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CARPAL TUNNEL SYNDROME AND MICRONUTRIENT LEVELS: A RETROSPECTIVE EVALUATION

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Abstract

Aim: This study aimed to compare demographic, biochemical, and electrophysiological parameters between patients with carpal tunnel syndrome (CTS) and healthy individuals, and to evaluate the potential roles of these parameters in the disease's pathophysiology.

Material and Methods: The study included 62 healthy controls and 408 patients with CTS (128 unilateral and 280 bilateral). Demographic characteristics, biochemical parameters (including vitamin D, hemoglobin, ferritin, and other routine biochemical tests), and electromyography (EMG) findings were assessed. Comparisons between groups were performed using appropriate non-parametric tests, with a p-value of <0.05 considered statistically significant.

Results: Levels of vitamin D, hemoglobin, and ferritin were significantly reduced in patients with CTS, compared with healthy controls (all $p<0.01$). No significant differences were detected in the remaining biochemical parameters. Electrophysiological evaluation demonstrated that disease severity was more pronounced in bilateral CTS cases than in unilateral cases.

Conclusion: It has been demonstrated that not only anatomical and mechanical factors but also metabolic and hematological parameters may play a role in the development of CTS. In particular, incorporating the assessment of vitamin D, hemoglobin, and ferritin levels into routine evaluations may contribute to the early diagnosis and management of CTS.

Keywords: Carpal tunnel syndrome, vitamin D, ferritin, hemoglobin, biochemical parameters, electromyography

INTRODUCTION

Carpal tunnel syndrome (CTS) is one of the most common entrapment neuropathies, caused by compression of the median nerve at the wrist. Clinically, it presents with pain, paresthesia, numbness, and weakness of the hand muscles. Various mechanical and metabolic factors contribute to the etiopathogenesis of CTS, including repetitive hand movements, anatomical variations, and systemic diseases (1). Although clinical examination is essential for diagnosis, electromyography (EMG) and ultrasound are commonly used to confirm the condition (2).

In recent years, increasing attention has been directed toward the impact of vitamin and mineral deficiencies on peripheral nervous system health. Micronutrients such as B vitamins, vitamin D, and folate have been demonstrated to play essential roles in the structure, transmission, and repair of nerve cells.

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Among them, vitamin D is notable not only for its role in bone health but also for its neuroprotective effects on both the central and peripheral nervous systems, as it contributes to the regulation of nerve growth factors and the suppression of inflammatory processes (3).

Vitamin B12 (cobalamin) serves as a critical cofactor in DNA synthesis, maintenance of myelin sheath integrity, and neuronal methylation processes. Its deficiency leads to substantial damage, particularly to sensory neurons, and electrophysiological alterations may be detectable even at subclinical levels (4). Similarly, folic acid plays an essential role in the development and repair of the nervous system. Owing to folic acid's regulatory function in homocysteine metabolism, its deficiency may increase the risk of oxidative stress and neuronal injury (5). The associations between vitamin D, vitamin B12, and folic acid levels and CTS have been examined in various studies (6-8).

The effects of iron on brain energy metabolism, neurotransmitter synthesis, and myelin formation are well established. In cases of iron deficiency, neuronal energy production, impulse transmission, and myelin integrity may be adversely affected. Iron deficiency has been linked to several neurological disorders, most notably restless legs syndrome, cognitive impairment, and developmental neurological problems. However, the role of iron, together with other vitamins and minerals, in nerve conduction has not been sufficiently clarified in localized peripheral neuropathies such as CTS. Although some studies have suggested associations between micronutrients such as vitamin D, vitamin B12, and folic acid, and CTS (6-8), research on the relationship between iron deficiency and CTS remains scarce. Nevertheless, iron deficiency may exert significant effects on nerve regeneration and neurophysiological functions.

Evaluating serum levels of vitamin D, vitamin B12, iron, and folic acid in patients with CTS and investigating their relationship with electrophysiological findings, may represent an important step toward improving the diagnosis and management of the disease.

MATERIAL AND METHODS

This study has a retrospective and cross-sectional design and was conducted by reviewing the files of patients with a preliminary diagnosis of CTS who underwent EMG at University of Health Sciences Türkiye, Elazığ Fethi Sekin City Hospital between June 2024 and May 2025.

The study included two groups based on EMG results:

• Patients with confirmed CTS consisted of cases with median nerve entrapment neuropathy. Patients were classified as having mild, moderate, or severe CTS according to electrodiagnostic findings, and the unilateral or bilateral nature of involvement was also recorded. Mild CTS was defined as involvement limited to the sensory fibers of the median nerve, moderate CTS as cases with prolonged motor distal latency, and severe CTS as cases with motor amplitude loss (9).

• **Patients with control EMG results:** This group included cases in which EMG was performed due to a preliminary diagnosis of CTS, but no pathology was detected in the median nerve.

Patient age, sex, and laboratory parameters (vitamin D, vitamin B12, ferritin, folic acid, and magnesium levels) were obtained from medical records.

Inclusion Criteria

• Age ≥18 years

• Undergoing EMG with a preliminary diagnosis of CTS

• Availability of laboratory data on vitamin D, vitamin B12, ferritin, folic acid, and magnesium levels obtained simultaneously with EMG

• Complete medical records

Exclusion Criteria

• Presence of systemic diseases such as diabetes, hypothyroidism, chronic renal failure, rheumatologic disorders, or a history of cancer

• Causes of peripheral neuropathy other than vitamin B12 deficiency

• Previous history of wrist surgery

• Presence of neurological disorders other than CTS, such as polyneuropathy or cervical radiculopathy

• Pregnancy

Data Collection Tools

A sociodemographic and clinical data form, developed by the authors based on the literature and clinical experience, was used to collect the data. This form included demographic information (age, sex), laboratory parameters, and EMG results (classified as mild, moderate, or severe CTS). The laboratory data closest to the date of each patient's EMG were retrieved from the hospital information management system and recorded in an electronic database.

Ethics Committee Approval

The study was approved by the Non-Interventional Local Ethics Committee of University of Health Sciences Türkiye, Elazığ Fethi Sekin City Hospital (approval no: 2025/12-32; date: 25.07.2025). All procedures were conducted in accordance with the principles of the Declaration of Helsinki.

Statistical Analysis

Statistical analyses were performed using SPSS version 22.0 (SPSS Inc., Chicago, IL, USA). The normality of continuous variables was assessed with the Kolmogorov-Smirnov test. Non-normally distributed continuous data were presented as median and interquartile range (25^{th}-75^{th} percentile), while categorical data were presented as frequency and percentage. For comparisons among more than two groups, the Kruskal-Wallis test was applied, followed by the Dunn post-hoc test for pairwise comparisons when significant differences were observed. Comparisons between two groups were conducted using the Mann-Whitney U test. Categorical variables were analyzed using Pearson's chi-square test or Fisher's exact test, as appropriate. Correlations between continuous variables were evaluated with Spearman's rank correlation test. To identify risk factors, univariate logistic regression analysis was performed, and variables found to be significant were subsequently entered into a multivariate model. The diagnostic performance of various parameters was assessed using receiver operating characteristic curve analysis. A p-value of <0.05 was considered statistically significant.

RESULTS

The study included a control group of 62 individuals (42 women, 20 men) and a CTS group of 408 individuals (343 women, 65 men). A statistically significant difference was observed between the groups in terms of sex distribution (p=0.002). The median age was 57 years (48-63) in the control group and 55 years (47-61) in the CTS group, with no significant difference between the groups (p=0.387). Evaluation of biochemical parameters revealed that the median vitamin D level was 15 (10-20) in the CTS group and 18 (12-22) in the control group, a difference that was statistically significant (p=0.002). The median hemoglobin level was 13.6 (12.7-14.2) in the CTS group and 13.9 (13.2-14.8) in the control group. It was significantly lower in the CTS group (p<0.001). The median ferritin level was 33 (13-64.7) in the CTS group and 45 (25-85) in the control group showing a statistically significant difference (p=0.009). No significant differences were detected between the groups with respect to white blood cell, neutrophil, lymphocyte, monocyte, platelet, glucose, urea, creatinine, alanine aminotransferase (ALT), vitamin B12, and folate levels, (all p>0.05), (Table 1).

In our study, the unilateral CTS group included 128 individuals (109 women, 19 men). A statistically significant difference was observed between the groups in terms of sex distribution (p=0.005). The median age was 57 years (48-63) in the control group and 54 years (45.25-61) in the unilateral CTS group, with no significant difference between them (p=0.186). Biochemical analyses showed that vitamin D levels were 12 (10-20) in the

Table 1. Comparison between patients with carpal tunnel syndrome and healthy controls

Variable	Control group median (25^{th}-75^{th} percentile)	CTS group median (25^{th}-75^{th} percentile)	p-value
n (female/male)	62 (42/20)	408 (343/65)	**0.002**
Age (years)	57 (48-63)	55.00 (47.00-61.00)	0.387
Vitamin D (µg/L)	18 (12-22)	15.00 (10.00-20.00)	**0.002**
White blood cell (10^9/L)	7.2 (6.0-9.0)	7.15 (6.03-8.68)	0.832
Hemoglobin (g/dL)	13.9 (13.2-14.8)	13.60 (12.70-14.20)	**0.000**
Platelet (10^9/L)	248 (218-300)	263.00 (226.25-304.50)	0.169
Neutrophil (10^9/L)	4.16 (3.35-5.06)	4.14 (3.33-5.30)	0.831
Lymphocyte (10^9/L)	2.16 (1.67-2.65)	2.11 (1.66-2.63)	0.571
Monocyte (10^9/L)	0.53 (0.45-0.65)	0.54 (0.42-0.68)	0.983
Glucose (mg/dL)	98.5 (93-112)	97.00 (88.00-107.00)	0.053
Urea (mg/dL)	31.5 (25-37)	29.00 (24.00-35.00)	0.059
Creatinine (mg/dL)	0.71 (0.60-0.87)	0.67 (0.59-0.82)	0.212
Alanine aminotransferase (U/L)	19 (15-24)	17.8 (14.00-23.00)	0.152
Vitamin B12 (µg/L)	186.5 (127-252)	173.00 (128.25-232.00)	0.494
Folate (µg/L)	7.9 (6.3-9.6)	8.27 (6.59-10.52)	0.263
Ferritin (µg/L)	45 (25-85)	33.00 (13.00-64.75)	**0.009**

CTS: Carpal tunnel syndrome

unilateral CTS group and 18 (12-22) in the control group, a difference that was statistically significant (p<0.001). The median hemoglobin level was 13.4 (12.5-14.2) in the unilateral CTS group and 13.9 (13.2-14.8) in the control group, and the median was significantly lower in the CTS group (p<0.001). The median ferritin level was 30 (10-61) in the unilateral CTS group and 45 (25-85) in the control group, also showed a statistically significant difference (p=0.007). No significant differences were found between the groups with respect to white blood cell, neutrophil, lymphocyte, monocyte, platelet, glucose, urea, creatinine, ALT, vitamin B12, and folate levels (all p>0.05). EMG severity showed a median score of 1 (1-2) in the unilateral CTS group, which differed significantly from the control group (p<0.001), (Table 2).

Our study included a bilateral CTS group of 280 individuals (234 women, 46 men). A statistically significant difference was observed between the groups in terms of sex distribution (p=0.007). Multiple comparisons revealed that the proportion of women was significantly higher in both the unilateral and bilateral CTS groups compared with the control group, while no significant difference was found between the unilateral and bilateral groups. The median ages were 57 years (48-63) in the control group, 54 years (45-61) in the unilateral CTS group, and 56 years (47-62) in the bilateral CTS group, with no significant difference across groups (p=0.270). Median vitamin D levels were 18 (12-22) in the control group, 12 (10-20) in the unilateral CTS group, and 15 (11-20) in the bilateral CTS group. According to the Dunn post-hoc test, significant differences were found among the three groups; vitamin D levels were lowest in the unilateral CTS group and highest in the control group (p=0.001). Median hemoglobin levels were 13.9 (13.2-14.8) in the control group, 13.4 (12.5-14.2) in the unilateral CTS group, and 13.7 (12.7-14.3) in the bilateral CTS group. Multiple comparisons indicated that hemoglobin levels in the unilateral CTS group were significantly lower than those in the control group. In multiple comparisons, hemoglobin levels were significantly lower in the unilateral CTS group compared to the control group, while the bilateral group had levels that were intermediate between the control and unilateral CTS groups (p=0.001). Median ferritin levels were 45 (25-85) in the control group, 30 (10-61) in the unilateral CTS group, and 33 (14-65) in the bilateral CTS group. A significant difference was observed between the control group and both CTS groups (p=0.020); however, no difference was detected between the unilateral and bilateral groups . No statistically significant differences were found among the groups in terms of white blood cell, neutrophil, lymphocyte, monocyte, platelet, glucose, urea, creatinine, ALT, vitamin B12, and folate levels

Table 2. Comparison between unilateral CTS patients and healthy controls

Variable	Control group median (25^{th}-75^{th} percentile)	CTS group median (25^{th}-75^{th} percentile)	p-value
n (female/male)	62 (42/20)	128 (109/19)	**0.005**
Age (years)	57 (48-63)	54.00 (45.25-61.00)	0.186
Vitamin D (µg/L)	18 (12-22)	12.00 (10.00-20.00)	**0.000**
White blood cell (10^9/L)	7.2 (6.0-9.0)	7.05 (6.1-8.68)	0.974
Hemoglobin (g/dL)	13.9 (13.2-14.8)	13.40 (12.50-14.20)	**0.000**
Platelet (10^9/L)	248 (218-300)	268.00 (224-311)	0.159
Neutrophil (10^9/L)	4.16 (3.35-5.06)	4.19 (3.42-5.43)	0.501
Lymphocyte (10^9/L)	2.16 (1.67-2.65)	2.12 (1.71-2.79)	0.883
Monocyte (10^9/L)	0.53 (0.45-0.65)	0.53 (0.43-0.64)	0.994
Glucose (mg/dL)	98.5 (93-112)	97.00 (88.25-106)	0.121
Urea (mg/dL)	31.5 (25-37)	29.00 (24.00-34.20)	0.054
Creatinine (mg/dL)	0.71 (0.60-0.87)	0.68 (0.58-0.82)	0.284
Alanine aminotransferase (U/L)	19 (15-24)	17.00 (14.00-22.75)	0.161
Vitamin B12 (µg/L)	186.5 (127-252)	178.00 (129-230)	0.691
Folate (µg/L)	7.9 (6.3-9.6)	8.3 (6.5-10.1)	0.335
Ferritin (µg/L)	45 (25-85)	30.00 (10.00-61.00)	**0.007**
Electromyographic severity		1 (1-2)	**0.000**

CTS: Carpal tunnel syndrome

(all p>0.05). Evaluation of EMG severity revealed that in the unilateral CTS group, 68.8% of cases were classified as mild, 24.2% as moderate, and 7% as severe. In the bilateral CTS group, the right hand showed 52.2% mild, 38.2% moderate, and 9.6% severe involvement, while the left hand showed 58.2% mild, 34.6% moderate, and 7.2% severe involvement (Table 3).

As a result of the logistic regression analysis, potential risk factors that could influence the development of CTS were evaluated. The model was found to be generally significant (p<0.001). Among the variables included in the analysis, vitamin D and hemoglobin levels were found to have a statistically significant relationship with CTS. It was observed that each unit increase in vitamin D levels reduced the likelihood of developing CTS [B=-0.045; odds ratio (OR)=0.956; 95% confidence interval (CI): 0.920-0.993; p=0.022]. Similarly, each unit increase in hemoglobin levels was also associated with a significant protective effect (B=-0.321; OR=0.725; 95% CI: 0.568-0.926; p=0.010). In contrast, age, gender, white blood cell, neutrophil, lymphocyte, monocyte, glucose, urea, creatinine, ALT, B12, folate, and ferritin levels were not found to have a significant effect on the development of CTS (p>0.05) (Table 4).

DISCUSSION

This study demonstrated that vitamin D and ferritin levels were significantly lower in patients with CTS compared with healthy controls.

Vitamin D is known to play an important role in muscle and nerve function, inflammatory processes, and neurological recovery mechanisms. Previous studies have suggested that vitamin D deficiency is an independent risk factor for the development of CTS symptoms. Beyond its effects on neurological functions, vitamin D also suppresses the expression of vascular endothelial growth factor, which has been associated with increased inflammatory fibrosis that may contribute to the onset of CTS (10-13). Nageeb et al. (14) and Abdul-Razzak and Kofahi (15) reported that CTS patients had significantly lower vitamin D

Table 3. Comparison between unilateral, bilateral CTS patients and healthy controls

Variable	Control group median (25^{th}-75^{th} percentile)	Unilateral CTS group median (25^{th}-75^{th} percentile)	Bilateral CTS group median (25^{th}-75^{th} percentile)	p-value
n (female/male)	62 (42/20)[a]	128 (109/19)[b]	280 (234/46)[b]	0.007
Age (years)	57 (48-63)	54 (45-61)	56 (47-62)	0.270
Vitamin D (µg/L)	18 (12-22)[a]	12 (10-20)[b]	15 (11-20)[c]	0.001
White blood cell (10^9/L)	7.2 (6.0-9.0)	7.05 (6.1-8.7)	7.2 (6.0-8.7)	0.881
Hemoglobin (g/dL)	13.9 (13.2-14.8)[a]	13.4 (12.5-14.2)[b]	13.7 (12.7-14.3)[ab]	0.001
Platelet (10^9/L)	248 (218-300)	268 (225-311)	261 (228-302)	0.347
Neutrophil (10^9/L)	4.16 (3.35-5.06)	4.19 (3.42-5.43)	4.12 (3.28-5.26)	0.619
Lymphocyte (10^9/L)	2.16 (1.67-2.65)	2.12 (1.71-2.80)	2.10 (1.60-2.56)	0.345
Monocyte (10^9/L)	0.53 (0.45-0.65)	0.53 (0.43-0.64)	0.54 (0.42-0.69)	0.999
Glucose (mg/dL)	98.5 (93-112)	97 (88-106)	96 (87-107)	0.141
Urea (mg/dL)	31.5 (25-37)	29 (24-34)	29 (24-35)	0.155
Creatinine (mg/dL)	0.71 (0.60-0.87)	0.68 (0.58-0.82)	0.66 (0.59-0.82)	0.457
Alanine aminotransferase (U/L)	19 (15-24)	17 (14-23)	18 (14-23)	0.328
Vitamin B12 (µg/L)	186.5 (127-252)	178 (129-230)	170 (128-233)	0.683
Folate (µg/L)	7.9 (6.3-9.6)	8.3 (6.5-10.1)	8.2 (6.6-10.6)	0.533
Ferritin (µg/L)	45 (25-85)[a]	30 (10-61)[b]	33 (14-65)[b]	0.020
EMG severity-mild, n (%)	0 (0%)	88 (68.8%)	146/163 (52.2%/58.2%)	
EMG severity-moderate, n (%)	0 (0%)	31 (24.2%)	107/97 (38.2%/34.6%)	
EMG severity-severe, n (%)	0 (0%)	9 (7.0%)	27/20 (9.6%/7.2%)	

[a,b,c]: Different superscripts (different letters within a column or group) indicate statistically significant differences between groups (p<0.05). There are no significant differences between groups sharing the same letter
CTS: Carpal tunnel syndrome

Table 4. Binary logistic regression results

	B	SE	%95 CI	Exp (B)	p-value
Constant	8.675	2.223		5852.015	<0.001
Age	-0.005	0.015	0.966-1.025	0.995	0.737
Female	-0.446	0.416	0.283-1.446	0.640	0.283
Vitamin D	-0.045	0.020	0.920-0.993	0.956	0.022
Hemoglobin	-0.321	0.124	0.568- 0.926	0.725	0.010
White blood cell	-0.025	0.097	0.806-1.179	0.975	0.795
Platelet	-0.001	0.002	0.995-1.004	0.999	0.834
Neutrophil	0.033	0.110	0.833-1.282	1.034	0.764
Lymphocyte	-0.243	0.229	0.500-1.230	0.785	0.290
Monocyte	1.042	1.048	0.364-22.108	2.836	0.320
Glucose	-0.013	0.010	0.968-1.005	0.987	0.161
Urea	0.000	0.002	0.996-1.003	1.000	0.879
Creatinine	0.002	0.008	0.986-1.019	1.002	0.801
Alanine aminotransferase	0.017	0.018	0.982-1.053	1.017	0.338
Vitamin B12	-0.001	0.001	0.997-1.000	0.999	0.142
Folate	0.024	0.041	0.946-1.109	1.024	0.552
Ferritin	0.000	0.000	1.000-1.000	1.000	0.774

B: Regression coefficient, SE: Standard error, CI: Confidence interval, Exp (B): Exponentiated B (odds ratio)

levels than healthy controls, and that this deficiency may play a role in the pathogenesis of CTS. In line with these findings, our study also demonstrated significantly lower vitamin D levels in the patient group compared with the controls.

Our study demonstrated that ferritin levels were lower in patients with CTS compared with healthy individuals. This finding is consistent with evidence in the literature suggesting that disturbances in iron metabolism may affect peripheral nervous system function. Degirmenci and Kececi (16) reported that neuropathic findings related to iron deficiency were present in patients with both iron deficiency anemia and CTS. Swaminathan et al. (17) also showed marked impairments in peripheral nerve conduction studies among individuals with iron deficiency anemia; while Sharma et al. (18) reported resolution of these impairments following iron replacement therapy. More recent research has highlighted the role of Schwann cells in promoting neuronal growth and regeneration by supplying iron to axonal mitochondria in the peripheral nervous system, a mechanism described in detail by Mietto et al. (19). Collectively, these findings suggest that iron deficiency can adversely affect nerve function and support the hypothesis that the low ferritin levels observed in our study may contribute to the pathophysiology of CTS.

Although the low hemoglobin levels observed in CTS patients in our study are significant, we believe that they are not clinically significant because the values are not sufficiently varied. A reduction in hemoglobin may impair nerve function by limiting oxygen delivery to peripheral tissues. Evidence supporting the relationship between anemia and neuropathic disorders is also available in the literature. Swaminathan et al. (17) reported prolonged distal latencies and reduced motor conduction velocities in the median, ulnar, and posterior tibial nerves of patients with iron deficiency anemia. Similarly, Kabakuş et al. (20) documented impairments in motor conduction parameters. Sharma et al. (18) found decreased amplitudes and increased latencies in both motor and sensory components, with partial reversibility following iron replacement therapy. In addition, Degirmenci and Kececi (16) demonstrated that polyneuropathy and CTS may coexist in cases of iron deficiency anemia. These findings suggest that iron deficiency adversely affects peripheral nerve function and may predispose individuals to the development of neuropathy. Given iron's fundamental role in myelination and energy metabolism (21) it is plausible that the hypoxic state associated with iron deficiency could worsen the clinical course of compressive neuropathies such as CTS (19,22,23). Accordingly, incorporating the assessment

of hemoglobin and ferritin levels into the routine evaluation of CTS patients may enhance diagnostic accuracy and improve prognosis through timely replacement therapy.

In our study, EMG severity was predominantly mild in unilateral CTS cases (68.8%), whereas moderate and severe forms were more common in bilateral CTS cases (right hand: 38.2% moderate, 9.6% severe; left hand: 34.6% moderate, 7.2% severe). This distribution suggests that bilateral involvement may be associated with greater clinical and electrophysiological severity. Consistent with our findings, the literature also reports more advanced EMG abnormalities in bilateral cases. Srikanteswara et al. (24) demonstrated that disease severity was more pronounced in bilateral CTS, while Becker et al. (25) reported that EMG findings were mild in the majority of unilateral CTS cases (74.1%), indicating a comparatively milder course.

Study Limitations

This study has certain limitations. Its cross-sectional design precludes the establishment of causal relationships. One of the important limitations of our study is the imbalance in gender distribution between the patient and control groups. In addition, the single-center setting and a sample size that may not fully represent larger populations limit the generalizability of the findings. Prospective, multicenter studies are required to further clarify the mechanisms underlying the relationship between vitamin D, ferritin, and hemoglobin levels, and CTS.

CONCLUSION

In conclusion, this study compared demographic, biochemical, and electrophysiological parameters between patients with CTS and healthy controls. CTS was found to be more prevalent in women, and vitamin D and ferritin levels were significantly lower among affected patients. These findings indicate that, in addition to anatomical and mechanical factors, metabolic and hematological parameters may play a role in the pathophysiology of CTS. Electrophysiological assessments revealed more severe disease in bilateral cases, emphasizing the need for closer clinical monitoring of these patients. Incorporating biochemical evaluations into routine clinical practice and correcting micronutrient deficiencies may support earlier intervention and improve treatment outcomes.

Ethics

Ethics Committee Approval: The study was approved by the Non-Interventional Local Ethics Committee of University of Health Sciences Türkiye, Elazığ Fethi Sekin City Hospital (approval no: 2025/12-32; date: 25.07.2025).

Informed Consent: Retrospective study.

Footnotes

Authorship Contributions

Surgical and Medical Practices: E.Y.U., M.F.U., Concept: E.Y.U., M.F.U., Design: E.Y.U., M.F.U., Data Collection or Processing: E.Y.U., M.F.U., Analysis or Interpretation: E.Y.U., M.F.U., Literature Search: E.Y.U., M.F.U., Writing: E.Y.U., M.F.U.

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