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Research article

The prevalence of carpal tunnel syndrome in patients with epilepsy

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ABSTRACT

Objective: Carpal tunnel syndrome (CTS) is the most common type of entrapment neuropathy caused by compression of the median nerve in the carpal tunnel. Epilepsy is characterised by recurrent seizures caused by abnormal neuronal discharges in the brain.
This study aimed to investigate whether there is a link between epilepsy and carpal tunnel and, if so, the underlying factors.
Materials and methods: Two hundred patients with epilepsy were included in this study. The patients' history of epilepsy, seizure type, and seizure frequency were assessed. The Tinel, Phalen, and Flick physical examination tests were performed on patients with complaints that matched those of median nerve neuropathy. Patients with epilepsy and clinically diagnosed carpal tunnel syndrome completed the Boston Carpal Tunnel Syndrome Questionnaire, and nerve conduction studies were performed. The relationship between seizure type and frequency in patients with carpal tunnel syndrome was compared.
Results: Compared to focal-aware motor-onset seizures, the risk of detecting carpal tunnel syndrome was 88.7 times higher in focal-onset bilateral tonic-clonic seizures. Patients with a seizure frequency of one per month or more had a 0.704 times lower risk of CTS than those with a frequency of one per week or more ($p = 0.026$).
Discussion: Patients with epilepsy, especially those experiencing frequent seizures or specific seizure types, may be more susceptible to repetitive wrist flexion-extension postures. Therefore, during clinical follow-up, it is important to inquire about the presence of carpal tunnel syndrome in patients with epilepsy.

1. Introduction

Epilepsy is a brain disease characterised by a predisposition to recurrent seizures. According to the International League Against Epilepsy (ILAE); epilepsy is a disease of the brain defined by any of the following conditions.

1. At least two unprovoked (or reflex) seizures occurring >24 h apart.
2. One unprovoked (or reflex) seizure and the probability of further seizures similar to the general recurrence risk (at least 60%) after two unprovoked seizures occurring over the next 10 years.

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3. Diagnosis of an epilepsy syndrome [1].

Many patients with epilepsy experience various traumas as a result of seizures. Because patients cannot use their protective reflexes to support their fall, they may experience head, orthopaedic, or soft-tissue damage. Repetitive muscle activity and increased muscle tone during epileptic seizures can result in bone, ligament, and connective tissue injuries.

Carpal tunnel syndrome (CTS) occurs when the median nerve in the wrist is compressed as it passes through the carpal tunnel [2]. Obesity, monotonous wrist activity, pregnancy, rheumatoid arthritis, and trauma are the risk factors for CTS [2]. According to various studies, carpal tunnel syndrome can occur due to microtrauma to the wrist, forearm, or arm [2]. In addition, there is a higher incidence of CTS in musicians whose movements are similar to the clonic movements of a seizure [3].

Prolonged or repetitive wrist flexion and extension postures, which may also occur in epileptic seizures, may increase pressure in the carpal tunnel and cause CTS in patients with epileptic seizures over time [2].

Carpal tunnel syndrome (CTS) can be accurately diagnosed using ultrasonography and effectively treated with injection therapy [4].

Considering the innovations in CTS diagnosis and treatment, it is important to detect the possible presence of CTS in epilepsy patients in order to improve the quality of life of epilepsy patients. We did not find any study in the literature on the relationship between epilepsy patients and CTS.

This study aimed to improve the quality of life in patients with epilepsy by investigating the frequency of carpal tunnel syndrome in epilepsy patients.

2. Materials and methods

2.1. Study participants and procedures

Two hundred epilepsy patients followed in the Neurology Clinic of Tokat Gaziosmanpaşa University Hospital were included in the study. Patients with epilepsy aged >18 years who were evaluated using the seizure type classification of the ILAE-2017 diagnostic criteria were fully informed about the study, and informed consent forms were obtained from all patients. The study was conducted in accordance with the principles of the Declaration of Helsinki.

Patients with diabetes mellitus, rheumatoid arthritis, hypothyroidism, wrist fractures, a history of renal failure or dialysis, B1–B12–B6 deficiency, those who underwent surgery for CTS, and pregnant women were excluded.

2.2. Data collection

An inquiry was made to determine the seizure type, frequency, and whether the seizures were controlled in patients with epilepsy included in the study.

Patients with complaints of pain, numbness, and paraesthesia in their hands suggestive of CTS in their anamnesis were clinically diagnosed with CTS by performing Tinel, Phalen, and Flick tests, and clinical staging was performed by completing the Boston questionnaire.

The patients rested for 15 min before the examination at a room temperature of 22–24 °C, and the hands to be examined were prepared for the nerve conduction study. The palmar skin temperature was maintained at or above 31 °C. A Medelec electrophysiological measurement device was used in this study. Nerve conduction studies (NCS) were performed according to the American

Table 1
Normal laboratory values.

NERVE	MOTOR RESPONSE				
Median	Line	Latency	Nerve conduction velocity	Amplitude	F latency
	Wrist	3,8 ms		4,3 mV	32,0 ms
	Wrist - Elbow		49,7 m/s		
	Elbow - Armpit		49,9 m/s		
Ulnar	Wrist	3,3 ms		7 mV	32 ms
	Wrist - Below the elbow		49,9 m/s		
	Below the elbow - Above the elbow		39,6 m/s		
	Above the elbow -Armpit		52,0 m/s		
NERVE	SENSORY				
	Line		Nerve conduction velocity	Amplitude	
Median	1.Digit - Wrist		32,9 m/s	10,0 mV	
	2.Digit - Wrist		39,4 m/s	10,0 mV	
	3.Digit - Wrist		39,6 m/s	10,0 mV	
	Palm - Wrist		35,2 m/s	34,4 mV	
Ulnar	Wrist - Elbow		49,0 m/s	10,0 mV	
	Elbow - Armpit		53,2 m/s	5,0 mV	
	5.Digit - Wrist		37,3 m/s	7,0 mV	
	Wrist - Below the elbow		49,8 m/s	5,2 mV	
	Elbow - Armpit		48,2 m/s	8,6 mV	

Association of Electrodiagnostic Medicine criteria. Median nerve compound motor action potentials (CMAP) were recorded from the abductor pollicis brevis (APB) and stimulation 3 cm proximal to the distal crease of the wrist was followed in patients. The median sensory nerve action potentials (SNAP) were recorded by orthodromic stimulation of the 2nd digit from the median nerve at the wrist (3 cm proximal to the distal crease). The ulnar nerve SNAPs were examined by stimulating the 5th digit and recording from the wrist (3 cm proximal to the wrist crease) [5].

Electrophysiologically, patients were classified according to the following criteria [6]:

Mild CTS: Difference between median sensory response distal latency and ulnar sensory response distal latency >1 ms or difference between 4th finger recorded median-ulnar nerve peak latencies >0.5 ms.

Moderate CTS: Prolonged distal latency of the median motor nerve (>4.0 ms).

Severe CTS: Often, low or absent sensory potential amplitude and decreased motor response amplitude (5.5 ms).

Our laboratory normals are given in Table 1.

As a comparison test, the 2nd-finger sensory latency for the median nerve, the 5th-finger sensory latency for the ulnar nerve, and the sensory latency difference between the 2nd and 5th fingers were recorded.

The relationships between epilepsy parameters and the frequency and severity of CTS were also investigated.

2.3. Statistical analysis

The Significance Test of Difference Between Two Means (Student's t-test) and one-way analysis of variance (ANOVA) were used to compare mean quantitative variables between groups. To determine whether there was a relationship between the qualitative variables, cross-tables and chi-square tests were used. Multiple logistic regression analysis was performed to determine the relationship between the presence of CTS and selected variables. Pearson's correlation coefficient was used to evaluate the relationship between quantitative variables. Ready-made statistical software (SPSS 22.0, Chicago, IL, USA) was used for calculations. When 95% confidence (1-α), 95% test power (1-β), OR = 2.33 were taken, according to the results of Logistic regression power analysis, the minimum number of samples to be included in the study was determined as 200.

3. RESULTS

The study included 121 females and 79 males (Table 2).

The patients' occupations included in the study were grouped as housewives, civil servants, workers, students, farmers, and unemployed. The patients' hobbies included in the study were grouped into housework and cleaning, field and garden work, computer use, and handicrafts. Statistically significant data were not obtained for hobbies and occupational groups.

While 77 patients had generalised-onset seizures, 123 had focal-onset seizures. None of the patients had any unclassifiable or unspecified seizure types (Table 3).

Clinical and electrophysiological staging were performed in 70 patients with epilepsy and CTS. While 42 clinically staged patients were in Stage 1, the remaining 28 were in Stage 2. There were no patients in the Stage-3, Stage-4, and Stage-5 subgroups. Of the electrophysiologically staged patients, 35 were classified as negative CTS, 20 as very mild CTS, and 15 as mild CTS. No patients were in the moderate, severe, or very severe CTS groups (Table 4).

No correlation was found between the frequency of seizures in the last one year, whether the seizures were under control, the last seizure interval, and the presence of CTS (Table 5). While the rate of patients staged as negative CTS having had one or more seizures in the last 6 months was 2.9%, the rate of patients staged as mild CTS having had one or more seizures in the last 6 months was 2.9%. It was 26.7% and was statistically significant (p = .011) (Table 6).

The Pearson chi-square test was used.

The Pearson chi-square test was used.

The risk of CTS in focal-onset bilateral tonic-clonic seizures was 88.7 times higher than in focal-aware motor seizures (p = 00.001) (Table 7).

The risk of CTS in those with a seizure frequency of once a week or more often per month was 70.4% lower than in those with a seizure frequency of once a week or more often, and it was statistically significant (p = 0.026) (Table 8).

The risk of CTS in those with a seizure frequency of once a week or more per year was 68.4% lower than in those with a seizure frequency of once a week or more, and it was statistically significant (p = 0.027) (Table 8).

Table 2
Distribution of qualitative variables.

Variables	Category	n (%)
Sex	Female	121 (60,5)
	Male	79 (39,5)
Dominant hand	Right	180 (90)
	Left	20 (10)

Table 3
Demographic data distribution regarding seizures.

Variables	Category	n (%)
Seizure type classification	Generalised	77 (38,5)
	Focal	123 (61,5)
Focal onset seizure classification	Focal aware motor	22 (11)
	Focal aware non-motor	14 (7)
	Focal impaired awareness motor	34 (17)
	Focal impaired awareness non-motor	24 (12)
	Focal-onset bilateral tonic-clonic	29 (14,5)
Generalised onset seizure classification	Motor	77 (38,5)
	Non-motor	0 (0)
Seizure frequency in the last 1 year	1 or more per week	35 (17,5)
	1 or more per month	42 (21)
	1 or more in 3 months	33 (16,5)
	1 or more per 6 months	20 (10)
	1 or more per year	70 (35)
Control on seizure	Controlled	160 (80)
	Uncontrolled	40 (20)
The time interval for the last seizure	Within the last 1 week	53 (26,5)
	Within the last 1 month	53 (26,5)
	Within the last 3 months	17 (8,5)
	Within the last 6 months	21 (10,5)
	Within the last 1 year	56 (28)

Tablo 4
Distribution of variables by clinical and electrophysiological staging.

Variables	Category	n (%)
CTS Clinical staging	Stage-1 CTS	42 (21)
	Stage-2 CTS	28 (14)
	No CTS	130 (65)
CTS Electrophysiological staging	Negative CTS	35 (17,5)
	Very Mild CTS	20 (10)
	Mild CTS	15 (7,5)
	No CTS	130 (65)

The frequency of CTS detection was 93.1% in patients with focal-onset bilateral tonic-clonic seizures, 29.4% in patients with focal impaired awareness of motor seizures, and 18.2% in patients with focal-aware motor seizures ($p = 00.001$).

4. DISCUSSION

Epilepsy is characterised by the unpredictable occurrence of seizures [7,8]. Because of their inability to use their protective reflexes to support their fall during a seizure, patients with epilepsy may suffer head, orthopaedic, or soft tissue damage and microtrauma [7,8].

A multicentre European cohort of 951 children and adults with epilepsy was prospectively followed and compared with a cohort of 909 matched controls [7,8]. In the epilepsy group, 24% of the accidents were seizure-related [7,8]. While most injuries were mild, 6 of 80 patients suffered severe trauma (five fractures and one subdural hematoma) [7,8). This could be due to an inability to activate protective reflexes during seizures, resulting in falls and fractures [7,8]. This may cause an increased load on the skeleton owing to muscle contractions during seizures, which may cause spinal, extremity, and ligament injuries [7,8].

A prospective European cohort study revealed that contusions, wounds, and abrasions accounted for 26%, 23%, and 11% of accidents in patients with epilepsy, and all injury types were more common in the epileptic cohort than in controls [9,10]. Soft tissue injury is the most common type of injury caused by seizures [9,10].

Although CTS is an idiopathic syndrome, existing risk factors are associated with its prevalence [11,12]. Prolonged positions when wrist flexion or extension is exceeded, monotonous flexor muscle use, and vibration exposure are among the most notable mechanical risk factors [11,12].

CTS pathophysiology of CTS consists of a combination of mechanical trauma, increased pressure, and ischaemic damage to the median nerve inside the carpal tunnel [13,14]. Normal pressure inside the carpal tunnel varies between 2 mmHg and 10 mmHg [13,14]. Change in the wrist position in the carpal tunnel can cause dramatic shifts in intracarpal tunnel pressure [15,16]. Therefore, while extension increases the resting pressure by more than tenfold, flexion of the wrist causes an eightfold increase [15,16]. As a result, it has been suggested that repetitive wrist movements are important risk factors for CTS [15,16]. In contrast, in nerve injury, demyelination, which occurs when the nerve is frequently subjected to involuntary forces, is a significant step in the way to damage the median nerve [15,16].

Focal awareness non-motor seizures and focal awareness non-motor seizure types with preserved consciousness were more common in patients without CTS. Because a repetitive flexion-extension posture does not develop in the extremities of patients with this

Table 5
The distribution of qualitative variables based on the presence of carpal tunnel syndrome (CTS) diagnosis.

		CTS diagnosis		χ^2	p
		CTS is present	CTS is not present		
		n (%)	n (%)		
Seizure type classification	Generalised onset	24 (31.2)	53 (68.8)	0.808	0.369
	Focal onset	46 (37.4)	77 (62.6)		
Classification of focal seizures	Focal aware motor	4 (18.2)	18 (81.8)	55.055	**<0.001**
	Focal aware non-motor	1 (7.1)	13 (92.9)		
	Focal impaired awareness motor	10 (29.4)	24 (70.6)		
	Focal impaired awareness non-motor	4 (16.7)	20 (83.3)		
	Focal-onset bilateral tonic-clonic	27 (93.1)	2 (6.9)		
Seizure frequency in the last 1 year	1 or more per week	17 (48.6)	18 (51.4)	7.081	0.132
	1 or more per month	12 (28.6)	30 (71.4)		
	1 or more in 3 months	15 (45.5)	18 (54.5)		
	1 or more per 6 months	7 (35)	13 (65)		
	1 or more per year	19 (27.1)	51 (72.9)		
Control on seizure	Controlled	51 (31.9)	109 (68.1)	3.434	0.064
	Uncontrolled	19 (47.5)	21 (52.5)		
The time interval for the last seizure	Within the last 1 week	25 (47.2)	28 (52.8)	7.370	0.118
	Within the last 1 month	19 (35.8)	34 (64.2)		
	Within the last 3 months	7 (41.2)	10 (58.8)		
	Within the last 6 months	5 (23.8)	16 (76.2)		
	Within the last 1 year	14 (25)	42 (75)		
Year of follow-up with an epilepsy diagnosis	<3	15 (37.5)	25 (62.5)	0.502	0.918
	3–5 Years	8 (33.3)	16 (66.7)		
	5–10 years	14 (31.1)	31 (68.9)		
	>10	33 (36.3)	58 (63.7)		

Table 6
Distribution of qualitative variables based on electrophysiologic staging in the group with carpal tunnel syndrome (CTS).

		CTS is present			χ^2	p
		Electrophysiological CTS staging				
		CTS Negative	Very Mild CTS	Mild CTS		
		n (%)	n (%)	n (%)		
Seizure frequency in the last 1 year	1 or more per week	9 (25.7)	3 (15)	5 (33.3)	16.246	**0.039**
	1 or more per month	5 (14.3)	6 (30)	1 (6.7)		
	1 or more per 3 months	10 (28.6)	2 (10)	3 (20)		
	1 or more per 6 months	3 (8.6)	0 (0)	4 (26.7)		
	1 or more per year	8 (22.9)	9 (45)	2 (13.3)		
The time interval for the last seizure	Within the last 1 week	15 (42.9)	5 (25)	5 (33.3)	19.763	**0.011**
	Within the last 1 month	9 (25.7)	8 (40)	2 (13.3)		
	Within the last 3 months	5 (14.3)	0 (0)	2 (13.3)		
	Within the last 6 months	1 (2.9)	0 (0)	4 (26.7)		
	Within the last 1 year	5 (14.3)	7 (35)	2 (13.3)		

Table 7
Multivariate logistic regression results for focal seizures and carpal tunnel syndrome (CTS).

Independent variables	β	S.E.	p	Odds Ratio	95% confidence interval for the odds ratio	
					Lower	Upper
Focal Aware Seizure-Motor			**0.000**			
Focal Aware Seizure-Non Motor	−0.948	1.276	0.457	0.387	0.032	4.727
Focal İmpaired Awareness Motor	0.622	0.789	0.431	1.862	0.396	8.747
Focal İmpaired Awareness Non-Motor	0.188	0.872	0.829	1.207	0.219	6.663
FOBTC	4.486	1.045	**0.000**	88.741	11.436	688.604

S.E.: Standard error. Reference categories: Focal Aware Seizure-Motor for focal seizures, FOBTC; focal-onset bilateral tonic-clonic.

type of seizure, it is thought that there will be no predisposition to carpal tunnel syndrome. In addition, during conscious seizures, patients retain their reflexes to prevent falls and are thought to be able to protect their extremities and themselves.

If patients lose consciousness during a focal-onset bilateral tonic-clonic seizure, they may be unable to use their protective reflexes to support their falls, thereby increasing the risk of microtrauma during the seizure, in addition to repetitive flexion-extension wrist

Table 8
Multivariate logistic regression results for seizure frequency and carpal tunnel syndrome (CTS).

Independent variables	β	S.E.	p	Odds ratio	95% confidence interval for the odds ratio	
					Lower	Upper
Once a week or more often			0.125			
Once a month or more often	−1.216	0.545	**0.026**	0.296	0.102	0.862
Every 3 months or more often	−0.404	0.565	0.475	0.668	0.220	2.022
Every 6 months or more often	−0.662	0.667	0.320	0.516	0.140	1.904
Once a year or more often	−1.151	0.522	**0.027**	0.316	0.114	0.880

S.E.: Standard error. Reference categories: 1 week or more for seizure frequency.

movements in the extremities. Increased pressure in the carpal tunnel may predispose patients to CTS.

Patients with epilepsy staged as having mild CTS based on electrophysiological staging had a higher rate of having one or more seizures in the previous 6 months than patients staged as having very mild CTS. This result suggests that a certain period must have passed after exposure to microtrauma and a possible carpal tunnel pressure increase for CTS in patients with epileptic seizures.

Participants who experienced seizures once a month or once a year or more were at a lower risk of developing CTS than those who experienced seizures once a week or more. These findings suggest frequent seizures are associated with an increased risk of repetitive wrist flexion-extension posture, exposure to microtrauma, and the development of CTS.

This study has some limitations. The number of patients included in this study was 200. There was no control group other than the patients with epilepsy. Therefore, it is unclear whether the incidence of CTS differs between patients with and without epilepsy (with similar age and comorbidities) in the indigenous population. The study was cross-sectional, and long-term follow-up of patients could not be performed.

Certain occupations, such as typing, assembly work, meat cutting, and playing musical instruments, which require prolonged use of the hands in flexed postures or repetitive wrist movements, are generally considered to precipitate or worsen CTS [17,18]. The occurrence of CTS in patients with dystonic movements of the hand and athetoid dystonic cerebral palsy is because of repetitive hand movements [17,18]. In patients with dystonia, involuntary dystonic muscle contractions maintain the wrist at either hyperextension or hyperflexion. Continuous wrist hyperextension or hyperflexion may be responsible for CTS [17,18].

Considering the aetiology of CTS, median nerve damage may occur due to increased pressure in the carpal tunnel due to microtrauma, flexion, and extension postures that may develop during epileptic seizures. In this study, epilepsy patients and the relationship of parameters such as seizure type and seizure frequency with CTS were examined, which are thought to be associated with focal onset bilateral tonic-clonic seizures and the frequency of seizures, and these parameters may predispose patients to CTS. CTS symptoms should be investigated in the follow-up of patients with epilepsy, and patients with complaints should be evaluated for CTS to improve their quality of life.

Data availability statement

Data will be made available on request.

CRediT authorship contribution statement

Hicret Betul Akdag: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Betul Cevik:** Supervision, Project administration, Data curation. **Orhan Sumbul:** Supervision. **Durdane Aksoy:** Supervision. **Semiha Gulsum Kurt:** Software, Resources.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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