Effects of sensory deficits on balance, functional status and trunk control in patients diagnosed with guillain–barré syndrome

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ABSTRACT

الأهداف: التحقق من آثار العجز الحسي على التوازن، والوضع الوظيفي ومراقبة الجذع في المرضى الذين تم تشخيصهم بمتلازمة غيان باري (GBS).

الطريقة: شارك في هذه الدراسة الوصفية 20 مريضاً تم تشخيص إصابتهم بمرض GBS والذين كانوا في قسم الأمراض العصبية في جامعة مصطفى كمال في عام 2017. كان هناك 11 ذكور و 9 إناث، وكان متوسط العمر 41.55±18.49 عام. تم تقييم التحكم الجذع لمرضىGBS باستخدام مقياس ضعف الجذع (TIS)، تم تقييم الوصول إلى الدالة باستخدام اختبار الوصول الوظيفي (FRT) في وضع الجلوس وتوازن الجسم الذي تم تقييمه باستخدام مقياس التوازن (BBS). تم تقييمها باستخدام اختبار شعاعي واحد Semmes–Weinstein monofilament، تم تقييم الحس العميق باستخدام اختبار استقبال الحس العميق القاصي وتم تقييم حالة الإعاقة باستخدام مقياس العجز Guillain–Barré syndrome (disability scale (GBSDS.

النتائج: وجدنا علاقة معتدلة وإيجابية وهامة بين علامات العاصفة و BBS وبين درجات التحسن و TIS. لم يكن الارتباط بين التحسن وFRT في وضع الجلوس وبين التحسن و GBSDS كبيراً. وجدنا علاقة معتدلة وسلبية بين لمسة خفيفة و FRT في وضعية الجلوس، TIS ، BBS ، ولكن ترابط معتدل وإيجابي بين لمسة خفيفة و GBSDS.

الخاتمة: يجب على كل من أطباء الأعصاب والأخصائيين في العلاج الطبيعي أخذ الوظيفة الحسية والحركية بعين الاعتبار في برنامج التقييم وإعادة التأهيل للمرضى المشخصين بمرض GBS.

Objectives: To investigate the effects of sensory deficits on balance, functional status and trunk control in patients diagnosed with Guillain–Barré syndrome (GBS).

Methods: Twenty patients who were diagnosed with GBS and who were in the neurology department of Mustafa Kemal University in 2017, participated in this descriptive study. There were 11 males and 9 females, and the average age was 41.55 ± 18.49 years. The trunk control of the GBS patients was assessed using the trunk impairment scale (TIS), reaching function was assessed using the functional reaching test (FRT) in the sitting position and body balance assessed using the Berg balance scale (BBS). Light touch was assessed using Semmes–Weinstein monofilament test, proprioception was assessed using the distal proprioception test and disability status was assessed using the Guillain–Barré syndrome disability scale (GBSDS).

Results: We found a moderate, positive and significant correlation between proprioception scores and the BBS and between proprioception scores and the TIS. The correlation between proprioception and FRT in the sitting position and between proprioception and the GBSDS was not significant. We found a moderate and negative correlation between light touch and the FRT in the sitting position, TIS, BBS, but a moderate and positive correlation between light touch and the GBSDS.

Conclusion: Neurologists and physiotherapists should both take sensory and motor function into consideration in the assessment and rehabilitation program of patients diagnosed with GBS.

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Guillain–Barré syndrome (GBS) is characterised by rapidly evolving ascending motor and sensory deficits that progress for over up to 4 weeks.[1,2] Extremity and trunk muscles are impaired; trunk muscles are involved in 34% of GBS patients.[3] Awareness of the body and its relationship to the surrounding environment is provided by sensation. The history of sensation dates back to the first descriptions of the 5 senses by the Greek philosopher, Aristotle.[4]

Correlations between sensory and motor function have been studied by many researchers. Erickson et al,[5] reported that tactile sensations of the foot sole have been shown to influence gait pattern control in lower limb joints, as well as the activity of the tibialis anterior muscle. In other studies, stroke patients who experienced sensory and motor impairments had a poorer prognosis than those with motor deficits alone.[6,7] Another study showed a weak to moderate correlation between higher order sensory functions and manual dexterity in patients with idiopathic Parkinson's disease.[8] Many studies have examined the correlation between motor and sensory deficits in a range of diseases, but there are few studies that focused on Guillain–Barré syndrome.

The aim of the present study was to investigate the effects of sensory deficits on balance, functional status and trunk control. It was hypothesised that (i) loss of tactile sensation could affect balance and functional status of GBS patients; (ii) loss of proprioception could affect balance and functional status of GBS patients; and (iii) trunk function could affect the functional motor performance of GBS patients.

Methods. The study was conducted at the Mustafa Kemal University Hatay, Turkey, Department of Physiotherapy and Rehabilitation between January-June 2017. Subjects of any ethnicity and between the ages of 18-75 years with a diagnosis of GBS were included in the study. Twenty patients who were diagnosed with GBS (11 male, 9 female) participated in the study. The average age of the study participants was 41.55±18.49 years. All participants were previously diagnosed with GBS by a neurologist before participating in the study and the diagnose made according to "The revised version of the NINDS diagnostic criteria from 1990". The study was approved by the Mustafa Kemal University Ethical Council, and written consent was obtained from the participants prior to participation.

Inclusion criteria. Patient diagnosed with GBS, irrespective of race; able and willing to voluntarily give informed consent prior to the performance of any study specific procedures; and no sensory deficits pre-GBS.

Exclusion criteria. Pregnancy (as determined by a urine pregnancy test) or a lactating female; seizures at the assessment time; evidence of upper motor neuron involvement; or any medical condition, including psychiatric disease.

The assessment protocol was applied by a physiotherapist who was trained to use the scales. The instruments were administered during the morning in a single day, and the patients were offered rest periods between tasks to avoid fatigue. The patients were tested with BBS, TIS, GBSDS and FRT. The sensory assessment was carried out following the motor assessments (**Table 1**).

Motor assessment. The disability status of each patient was examined using the GBSD, adapted from Hughes et al.[9] The scoring was as follow: 0= a healthy state; 1=minor symptoms and capable of running; 2=able to walk 10 m or more without assistance but unable to run; 3=able to walk 10m across an open space with help; 4=bedridden or chair bound; 5=requiring assisted ventilation for at least part of the day; and 6= dead.

The trunk control of each GBS patients was assessed using the TIS, reaching function was assessed using the FRT and body balance was assessed using the BBS. The TIS was developed by Verheyden et al,[10] and it aimed to evaluate the trunk in patients who have suffered from a stroke. Trunk impairment scale is used in patients with stroke, Parkinson's disease and other neuromuscular diseases. We conducted a Manual muscle test for the both extremities to decide the uneffected side.[11] The total score for TIS ranged between 0 (for a minimal performance)-23 (for a perfect performance). The BBS is a 14-item objective measure designed to assess static balance and fall risk in adult populations. The maximum score is 56 and the high score defines better balance.[12]

Table 1 - Motor and sensorial assessment methods used in the study.

Motor assessment	Sensorial assessment
- Berg Balance Scale (BBS)	- Semmes-Weinstein Monofilament Test
- Trunk Impairment Scale (TIS)	- Distal Proprioception Test
- GBS Disability Scale (GBSDS)	- Visual Analog Scale (VAS)
- Functional Reach Test (FRT)	

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Sensory assessment. To determine sensitivity in the sole of the foot and the malleolus, the Semmes–Weinstein monofilament examination was carried out. The monofilament was pressed to each site with sufficient force to produce bowing at a 90° angle for at least 2 seconds. During the test, the participants were in a supine position and unable to see the test process. They were instructed to respond with a "yes" when touch was felt, and to state the site that was being touched. We started by using the smallest microfilament, and we used increasingly larger microfilaments as the examination continued. If the patient could not feel the touch, a thicker microfilament was used. The interval between stimuli was varied from 2-5 seconds so that the observer could judge whether the responses accurately followed stimuli.[13] Light touch was examined at different points: medial and lateral malleolus, medial and posterior sides of the knees, heels, and first and fifth fingers on the right and left sides.

Proprioception was evaluated using a distal proprioception test. Proprioception in fingers and extremities were tested by determining if the patient (with eyes closed) could feel the finger or extremity that had been moved up or down. The test was repeated 10 times, and the patients were asked to guess the position each time.[14] The pain was assessed using a 10 cm visual analogue scale (VAS).[15]

Statistical analysis. Statistical analyses were performed using Statistical Software SPSS 22.0 (IBM Corp., Armonk, NY, USA). Categorical variables were arranged by frequency, and scaled measurements were arranged by the mean ± the standard deviation. The parametric data was tested for normality using the Shapiro-Wilk test. Spearman's test was used for the correlation analyses of the independent variables. To categorise the level of Spearman's correlation coefficient (r), we adopted the following scores: r<0.40 corresponded to a weak correlation, r=0.75 corresponded to a moderate correlation, and r>0.75 corresponded to a high correlation.[16] A *p*-value>0.05 was considered significant.

Results. Twenty patients (11 male, 9 female) aged 41.55 ± 18.49 years were included in the study. The disability score was equal to 2 for 3 patients, equal to 3 for 7 patients and equal to 4 for 10 patients. Only 3 patients had a history of falling, while 9 patients had a fear of falling. All of the patients were in the acute service, and the mean duration of the disease was 6.35±4.22 days (range: 1-14 days) (**Table 2**).

Table 2 - Demographic data of the patients. N=20.

Factors	n (%)
Gender	
Male	11 (55)
Female	9 (45)
GBS Disability Score	
1	0 (0)
2	3 (15)
3	7 (35)
4	10 (50)
5	0 (0)
Falling history	
Yes	3 (15)
No	17 (85)
Falling Place	
Home	2 (66.7)
Outside	1 (33.3)
Fear of falling	
Yes	9 (45)
No	11 (55)
Dominant side	
Right	19 (95)
Left	1 (5)

GBS - Guillain–Barré syndrome

The mean BBS score was 15.85±19.25 (range: 0-56). The mean TIS score was 11.85±8.78 (range: 0-23), while the mean FRT distance in the sitting position was 5.8±6.09cm (range: 0-13 cm) and the mean VAS was 4.7±2.65 (range: 0-9).

We found a moderate, positive and significant correlation between proprioception scores and the BBS and between proprioception scores and the TIS. The correlation between proprioception and the FRT in the sitting position and between proprioception and the GBSDS was not significant. We found a moderate, negative but not significant correlation between VAS and TIS (**Table 3**).

We found a moderate and negative correlation between light touch and FRT in the sitting position, TIS and BBS, but a moderate and positive correlation between light touch and the GBSDS (**Table 4**).

We found a high, positive and significant correlation between the TIS and FRT in the sitting position (rho=0.861), and a moderate, negative and significant correlation between the TIS and GBSDS (rho=-0.662). A high correlation was found between the TIS and BBS (rho=0.862).

Discussion. The present study was conducted to examine the effects of sensory impairment on motor functions, and to analyse the correlation between trunk

Table 3 - Correlation between proprioception and functional scales; VAS and functional scales.

			X±SD	FRT in sitting		BBS		TIS		GBSDS	
				rho	*p*-value	rho	*p*-value	rho	*p*-value	rho	*p*-value
PROPRIOCEPTION	Knee	R	7.7±2.7	0.257	0.275	0.401	0.080	0.551	0.012	-0.313	0.179
		L	7.75±2.55	0.253	0.282	0.411	0.072	0.522	0.018	-0.195	0.411
	Ankle	R	8.15±2.13	0.434	0.056	0.505	0.023	0.654	0.002	-0.430	0.059
		R	8.00±2.24	0.316	0.175	0.509	0.022	0.666	0.001	-0.339	0.014
VAS			4.70±2.65	-0.212	0.370	-0.265	0.259	-0.408	0.074	0.001	0.997

FRT - Functional Reach Test, BBS - Berg Balance Scale, TIS - Trunk Impairment Scale, GBSDS - Guillain–Barré syndrome Disability Scale, VAS - Visual analogue scale, R - right, L - left

Table 4 - Correlation between light touch and functional scales.

				FRT in sitting		BBS		TIS		GBSDS	
Light Touch			Median	rho	*P*-value	rho	*P*-value	rho	*P*-value	rho	*P*-value
Malleol	Med.	R	3.61	-0.296	0.206	-0.462	0.040	-0.380	0.098	0.341	0.140
		L	3.61	-0.387	0.092	-0.546	0.013	-0.535	0.015	0.313	0.180
	Lat.	R	3.61	-0.441	0.052	-0.370	0.109	-0.399	0.081	0.244	0.300
		L	3.61	-0.447	0.048	-0.544	0.013	-0.549	0.012	0.379	0.10
Knee	Med.	R	3.61	-0.259	0.271	-0.218	0.355	-0.209	0.377	0.088	0.712
		L	3.61	-0.259	0.271	-0.218	0.355	-0.209	0.377	0.088	0.712
	Post.	R	3.61	-0.269	0.252	-0.321	0.167	-0.302	0.196	0.224	0.343
		L	3.61	-0.350	0.130	-0.290	0.215	-0.271	0.248	0.235	0.319
Heel		R	4.31	-0.440	0.052	-0.540	0.014	-0.490	0.028	0.502	0.024
		L	4.31	-0.467	0.038	-0.443	0.050	-0.444	0.050	0.361	0.118
Finger	5th	R	3.61	-0.372	0.106	-0.496	0.026	-0.459	0.042	0.436	0.054
		L	3.61	-0.450	0.047	-0.278	0.236	-0.231	0.328	0.220	0.351
	1st	R	3.61	-0.493	0.027	-0.418	0.067	-0.379	0.10	0.337	0.146
		L	3.61	-0.515	0.020	-0.497	0.026	-0.461	0.041	0.403	0.078

VAS - Visual Analog Scale, FRT - Functional Reach Test, BBS - Berg Balance Scale, TIS - Trunk Impairment Scale, GBSDS - Guillain Barre Syndrome Disability Scale, R - right, L - left, Med. - medial, Lat. - leteral, Post. - posterior.

control and motor functions of the body in patients with GBS. We found a moderate correlation between sensory tests and motor functions. Our results show that the severity of the disease does not cause more proprioception problems, but it does affect light-touch sensory. While proprioception did not affect the FRT in the sitting position, light-touch sensory affected. Pain had no correlation with functional scales. Trunk control status affected the FRT in the sitting position, body balance and disability status.

In Ruts et al's,[17] study was found that severity of weakness and disability were significantly correlated with intensity of pain. In the present study, we found that pain did not affect functional status. That finding was not a result of amount of the pain (4.70±2.65), the patients were in acute phase and they were mostly not ambulate so the pain was not triggered by movement. Also, the duration of disease for the patients in the present study ranged from 0-14 days, which means the short length of time did not cause the functional status to be affected by the pain.

There are many studies that have examined the correlation between motor and sensory functions in different diseases. Scalha et al,[6] conducted a study to investigate the correlations between measurements of motor and sensory functions. They found a correlation between the sensory and motor functions of the upper limbs in chronic hemiparetic stroke patients. In a systematic review, Joushua et al declared that proprioceptive training provides meaningful improvements in somatosensory and sensorimotor function.[18] In a study, it was found that there is a correlation between electrically induced reflex activity and involvement of proprioceptive in afferent fibres in patients with GBS.[19] Proprioceptive training induces cortical reorganisation, reinforcing the notion that proprioceptive training is a valuable method for improving sensorimotor function. Proprioception was correlated with the BBS and TIS. Most of the BBS parameters were conducted while standing, so any sensory impairment affected the result of the BBS. Standing straight required healthy peripheral somatosensorial input. Proprioception impairment caused problems in balance, and this resulted a risk of falling, balance and movement problems. While proprioception impairment in the ankle affected balance, the proprioception impairment in the knee did not. We think orders of tests in the BBS were made mostly by standing, not kneeling. That is why we obtained these results.

Proprioception did not change in terms of the GBSDS. We found that the severity of the disease did not cause more proprioception problems. While proprioception impairment did not affect the FRT in the sitting position, the light-touch sensory affected.

Kars et al,[20] conducted a review to identify the impact of reduced somatosensation on balance. They declared that based on the knowledge of the association between specific somatosensory loss and deterioration of balance, conclusions can be made about the role of somatosensation in balance while standing. They found that this reduced somatosensation seemed to have a negative effect on balance in patients with diabetic neuropathy and Charcot-Marie tooth disease type 2; however, those findings did not appear to apply to patients with Charcot-Marie tooth disease type 1; or in healthy subjects. Margeret et al,[21] reported the importance of sensation for motor control, and the authors stated that importance of considering sensation as a separate entity and as a prerequisite for normal movement could not be underestimated. In Daneshjoo et al's study,[8] they examined sensory measures that could predict manual dexterity in patients with idiopathic Parkinson's disease. The study found a low to moderate correlation between higher order sensory functions and manual dexterity in patients with idiopathic Parkinson's disease. Haptic performance was associated with manual dexterity in those patients.[8]

While a light-touch sensory examination of the malleolus, heel and fingers as correlated with the FRT in the sitting position, there was not a correlation following examination of the knee. There was no correlation between the knee and any of the other scales. The distal part of the extremity was more important than the proximal part of the body for sending somatosensorial information to the central nervous system and for providing healthy movement. A light-touch sensory examination of the first and fifth fingers was correlated with functional scales in the left or in the right foot. We think that the ability of both the first and fifth fingers to detect light touch affects the functional status of the body, and these 2 fingers play an important role in functionality.

Berg balance scale and TIS scores were affected by all of the light-touch sensory results, with the exception of the knee. For better balance and trunk movement, all parts of the feet should have the ability to detect light touch. A positive correlation was observed between the GBSDS and light touch of the right heel. We determined the ability to detect light touch in the heel becoming worse as disease severity increased.

We found a moderate correlation between tactile stimulation, proprioception and motor function in patients diagnosed with GBS. The present study will contribute a new perspective to the literature about GBS treatment. A few studies have examined motor-sensory correlations in GBS patients. The correlation between sensory and motor functions requires a holistic approach that goes beyond investigations of only motor or sensory function. Until recently, rehabilitation focused only on motor functions, but as we see in the literature, motor or sensory function on its own is not enough for qualitative and healthy functions; both of them is important and necessary for functional movement.

"Sensation is the fundamental ingredient that mediates the proprioceptive mechanism. The articular structures of the body act as sensory chambers which relay proprioceptive information between specific neural pathways within the 2 peripheral nervous system and central nervous system. These neural pathways also transport the necessary sensorimotor information which modulates muscle function".[4] The results from the present study provide evidence of a relationship between motor and sensory functions. In the assessment as well as the treatment both of them should be included.

Alzaidi et al declared that upper extremity weakness was mainly distal, while lower extremity weakness was mainly proximal in GBS patients, and there was a predilection for trunk muscle involvement that was quite unusual in other types of polyneuropathy. Trunk muscles were involved in 34% of GBS patients.[3] Trunk impairment should be investigated in all the patients. The correlation between extremity functions and trunk control cannot be underestimated. Trunk control affects many functions, such as ventilation, gait and balance. An important aspect of function is trunk control, without it, the ability to maintain balance and fulfilling tasks worsens. Saether et al,[22] defined trunk control in the sitting position as having a moderate to good correlation with trunk control during gait. Also, Elsinawy et al,[23] reported that the relationship between trunk muscles and ventilatory function appear to be significant in chronic haemorrhagic stroke. Both knees and ankle proprioception affected the TIS results. Trunk impairment scale was conducted while sitting, and both the knees and ankles peoprioreceptors should send information to the central nervous system for healthy movement. Also, the trunk can make an intended action successfully by stabilising the lower extremities, and this can be accomplished by healthy sensory proprioception.

The best predictors for functional ability and destination at discharge from inpatient rehabilitation are both trunk performance in the sitting position and balance in the lying, sitting and standing postures after stroke. Scores from patients who underwent the Postural assessment scale for stroke may have a slightly better prognostic value than scores from the Trunk impairment scale.[24] In the literature, rehabilitation of patients with chronic stroke should include programs to improve trunk stability.[25] Trunk control has been studied many times in patients following a stroke, but studies in patients diagnosed with GBS are rare. Trunk control is affected in many patients, and the main question is how much the trunk control impairment affects balance, risk of falling and disability status. In the present study, we found a correlation between trunk control and functional motor status of the patients. Daily living activities mostly involve sitting and standing, and trunk control is the fundamental factor for balance; therefore, the trunk is important for daily life. Sitting function is made possible by trunk muscles; for quality sitting, healthy trunk muscles are needed. Trunk and extremity muscles work in cooperation to support functional movement, so impairment in one of them affects the other.

An important limitation of the present study was the small group size. Future studies should include bigger groups, and there should be an equal number of patients for each grade of the GBSDS.

In conclusion, this present study demonstrated a significant, moderate correlation between sensory functions and motor functions. Neurologists and physiotherapists should take into consideration both sensory and motor function in assessment and rehabilitation programs.

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