■Original Article

Correlation of electrodiagnostic findings and the disabilities of arm, shoulder and hand questionnaire in ulnar neuropathy at the elbow

Dirsekte ulnar nöropatide elektrodiagnostik bulgularla kol, omuz ve el sorunları anketinin korelasyonu

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Abstract

Aim: We aimed to find out whether there is a relationship between the electrodiagnostic findings and disabilities of arm, shoulder and hand (DASH) questionnaire in the ulnar neuropathy at the elbow (UNE).

Material and Methods: Patients whose clinical and electrodiagnostic findings were compatible with UNE were included in this retrospective cohort study. UNE patients were divided into mild, moderate and severe UNE according to the neurophysiological classification. DASH-disability / symptom (DASH-DS) scores of all patients were calculated. In addition, DASH work module (DASH-W) and DASH sports / performing arts module (DASH-SP) questionnaire were applied to some patients.

Results: Thirty-nine UNE patients were included in the study. There were 26 mild UNE patients, 8 moderate UNE patients, and 5 severe UNE patients. There was a positive correlation between neurophysiological classification of UNE and DASH-DS / DASH-W scores (p = 0.002 r = 0.491, p = 0.012 r = 0.453). An inverse correlation was found between DASH-W scores and ulnar nerve compound muscle action potential / sensory nerve action potential amplitudes (p = 0.036 r = -0.413, p = 0.006 r = -0.492). When the moderate and severe UNE group was evaluated as a single group, DASH-DS and DASH-W scores of mild UNE patients were low in those of moderate-severe UNE patients (p = 0.001, p = 0.012).

Conclusion: This study showed a positive correlation between the DASH scores and the neurophysiological classification in the UNE. In addition to the DASH-DS questionnaire, the use of the DASH-W questionnaire can be useful in UNE.

Keywords: DASH questionnaire; electrodiagnosis; ulnar neuropathy

Öz

Amaç: Dirsekte ulnar nöropatide (DUN) elektrodiagnostik bulgular ile kol, omuz ve el sorunları (DASH) anketi arasında bir ilişki olup olmadığını bulmayı amaçladık.

Gereç ve Yöntemler: Klinik ve elektrodiagnostik bulguları DUN ile uyumlu olan hastalar bu retrospektif kohort çalışmasına dahil edildi. DUN hastaları nörofizyolojik sınıflandırmaya göre hafif, orta ve şiddetli DUN olarak ayrıldı. Tüm hastaların DASH-özürlülük / semptom (DASH-ÖS) skorları hesaplandı. Ayrıca bazı hastalara DASH iş modeli (DASH-İ) ve DASH yüksek performans sporları ve müzisyenler anketi uygulanmıştır.

Bulgular: Otuz dokuz DUN hastası çalışmaya dahil edildi. Yirmialtı hafif DUN, 8 orta DUN ve 5 şiddetli DUN hastası vardı. DUN'un nörofizyolojik sınıflandırması ile DASH-ÖS / DASH-İ skorları arasında pozitif bir korelasyon vardı (p = 0.002 r = 0.491, p = 0.012 r = 0.453). DASH-İ skorları ile ulnar sinir bileşik kas aksiyon potansiyeli / duyusal sinir aksiyon potansiyeli amplitüdleri arasında ters bir korelasyon bulundu (p = 0.036 r = -0.413, p = 0.006 r = -0.492). Orta ve şiddetli DUN grubu tek bir grup olarak değerlendirildiğinde, hafif DUN hastalarının DASH-ÖS ve DASH-İ skorları orta-şiddetli DUN hastalarının skorlarından daha düşük bulundu (p = 0.001, p = 0.012).

Sonuç: Bu çalışma DUN'da DASH skorları ile nörofizyolojik sınıflandırma arasında pozitif bir korelasyon olduğunu göstermiştir. DASH-ÖS anketine ek olarak, DASH-İ anketinin kullanımı DUN'da faydalı olabilir.

Anahtar kelimeler: DASH anketi; elektrodiagnoz; ulnar nöropati.

Introduction

Ulnar neuropathy at the elbow (UNE) is the second most common entrapment neuropathy. The diagnosis can be made by clinical features, electrodiagnostic tests and imaging methods. Sensory abnormalities in the ulnar nerve dermatome or weakness or atrophy in the muscles innervated by the ulnar nerve may be observed in UNE [1,2,3,4]. Although ultrasonography is also used in the diagnosis of UNE, nerve conduction studies have a more important place in the diagnosis of UNE [1,3,5]. In nerve conduction studies, the slowing of the ulnar motor nerve conduction velocity (NCV) across the above elbow-below elbow segment or the detection of a conduction block in this segment supports the diagnosis of UNE [1,6,7,8,9,10]. Within the electrodiagnostic tests, short segment motor nerve conduction studies across the elbow segment is considered as the gold standard [1,4,7,8,9]. With this method, UNE can be diagnosed and lesion localization can be found. UNE can be mild or moderate, or it can be severe enough to cause disability. Therefore, it is important to diagnose and follow up UNE. In addition to physical therapy, some patients with a lesion under the humeroulnar aponeurotic arcade (HUA) may be operated [1,5,11]. The upper limb disability can be evaluated with the disabilities of arm, shoulder and hand questionnaire (DASH) questionnaire [12,13]. The DASH questionnaire was used for postoperative evaluation in patients with UNE under HUA [14,15]. It was aimed to find the relationship between DASH questionnaire and electrodiagnostic findings of UNE. Thus, we also aimed to evaluate the use of DASH in UNE.

Material and Methods

Individuals who applied to the electromyography (EMG) laboratory between July 2018 and December 2019 and whose clinical and electrodiagnostic features were compatible with UNE were included in this retrospective cohort study. Patients were excluded from the study if they had polyneuropathy or a disease such as diabetes mellitus that would cause polyneuropathy, or a family history of hereditary polyneuropathy, or a history of surgery of the extremity, if there were findings compatible with polyneuropathy in nerve conduction studies. If the clinical and electrodiagnostic findings were compatible with UNE, the patient was considered to have UNE [3,4,16]. The patient was considered to have clinically UNE when one of the following criteria was: 1) Continuous paresthesia in the ulnar nerve dermatome 2) Hypoesthesia in the ulnar nerve dermatome 3) Weakness in the muscles innervated by the ulnar nerve. Turkish version of DASH questionnaire was applied to all patients. This questionnaire consisted of 30 questions [12,13]. DASH disability / symptom (DASH-DS) score was calculated in patients. If the patient did not answer more than 1 questions, the DASH-DS score was not calculated. DASH work module (DASH-W) and DASH sports /

performing arts module (DASH-SP) questionnaire was also applied to some patients, and in this optional questionnaire, the score was calculated if all questions were answered.

Cadwell Sierra Summit EMG unit (Cadwell laboratories, Kennewick, Washington, USA) was used for nerve conduction studies and needle EMG. Median, ulnar, peroneal, posterior tibial, sural nerve sensory and motor nerve conduction studies and needle EMG were applied to all patients. Electrodiagnostic tests were performed if the temperature of the extremities was above 32 degrees, otherwise the extremities were heated. Stimulation and recording were made using surface electrodes. Nerve stimulation was performed supramaximally. Low-high filters for sensory and motor nerve conduction studies were set at 20Hz-2kHz and 20Hz-10kHz, respectively. In motor and sensory nerve conduction studies, sweep speed and sensitivity were 5 ms / division, 1 ms / division and 2 mV / division and 10 μV / division, respectively. Compound muscle action potential (CMAP) and sensory nerve action potential (SNAP) amplitudes were obtained by measuring peak to peak. Ulnar nerve CMAP was obtained from the abductor digiti quinti (ADQ) and first dorsal interosseous (FDI) muscles, and the median nerve CMAP was obtained from the abductor pollicis brevis muscle. Median and ulnar nerves were stimulated at wrist, 5 cm proximal to the recording electrode. The stimulation site was 12 cm proximal from the recording electrode to obtain ulnar nerve CMAP recording from FDI muscle (the pathway of the ulnar nerve was taken into account). Ulnar motor nerve conduction was performed based on Buschbacher's method [17,18]. Kanakamedala's method was used for short segment motor nerve conduction in the elbow [8]. Short segment motor nerve conduction study across the elbow was performed at 2 cm intervals. The stimulation points were 2 cm (D2) and 4 cm (D4) distal to the medial epicondyle, medial epicondyle (ME), 2cm (P2), 4cm (P4) and 6 cm (P6) proximal to the medial epicondyle. Ulnar and median sensory nerve conduction studies were performed orthodromically. Peak latency was used in sensory nerve conduction studies. Sural nerve SNAP was obtained antidromically. The posterior tibial and peroneal nerve CMAPs were obtained using conventional methods. Stimulation points for obtaining the peroneal nerve CMAP were the ankle, below the head of the fibula, and the popliteal fossa. For reference values of nerve conduction studies, previous studies were considered [4,19]. For the diagnosis of UNE, it should have been one of the following electrodiagnostic criteria; 1) Ulnar motor NCV above elbow-below elbow segment <45 m/s, 2) In motor nerve conduction study, presence of conduction block across elbow segment (CMAP amplitude obtained by above elbow stimulation reduced by more than 50% compared to CMAP obtained by below elbow stimulation) 3) the velocity difference between motor NCV of the forearm and elbow segments (FEVD) > 14 m/s, 3) latency difference in the short segment motor nerve conduction study > 0.6 ms [4,16]. The lower reference limits of ulnar SNAP amplitude of 5th digit-wrist segment and distal ulnar nerve CMAP amplitude recorded from the ADQ muscle were considered as 7.5 μV and 7.0 mV, respectively [4,19]. UNE patients were divided into mild, moderate, severe and extreme UNE according to the classification proposed by Padua [2]. Extreme UNE patients were excluded from the study because ulnar CMAP could not be obtained in extreme UNE. Patients were considered to be mild UNE if there was a slowing of ulnar motor NCV across elbow segment, and a moderate UNE if SNAP amplitude was reduced in addition to slowing of ulnar motor NCV across elbow segment, and severe UNE if the ulnar SNAP could not be obtained in addition to slowing of ulnar motor NVC across elbow segment. Concentric needle electrodes were used for needle EMG. Positive sharp wave and fibrillation potentials were carefully examined. When the motor unit action potential amplitude was > 4 mV, it was considered neurogenic. This study was approved by institutional ethical committee (number 45/621). Informed consent was obtained from all patients and the principles of the Helsinki Declaration were followed.

Statistical Analysis

The Shapiro-Wilk test was used to determine the distribution of the data. Comparisons were made using Kruskal-wallis and Mann-Whitney u tests for independent samples. Tamhane's T2 test was used as post-hoc analysis. Pearson's Chi-squared test was used to analyze categorical variables. Spearman's test was used for correlation. Mean ± standard deviation (SD) and median of numeric data were calculated for descriptive statistics. Statistical Package for the Social Sciences (SPSS IBM Corp; Armonk, NY, USA) 22.0 was used to perform the statistical analysis.

Results

Forty-one UNE patients who met clinical and electrodiagnostic criteria were reviewed. Since 2 patients did not answer too many questions in the DASH questionnaire, these patients were excluded from the study. Thirty-nine patients were included in the study. 27 patients (69%) were male. The mean age of the patients was 42.5 ± 14.4 (range 18-77) years. The mean height,

weight and body mass index were 171.4 ± 8.5 cm, 76.9 ± 12.6 kg, 26.2 ± 4.0 kg/m2, respectively. The mean duration of the symptoms was 8.6 ±14.3 (1-60) months. The symptoms and neurological examination findings of the patients are shown in Table 1. The most common symptom was paresthesia in the 4th and/or 5th digits (100%), and the most common neurological examination finding was hypoesthesia in the 4th and/or 5th digits (95%). Electrodiagnostic findings of the patients are shown in table 1. The most abnormality in nerve conduction studies was in short segment motor nerve conduction studies. All patients had prolonged latency difference in the short segment motor nerve conduction study recorded from ADQ or FDI muscles. There were more neurogenic needle EMG findings in ADQ and FDI muscles than flexor carpi ulnaris and flexor digitorum profundus (ulnar nerve) muscles.

Table 1. Clinical features and electrodiagnostic findings of the UNE patients	
	Number of patients with abnormal findings / total number of patients (%)
Symptoms	
Paresthesia of 4th / 5th digits	39 / 39 (100%)
Paresthesia of medial side of palm	26 / 39 (67%)
Wrist or forearm or elbow pain	15 / 39 (39%)
Weakness in hand	20 / 39 (51%)
Neurologic examination	
Hypoesthesia of the 4th and/or 5th digits	37 / 39 (95%)
Hypoesthesia of medial side of palm	28 / 39 (72%)
Weakness in ADQ muscle	16 / 39 (41%)
Weakness in FDI muscle	16 / 39 (41%)
Atrophy of ADQ muscle	4 / 39 (10%)
Atrophy of FDI muscle	6 / 39 (15%)
Tinel's sign	14 / 39 (36%)
Elbow flexion pressure test	23 / 39 (59%)
Ulnar nerve conduction studies	
5th-wrist segment SNAP amplitude	13 / 39 (33%)
Distal CMAP amplitude (recording from ADQ muscle)	7 / 39 (18%)
Motor NCV below elbow - above elbow segment m/s (recording from ADQ muscle)	20 / 39 (51%)
Motor NCV below elbow - above elbow segment m/s (recording from FDI) muscle)	19 / 33 (58%)
FEVD m/s (recording from ADQ muscle)	21 / 39 (54%)
FEVD m/s (recording from FDI muscle)	21 / 33 (64%)
Motor nerve conduction block across elbow segment	10 / 38 (26%)
Short segment ulnar motor nerve conduction studies	
Latency difference (recording from ADQ muscle)	33 / 39 (85%)
Latency difference (recording from FDI muscle)	29 / 33 (88%)
Latency difference (recording from ADQ or FDI)	39 / 39 (100%)
Latency difference at ME-P2 segment	31 / 39 (79%)
Latency difference at ME-D2 segment	7 / 39 (18%)
Latency difference at P2-P4 segment	1 / 39 (3%)
Needle EMG*	
ADQ	21 / 39 (54%)
FDI	23 / 39 (59%)
FDP (ulnar nerve)	9 / 37 (24%)
FCU	13 / 38 (34%)
ADQ or FDI or FDP or FCU	27 / 39 (69%)

ADQ: Abductor digiti quinti, FDI: first dorsal interosseous, FDP:flexor digitorum profundus (ulnar), FCU: flexor carpi ulnaris, EMG: electromyography, FEVD: the difference between the motor nerve conduction velocity of the forearm and elbow segments; CMAP: Compound muscle action potential, SNAP: sensory nerve action potential, NCV: nerve conduction velocity, ME: medial epicondyle, D2: 2 cm distal of ME, P2: 2 cm proximal to ME, P4: 4 cm proximal to ME. *:It was considered abnormal in the presence of active denervation finding or neurogenic motor unit action potential in the muscle examined with needle EMG.

According to the neurophysiological classification of UNE, 26 patients had mild UNE, 8 patients had moderate UNE, and 5 patients had severe UNE. Correlation of DASH scores and electrodiagnostic findings are shown in table 2. There was a positive correlation between neurophysiological classification of UNE and DASH-DS / DASH-W scores ($p = 0.002$ $r = 0.491$, $p = 0.012$ $r = 0.453$). In addition, an inverse correlation was found between DASH-W and ulnar nerve SNAP / CMAP amplitudes ($p=0.036$ $r=-0.413$, $p=0.006$ $r=-0.492$). Figure 1 shows the inverse correlation between distal ulnar nerve CMAP amplitude and DASH-W scores. DASH scores in the UNE groups are shown in table 3. DASH-DS scores of the moderate UNE group were significantly higher than the DASH-DS scores of the mild UNE group (Tamhane's T2 test was used for post-hoc analysis, $p=0.020$). When the UNE patients were divided into two groups as mild and moderate-severe UNE, the mean DASH-DS scores were obtained as 21.8 ± 17.0 (number=26, range 0-58) and 45.9 ± 20.7 (number=13, range 24-80) respectively in the mild and moderate-severe UNE group, and this difference was statistically significant (Mann-Whitney U test was used, $p = 0.001$). Similarly, the mean DASH-W scores were 20.7 ± 26.9 (number=19) and 43.2 ± 22.9 (number=11) respectively in mild UNE group and moderate-severe UNE group ($p = 0.012$). Figure 2 shows DASH-DS scores in the mild and moderate-severe UNE group.

Table 2. Correlation of electrodiagnostic findings and DASH scores

		DASH-DS	DASH-W	DASH-SP
Ulnar SNAP (5th-wrist segment)	P	0.056	0.036	0.645
	R	-0.330	-0.413	0.130
	Number	34	26	15
Ulnar CMAP amplitude	P	0.081	0.006	0.469
	R	-0.280	-0.492	-0.188
	Number	39	30	20
Ulnar motor NCV across elbow	P	0.132	0.842	0.150
	R	-0.245	-0.038	-0.315
	Number	39	30	17
Neurophysiological classification of UNE	P	0.002	0.012	0.641
	R	0.491	0.453	0.122
	Number	39	30	17

CMAP: Compound muscle action potential, SNAP: sensory nerve action potential, NCV: nerve conduction velocity, UNE: ulnar neuropathy at the elbow, DASH: The disabilities of arm, shoulder and hand questionnaire, DASH-DS: DASH disability / symptom, DASH-W: DASH-work module, DASH-SP: DASH sports / performing arts module. Spearman correlation test was used. P values < 0.05 were considered statistically significant.

Table 3. DASH scores in UNE groups based on neurophysiological classification

	DASH-DS scores mean ± SD (median)	DASH-W scores mean ± SD (median)	DASH-SP scores mean ± SD (median)
Mild UNE	21.8±17.0 (20.8) n=26	20.7±26.9 (12.3) n=19	24.4±31.7 (18.8) n=11
Moderate UNE	50.0±21.4 (52.9) n=8	44.6±26.4 (43.8) n=7	29.7±47.7 (9.4) n=4
Severe UNE	39.5±19.9 (25.8) n=5	40.6±18.8 (37.5) n=4	31.3±8.8 (31.3) n=2
p value	0.005	0.053	0.639

UNE: ulnar neuropathy at the elbow, DASH: The disabilities of arm, shoulder and hand questionnaire, DASH-DS: DASH disability / symptom, DASH-W: DASH-work module, DASH-SP: DASH sports / performing arts module. The DASH-DS score in the mild UNE group was significantly lower than the DASH-DS score in the moderate UNE group (p=0.020). Kruskal-wallis test was used. Tamhane's T2 test was used as post-hoc analysis. P values < 0.05 were considered statistically significant.

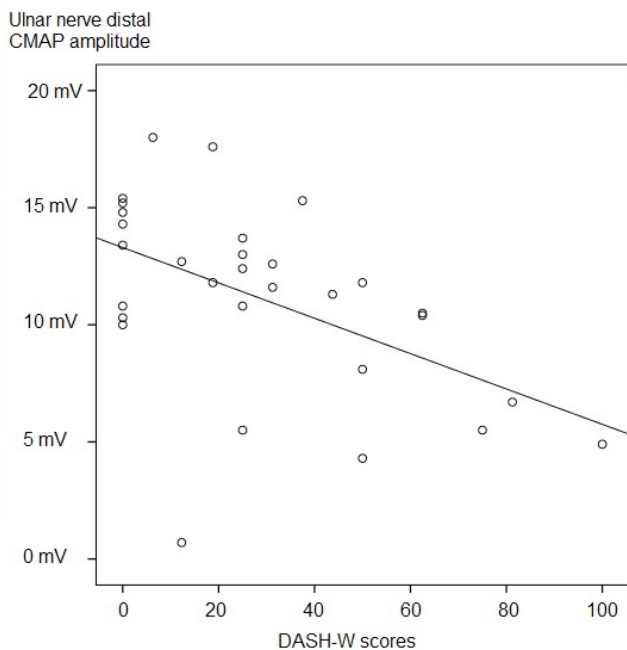**Figure 1.** Correlation of ulnar nerve distal CMAP amplitude recording from ADQ muscle and DASH-W scores.

ADQ: Abductor digiti quinti, CMAP: compound muscle action potential, DASH-W: DASH-work module. There was an inverse correlation between the ulnar nerve distal CMAP amplitude and the DASH-W score (p=0.006 r=-0.492). Spearman correlation test was used. P values < 0.05 were considered statistically significant.
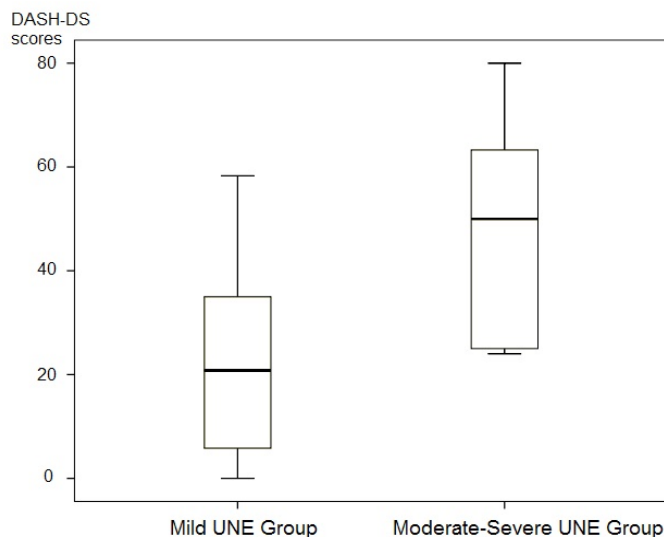

Figure 2. DASH-DS scores in mild UNE and moderate-severe UNE groups

DASH-DS: DASH disability / symptom, UNE: ulnar neuropathy at the elbow. Mean DASH-DS scores were 21.8 ± 17.0 (median 20.8, range 0-58) and 45.9 ± 20.7 (median 50.0, range 24-80) in the mild and moderate-severe UNE group, respectively. There was a statistically significant difference between the two groups (p = 0.001). Mann-Whitney u test was used. P values < 0.05 were considered statistically significant.

Discussion

UNE can cause mild to severe neuropathy. It may cause disability in some patients. In addition to physical therapy, surgical treatment is also a treatment option for some patients with lesions at HUA [11,14,15,20]. For this reason, it is important to diagnose and follow up UNE. Our primary goal in this study was to evaluate the correlation between electrodiagnostic findings and DASH questionnaire scores of UNE and to evaluate the use of the DASH questionnaire in the UNE.

The most common symptom in this study was paresthesia in 4th and/or 5th digits and the most frequent neurological examination finding was hypoesthesia in 4th and/or 5th digits. These findings were consistent with the literature [1,2,3,4]. Pain was a less common symptom. This finding was important because some of the questions in the DASH questionnaire were associated with pain. Tinel's sign and elbow flexion-pressure test were 36% and 59% positive, respectively, which supported the low diagnostic value of provocative tests reported in the literature [21]. The findings of nerve conduction studies in this study showed the importance of short segment motor nerve conduction studies in the diagnosis of UNE. All patients had abnormalities in the short segment motor nerve conduction study. This may be because the ulnar motor nerve conduction studies were performed by recording from both ADQ and FDI muscles. In previous studies, it was reported that ulnar motor nerve conduction studies performed by recording both muscles increased sensitivity for the diagnosis of UNE [1,3,4]. Consistent with the literature, in this study, ulnar nerve lesions at retroepicondylar groove were observed more than lesions at HUA in UNE [1,4,5]. Needle EMG findings were more abnormal in ADQ and FDI muscles than in proximal muscles innervated by ulnar nerve. These findings were consistent with the previous studies [4,22]. This can be explained by the topographic distribution of the ulnar nerve fascicles [23].

According to the Leeds assessment of neuropathic symptoms and signs (LANSS) pain scale, it was reported that electrodiagnostic findings did not differ in patients with and without neuropathic pain [24]. This may mean that the use of LANSS pain scale in UNE is limited. In addition, as we mentioned earlier in this study, pain was a less common symptom. In the DASH questionnaire, although there were questions about pain, the number of questions containing the word "pain" was less than five. The DASH questionnaire has been used in many studies related to UNE. DASH questionnaire is important in postoperative evaluation of patients operated

for UNE [14,15]. The DASH questionnaire was used in Padua's study for the neurophysiological UNE classification [2]. There was a positive correlation between DASH function scores and neurophysiological classification in that study. A similar positive correlation was found in this study. In this case, a positive correlation between neurophysiological classification and DASH scores can be mentioned. A significant difference was found in DASH scores between mild UNE and moderate UNE. Interestingly, while the DASH score of two severe UNE patients was 25, the DASH scores of some mild UNE patients were high (up to 58). It would be appropriate to interpret these findings as there may be mild UNE patients with high DASH scores as well as severe UNE patients with a low DASH scores. When UNE patients were divided into two groups, mild and moderate-severe, DASH-W scores were found to be significantly different in addition to DASH-DS scores. In this study, an inverse correlation was found between DASH-W and ulnar CMAP / SNAP amplitudes. Reduced CMAP or SNAP amplitudes are indicative of axonal degeneration. For this reason, it will be useful to use DASH-W in addition to DASH-DS in UNE. There was some limitations in this study. The low number of patients in the moderate and severe UNE group was one of the limitations of the study. The retrospective nature of the study was another limitation.

Conclusion

A positive correlation between DASH-DS / DASH-W scores and the neurophysiological classification of UNE, an inverse correlation between DASH-W and ulnar CMAP / SNAP amplitudes were found. In addition to DASH-DS, evaluation of UNE with DASH-W may increase the value of the DASH questionnaire. Some mild UNE patients may have high DASH scores, while some moderate and severe UNE patients may have low DASH scores.

Declaration of conflict of interest

Acknowledgements

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