perform the posture required by the test, and the individual remained in balance for 10 seconds, showing better torso control, and the test was considered positive.

DISCUSSION

The clinical course of GBS is characterized by progressive ascending symmetrical motor loss (from the lower to the upper limbs), loss of sensitivity, and hyporeflexia or areflexia. The progression of motor

weakness is rapid. The acute phase begins with the first symptoms until the stabilization of demyelination, which can last for days or weeks. After this period, the recovery phase begins, which can last from six months to two years, coinciding with remyelination and axon regeneration[14]. In the studied case, the recovery time—counted from the date of diagnosis and improvement of symptoms—was five months, with 20 sessions of physical therapy with concomitant use of ultrasound and laser and kinesiotherapy.

Among the resources commonly used in physical therapy for the regenerative purpose of peripheral nerve injuries, the concomitant use of ultrasound and low-level therapeutic laser aimed at the early return of the patient's normal functionality. In this study, the individual, via clinical and physical therapy evaluation, had severe alterations, with total analgesia to the tactile and deep sensitivity of the feet and hands. However, no studies were found involving the concomitant use of laser and ultrasound in a single device with the purpose of recovering peripheral innervation in GBS for a detailed discussion of the use of the technology and its main effects and benefits.

The effects on the peripheral innervation recovery promoted by the devices are reported separately in the literature. The cellular effect of the laser is linked to the activation of endogenous chromophores, promoting photophysical and photochemical effects that modulate several clinically relevant biological pathways[15]. The energy absorbed by the tissues via PBM stimulates tissue processes in a physiological way, favoring tissue regeneration (wound healing), as well as the modulation of inflammation, pain, and exacerbated immune responses. Current data suggest that PBM acts predominantly on cytochrome c oxidase (CcO) in the mitochondrial respiratory chain, facilitating electron transport by dissociating nitric oxide (NO) present in situations of cellular alteration, resulting in an increased transmembrane proton gradient, which drives the production of adenosine triphosphate (ATP)[16].

ATP is the universal energy source in living cells, essential for all biological reactions, and even a small increase in ATP levels can increase bioavailability to fuel cellular metabolism functions. The reactivation of the enzyme superoxide dismutase (SOD) via photo shutdown of H+ (proton ion) by light re-establishes the antioxidant action, contributing significantly to the modulation of the inflammatory process. In addition, other blood effects are reported, such as local vasodilation and normalization of hemoglobin functioning, which contributes to the acid-base balance of the blood and to the modulation of enzymatic and hormonal systemic functions[17]. Some systematic reviews and clinical studies have suggested the efficacy of laser photo biomodulation for the management of neurological diseases and GBS[16].

Therapeutic ultrasound is used for the physical therapy treatment of many diseases of the musculoskeletal system, but very little seems to be established regarding its use in the treatment of peripheral nerve injuries. Despite the lack of elucidation of the mechanisms of action involved and the discrepancies between parameterization, there seems to be a literary consensus that ultrasound can exert a pro-inflammatory action in the repair process[18]. According to some authors, it acts as an enhancer of the inflammatory response, promoting the release of histamine, macrophages, and monocytes, accelerating the cellular phase in the physiological resolution of inflammation[18]. However, it has been demonstrated that the peripheral nerve does not remain inert to the action of ultrasound[19].

In this report, it was possible to identify improvement in functional capacity and quality of life, walking without the use of a cane and independence for activities of daily living, which can be justified by the normalization of sensitivity, which contributed to the recovery of motor function. The association between sensory and motor functions is still being studied by researchers. Given this context, Erickson et al. observed that tactile sensitivity of the plantar face is related to the control of the ankle and knee joints, in addition to the control of the neuromuscular activity of the tibialis anterior muscle[20]. Sensitivity is the fundamental ingredient that mediates the proprioceptive mechanism[21]. The authors observed that the distal extremity of the upper and lower limbs was more important than the proximal part of the body for sending somatosensory information to the central nervous system and for providing healthy movements[20].

Margeret et al. observed the importance of sensitivity for motor control and affirmed the importance of considering sensitivity a prerequisite for the promotion of human movement[23].

Chang et al, in a case study, observed that the application of the laser on the back of the hand for ten sessions lasting one hour played a key role in the patient's recovery, reducing pain symptoms and improving the sleep quality of patients with GBS after COVID-19 vaccination[23]. In another study, the researchers, when applying intravascular laser to a patient with GBS in a wheelchair, observed an improvement in muscle strength,

which, before the intervention, was 2-3, going to 4-5, in addition to the decrease in neuropathic pain and walking with minimal support. Posture/balance tests provided direct evidence of positive correlation with laser intervention[24].

Via the evaluation of balance and proprioception using the Romberg test, it was possible to observe severe impairment before the intervention, and the individual was unable to perform the test. However, after the intervention, there was an improvement in proprioception, balance, and gait without support. Proprioceptive training is essential, but it was evident that the improvement in sensitivity resulted in the recovery of the individual's static and dynamic balance. Corroborating other authors, torso impairment should be investigated in all patients with GBS. The correlation between extremity functions and torso control cannot be underestimated. Torso control can affect body functions such as ventilation, gait, and balance[21,25-27].

Torso control has been studied many times in patients after a stroke[27], but studies in patients diagnosed with GBS are rare. Torso control is affected in many patients, and the main question is how much neuromotor impairment of the torso control affects balance, fall risk, and disability status[21]. Corroborating this study, an association was found between torso control and deficient functional motor status in the pre-intervention evaluation, in addition to significant improvements in the post-balance period, functional capacity and quality of life. The muscles of the torso and extremities work cooperatively to support functional movement, so that impairment in one affects the other[28].

Until recently, physical therapy focused only on the recovery of motor functions in individuals with GBS, But the literature and this study demonstrate that motor function is not sufficient for the total rehabilitation of functionality and quality of life. Procedures that promote the recovery of the sensory system are important, necessary, and should be additionally included in physical therapy treatment for recovery from the disease, and the concomitant use of therapeutic laser and ultrasound in early and safe rehabilitation has been shown to be effective, however, studies with larger sample sizes are still needed.

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