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ORIGINAL ARTICLE

Effect of Compliance with Exercise Program Given in Addition to Trigger Point Injection on Number of Trigger Points and Pain Level in Patients with Myofascial Pain Syndrome

ABSTRACT

Objective

The aim of this study was to compare the effects of adherence to an exercise program in addition to trigger point injection (TPI) on pain level and number of trigger points (TrP).

Methods

TPI was performed on active TrP on the backs of 40 patients with myofascial pain syndromes (MPS). Afterwards, exercise program was recommended to the patients. The pain-VAS and number of TrP in the patients who were called for control at 1st and 3rd months were re-evaluated. Patients with exercise compliance of 50% or more for 3 months were considered to be compliant with exercise, while below 50% were included in the exercise non-compliant group.

Results

Pain-VAS decreased in non-compliant and compliant exercise groups at 1st and 3rd months compared to baseline ($p<0,001$, $p<0,001$, $p=0.006$, $p<0,001$). At 3rd month, a decrease in pain-VAS compared to 1st month was observed only in the compliant group. The decrease compared to baseline at 1st and 3rd months was greater in the compliant group ($p<0,001$, $p=0,003$). No statistically significant difference was found in the number of TrP in the non-compliant group ($p=0.047$). In the compliant group, the number of TrP was significantly lower at 3rd month compared to baseline and 1st month ($p<0,001$, $p<0,001$). No significant difference was observed between the groups in terms of change in the number of TrP ($p=0,253$, $p=0,718$, $p=0,003$).

Conclusion

The importance of compliance with the exercise should be emphasized to patients with MPS.

Keywords: Trigger point injection, myofascial pain syndrome, exercise

Introduction

Myofascial pain syndrome (MPS) is one of the main causes of musculoskeletal pain and is mainly caused by trigger points. Trigger points are hyperirritable areas in the muscles and/or fascia that are localized in palpable taut bands. Trigger points cause mainly sensory, motor, and autonomic symptoms. Diagnosis of MPS is typically made by physical examination, and generally accepted diagnostic criteria include the presence of trigger points, pain on palpation, a referred pain pattern, and a local twitch response. Active trigger points cause constant pain, while latent trigger points are tender only to palpation. However, the clinical presentation may overlap with fibromyalgia syndrome, radiculopathy, and painful conditions of tendon or joint origin. However, regional pain distribution, referred pain with palpation of the trigger point, jerk sign, muscle twitch response, weakness without muscle atrophy, and decreased range of motion of the joint, and autonomic findings such as sweating, lacrimation, flushing and paresthesia are helpful in diagnosis. It is frequently seen between the ages of 27 and 50. The difference between the genders has not yet been determined. Studies have showed that MPS is responsible for 85% of back pain and 54.6% of head and neck pain. Despite being encountered so frequently, the pathophysiology

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of MPS is not yet clear. It is thought that excessive or incorrect use of muscles causes excessive acetylcholine release at the neuromuscular junction. Risk factors include trauma, poor ergonomic conditions, abnormal posture, and overuse. Additionally, temporomandibular joint dysfunction, insomnia, a history of cancer, and some psychological problems are also thought to be risk factors for MPS. As with the pathophysiology, there is no definitive consensus on treatment. Various methods such as exercise, posture correction, medical treatments such as tricyclic antidepressants or myorelaxants, physical therapy agents, trigger point injections, and elimination of the underlying causes are used. The most used methods are trigger point injections and passive stretching exercises after spraying a cooling spray on the relevant muscle (1). Among the applied treatment methods, exercise has a special place because it has a protective effect as well as a therapeutic effect. In the long term, treatments that do not have a protective effect cause patients to be dependent on repeated treatments and cause additional problems secondary to this (2). A better understanding of the effectiveness of the methods used, both in the short term and in the medium and long term, can make significant contributions to treatment management.

Comparing the effects of adherence to an exercise program in addition to trigger point injection with prilocaine on pain level and trigger point number at 1st and 3rd months was aimed.

Materials and Methods

The study was conducted by retrospectively and unblinded reviewing the files of 40 patients who were followed up with a diagnosis of MPS in our hospital's physical medicine and rehabilitation clinic between March 2024 and January 2025. The principles of the Declaration of Helsinki were followed in the study. Approval for the study was obtained from the ethics committee.

The inclusion criteria for the study were determined as volunteering to participate in the study, accepting trigger point injection, volunteering to do regular exercise, being diagnosed with MPS according to Travell-Simon's diagnostic criteria, having at least 1 active trigger point, and having pain in the neck and/or back region due to the trigger point, continuing complaints despite 2 weeks of medical treatment (analgesic and myorelaxant), not doing regular exercise in the last 6 months, not having any orthopedic, cardiac, respiratory, neuromuscular or psychiatric disease that would prevent exercise, not being allergic to prilocaine or 0.9% NaCl solution, and being at least literate. Travell-Simon's diagnostic criteria includes all 5 major criteria which are presence of localized spontaneous pain, altered sensations in the expected referred area, palpation of taut band within the muscle, localized tenderness at the point, reduction in range of movement when measurable and at least 1 of 3 minor criteria including local twitch response, reproduction of pain and altered sensations that develop by applying pressure to the trigger point and pain relief with trigger point treatment (1). Exclusion criteria were determined as leaving the study voluntarily, developing a new symptom or finding that would prevent exercise during the evaluation or treatment process, having cervical radiculopathy, having a diagnosis of fibromyalgia syndrome, pregnancy, known bleeding disorders, use of anticoagulants, anemia, known methemoglobinemia, having a history of trigger point injection in the last 6 months, being under the age of 18, and having a skin disease/lesion in the area where the injection would be applied. Considering the inclusion and exclusion criteria, the patients followed up with MPS were questioned about their neck and back pain-VAS scores after the first examination, and the number of trigger points in the painful areas was determined based on physical examination methods performed by a single physician and recorded by marking on the muscle diagram in the follow-up file. Procedure for the detection of trigger points the painful muscle was extended to approximately two-thirds of its own length, the skin and subcutaneous tissue were slid at right angles to the muscle fiber with the fingertips, and the reflected pain was determined by applying pressure to the detected tender point. Trigger point injections were performed using 0.5% procaine (obtained by diluting 2% procaine with 0.9% NaCl) on active trigger points on the backs of participants who gave informed consent. Afterwards, isometric strengthening and posture exercises for the cervical region flexors, extensors, lateral flexors, pectoral muscles, and posterior part of the deltoid muscle, as well as stretching exercises for the cervical flexors, extensors, lateral flexors, rotators, and pectoral muscles were recommended to the patients to be applied at home. All exercises were done in 1 set of 10 repetitions per day. Patients were asked to mark their exercise compliance on the exercise follow-up forms. The pain-VAS values and trigger point numbers in the painful areas of the patients who were called for control at 1st and 3rd months were re-evaluated and recorded. Patients with exercise compliance of 50% or more for 3 months were considered to be compliant with exercise, while patients with compliance below 50% were included in the exercise non-compliant group. Patients' exercise compliance was monitored with an exercise diary.

Statistical Analysis: IBM SPSS Statistics ver. 25 (IBM Corporation, Armonk, NY, US) software was used to analyze the data. Whether the data of continuous numerical variables showed a distribution close to normal was examined with the Shapiro-Wilk test, and whether the assumption of homogeneity of variances was met was examined with the Levene test. Descriptive statistics were expressed as mean ± standard deviation and median (25th percentile-75th percentile) for continuous numerical variables, while categorical variables were shown as number of cases and percentage (%). The significance of the differences between the groups in terms of continuous numerical variables for which the parametric test statistics assumptions were met was examined using Student's t-test, and the significance of the differences between the groups in terms of continuous numerical variables for which the parametric test statistics assumptions were not met was

examined using the Mann-Whitney U test. Continuity Corrected χ2, Fisher Freeman Halton, or Fisher's Exact Probability Test was used in the analysis of categorical data. The Friedman test was used to investigate whether there was a statistically significant change in pain-VAS levels and trigger point numbers according to the follow-up times in the groups that did and did not follow the exercise program. If the Friedman test statistics were found to be significant, the follow-up times that caused the difference were determined using the Dunn-Bonferroni multiple comparison test. Results were deemed statistically significant at $p < 0.05$ unless a Bonferroni adjustment was required to control the family-wise error rate. For the within-group trajectory analyses in Table 2, each outcome (VAS or TNS) was examined separately in two independent groups; therefore the nominal alpha was divided by two ($\alpha = 0.025$), and any post-hoc Dunn contrasts were interpreted against the same threshold. For the between-group change-score comparisons in Table 3, three pre-specified contrasts (Δ□–0, Δ□–0, Δ□–□) formed the relevant test family, so the alpha level was divided by three ($\alpha = 0.0167$). All *p*-values reported in Tables 2 and 3 already reflect these adjustments.

Additionally, post-hoc power analyses were undertaken to clarify whether the non-significant findings reflected true absence of effect or inadequate sample size. We calculated that, with a Bonferroni-adjusted significance level of α = 0.0167 and a target power of 80 %, only 11 participants per arm were required to detect the 0–3-month change in pain intensity (VAS), and 19 per arm for the 1–3-month comparison. Because the present study included 20 participants in each group, the effective power for all VAS analyses ranged between 81.8 % and 95.2 %, supporting the robustness of the pain-related results. In contrast, the same procedure indicated that ≈ 213 participants per arm would be necessary to detect the observed between-group difference in trigger-point number with 80 % power, meaning that our current sample (n = 40) provided only ~19.8 % power for this endpoint.

Results

Forty patients were included in the study. No significant difference was observed between the groups in terms of demographic data (p>0.05) (Table 1).

At baseline, pain-VAS and trigger point counts were statistically similar between the groups that complied with the exercise program and those that did not (p=0.529, p=0.265) (Table 2).

In both exercise-compliant and non-compliant groups , pain-VAS levels were lower at 1st and 3rd months compared to baseline (p<0.001, p<0.001 vs p=0.006, p<0.001, respectively). Only in the exercise-compliant group, pain-VAS levels at 3rd month were significantly lower compared to 1st month (p=0.006), (Figure 1), (Table 2).

Table 1. Demographic characteristics of the subjects according to the groups that comply with and do not comply with the exercise program

	Not comply (n=20)	Comply (n=20)	p-value
Age (year) *	45.1±11.3	51.7±14.0	0.113[a]
Gender			n/a
Male	1 (5.0%)	1 (5.0%)	
Female	19 (95.0%)	19 (95.0%)	
Education			0.310[b]
Primary School	6 (30.0%)	10 (50.0%)	
High School	11 (55.0%)	9 (45.0%)	
University	3 (15.0%)	1 (5.0%)	
Marital Status			n/a
Single	2 (10.0%)	2 (10.0%)	
Married	18 (90.0%)	18 (90.0%)	
Working Status			0.661[c]
Unemployed	16 (80.0%)	18 (90.0%)	
Working	4 (20.0%)	2 (10.0%)	
Place of Residence			n/a
District or Village	17 (85.0%)	17 (85.0%)	
Town Center	3 (15.0%)	3 (15.0%)	
Co-Morbidities			0.205[d]
No	13 (65.0%)	8 (40.0%)	
Yes	7 (35.0%)	12 (60.0%)	

Data are shown as mean ± standard deviation. [a] Student's t test, [b] Fisher Freeman Halton test, [c] Fisher's exact probability test, [d] χ2 test with continuity correction. n/a: No evaluation was made.

Table 2. Pain levels and trigger point numbers of the subjects in the groups that followed and did not follow the exercise program according to the follow-up times.

	Baseline	1st month	3rd month	p-value a
Pain-VAS				
Not compliant with exercise program	9.0 (7.0 – 10.0)A,B	6.0 (4.2 – 7.0)A	6.0 (4.2 – 7.0)B	<0.001
Compliant with exercise program	8.0 (6.5 – 10.0)A,B	5.0 (3.0 – 6.0)A,C	2.0 (1.0 – 3.0)B,C	<0.001
Number of trigger points				
Not compliant with exercise program	7.0 (5.2 – 10.0)	5.0 (4.0 – 8.7)	5.0 (4.0 – 8.7)	0.047
Compliant with exercise program	6.0 (5.0 – 8.0)B	6.0 (5.0 – 9.2)C	3.0 (2.2 – 5.0)B,C	<0.001

Data are shown as median (25th percentile – 75th percentile). a Friedman test, results were considered statistically significant for p<0.025 according to Bonferroni correction. A The difference between baseline and 1st month is statistically significant (p<0.01), B The difference between baseline and 3rd month is statistically significant (p<0.001), C The difference between 1st month and 3rd month is statistically significant (p<0.01).

Table 3. Comparisons between groups that followed and did not follow the exercise program in terms of changes in pain levels and trigger point numbers according to follow-up times.

	Not compliant (n=20)	Compliant (n=20)	p-value a
Pain-VAS			
1st month – baseline	-2.0 (-3.7 – -2.0)	-3.5 (-4.7 – -2.2)	0.091
3rd month – baseline	-3.0 (-4.0 – -0.2)	-5.0 (-7.0 – -4.2)	<0.001
3rd month – 1st month	0.0 (-2.0 – 1.7)	-2.0 (-3.0 – -2.0)	0.003
Number of Trigger Points			
1st month – baseline	-1.0 (-3.0 – 1.5)	0.0 (-1.7 – 1.0)	0.253
3rd month – baseline	-2.0 (-4.7 – 0.0)	-2.0 (-3.7 – -1.0)	0.718
3rd month – 1st month	-0.5 (-2.7 – 1.7)	-2.0 (-3.0 – -1.2)	0.026

Data are shown as median (25th percentile – 75th percentile). a Mann Whitney U test, Bonferroni correction, results were considered statistically significant for p<0.0167.

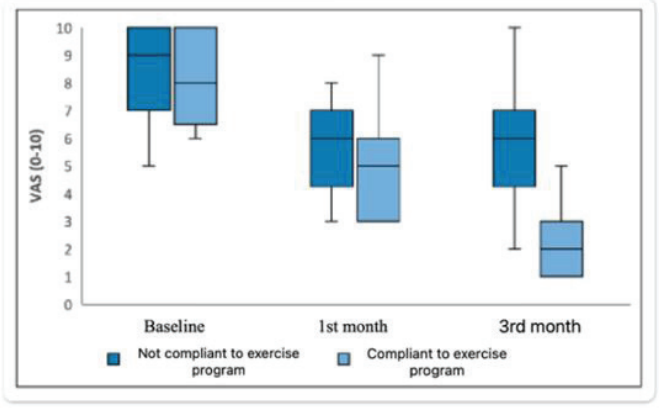

Figure 1. Box-plot graph of VAS levels of subjects in groups that did and did not comply with the exercise program according to follow-up times.

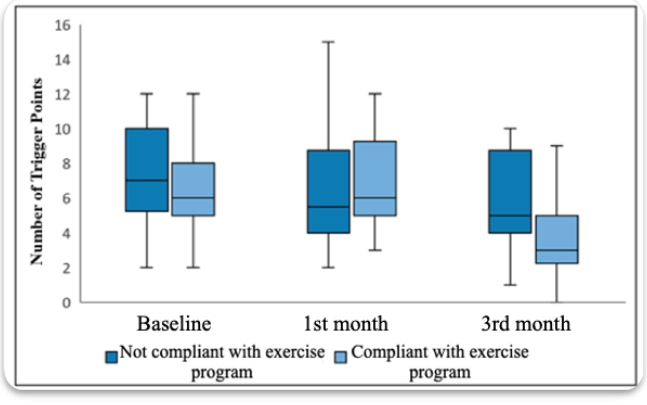

Figure 2. Box-plot graph of trigger point numbers in groups that did and did not comply with the exercise program according to follow-up times.

No significant difference was found in the number of trigger points between the follow-up times in the group that did not comply with the exercise procedure (p=0.047) (Table 2). In the group that complied with the exercise, the number of trigger points at the 3rd month was significantly lower than at the beginning and at the 1st month (p<0.001, p<0.001) (Figure 2).

There was no significant difference between the groups in terms of changes in pain-VAS levels at 1st month compared to baseline (p=0.091). Pain-VAS levels decreased more in the group complying with the exercise program at 3rd month compared

to baseline and 3rd month compared to 1st month (p<0.001, p=0.003). No significant difference was observed between the groups in terms of changes in trigger point numbers at 1st month compared to baseline, 3rd month compared to baseline, or 3rd month compared to 1st month (p=0.253, p=0.718, p=0.026) (Table 3).

Discussion

MPS accounts for the majority of complaints of pain. Better identification of effective and long-term protective treatments is critical for treatment management.

In our study, pain-VAS levels decreased in both groups at 1st month and 3rd month compared to baseline. However, the decrease in pain-VAS levels at 3rd month compared to 1st month was observed only in the exercise-compliant group. Among the groups, the decrease at 3rd month compared to baseline and 1st month was statistically greater in the exercise-compliant group than in the non-compliant group. Lugo et al. compared the effectiveness of a standard physical therapy program consisting of manual therapy, stretching and strengthening exercises, and warming treatments, 3 days a week, 4 weeks, combined with trigger point injections using 0.5% lidocaine on pain-VAS levels at 1st and 3rd months with the patient groups that received only trigger point injections and only physical therapy programs. Similar to our findings, no difference was observed between the groups at 1st month, but differently, no decrease was observed at 3rd month (3). In a 12-week randomized controlled study conducted by Majidi et al., the pain-VAS levels at 1st and 3rd months were compared after stretching and strengthening exercises applied to patients diagnosed with head-forward posture and MPS. Similar to our data, there was a significant improvement in the pain-VAS level within the exercise group at the 1st month compared to the beginning, at the 3rd month compared to the beginning, and at the 3rd month compared to the 1st month (4). In a systematic review, conducted by Mata Diz et al. showed that exercise has a small to moderate positive effect on pain intensity in MPS patients in the short term, and stretching and strengthening exercises in particular are more effective (5). These results suggest that the effect of stretching and strengthening exercises in the treatment of MPS begins in 1st month and this increase continues over time.

No statistically significant difference was detected in the number of trigger points between the follow-up times in the group that did not comply with the exercise program in our study (p=0.047). In the group that complied with the exercise program, the number of trigger points in the 3rd month was significantly lower compared to the beginning and the 1st month. No significant difference was observed between the groups in terms of the change in the number of trigger points in the 1st and 3rd months compared to the beginning or in the 3rd month compared to the 1st month. In the study conducted by Cho et al., patients with active trigger points in the suboccipital muscles, head forward posture, and tension-type headache were divided into 3 groups and suboccipital muscle inhibition was applied to one group, and posture exercises were applied to the other group in addition to suboccipital muscle inhibition, while the 3rd group was evaluated as the control group. While a decrease in the number of trigger points was observed in the group that performed posture exercises together with suboccipital muscle inhibition, it was observed that the improvement in the number of active trigger points was greater in the group that performed posture exercises in addition to suboccipital muscle inhibition (6). Ahmed et al., in their review, showed that aerobic exercise for at least 4 weeks had a positive effect on the number of trigger points and pain-VAS levels in MPS patients compared to the non-exercising group (7). These results suggest that various types of exercise may reduce the number of trigger points.

Also, our post-hoc power analyses strongly suggest that the lack of statistical significance for trigger point numbers is most likely a type-II error rather than evidence of no clinical effect. The study is sufficiently powered for pain outcomes but under-powered for structural changes assessed by trigger point numbers. The retrospective design limited our ability to perform an a priori sample-size calculation; we therefore analysed all eligible charts to maximise the available cohort. In addition, as in other retrospective studies, there may be inherent limitations of retrospective studies, such as reliance on existing documents or the potential for missing data. Nevertheless, future research should employ prospective, multi-centre designs and larger samples—potentially exceeding 400 participants overall—or alternative repeated-measures approaches to provide definitive evidence regarding trigger-point resolution.

Conclusion

In order to provide long-term pain control, compliance with a home exercise program based on stretching and strengthening may be more effective than trigger point injection alone. In patients who receive trigger point injections with a diagnosis of MPS in the outpatient clinic, an exercise program should be added to the treatment plan, and patients should be informed about the importance of compliance with the exercise program.

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Declarations

Ethics Committee Approval: This study was designed as a single-center, retrospective, descriptive observational analysis. Ethical approval was obtained from the Clinical Research

Ethics Committee of Etlik City Hospital (Approval No: AEŞH-BADEK-2025-0223).

The study was conducted in accordance with the principles of the Declaration of Helsinki

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ORIGINAL ARTICLE

Clinical Characteristics of Patients in a Tertiary Non-COVID-19 Intensive Care Unit During the Pandemic: What Has Changed?

ABSTRACT

INTRODUCTION: The COVID-19 pandemic profoundly impacted healthcare systems, necessitating rapid reallocation of resources, which significantly affected the management of non-COVID-19 intensive care unit (ICU) patients. This study aimed to examine the clinical characteristics and outcomes of patients admitted to a tertiary non-COVID-19 ICU before and during the pandemic.

METHODS: A retrospective cohort study was conducted, including 528 patients admitted between March 2019 and March 2021. Patients were divided into pre-pandemic (Non-COVID group, n=196) and pandemic (COVID group, n=332) cohorts. Demographic data, comorbidities, ICU admission details, and outcomes were analyzed. Statistical analyses included t-tests, chi-square tests, and Mann-Whitney U tests, with significance set at $p<0.05$.

RESULTS: The mean patient age was 72 years, with a higher proportion of males in the Non-COVID group (57.7% vs. 48.8%, $p=0.049$). The COVID group had significantly shorter ICU stays (median 6 vs. 9 days, $p=0.048$) and higher emergency department admissions (77.7% vs. 42.3%, $p<0.001$). Comorbidities such as hypertension, diabetes, and coronary artery disease were significantly more common during the pandemic period ($p<0.001$). Despite these differences, ICU mortality rates remained consistently high (82.3%) across both periods.

DISCUSSION AND CONCLUSION: The pandemic led to notable shifts in ICU admissions, with more critically ill patients presenting from emergency departments and with multiple comorbidities. Despite shorter ICU stays, high mortality rates persisted, underscoring the need for resilient critical care strategies during future health crises.

Keywords: Non-COVID-19 ICU, COVID-19 pandemic, clinical characteristics, comorbidities, ICU mortality

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Introduction

The COVID-19 pandemic introduced unprecedented challenges to healthcare systems globally, primarily due to the rapid increase in intensive care unit (ICU) admissions over a short period. Managing ICU capacity—already limited in numerous healthcare institutions—became even more critical as the demand for intensive care surged. In response, hospitals were compelled to swiftly restructure their infrastructure, reassign medical personnel, and establish dedicated COVID-19 ICUs to manage critically ill patients. This extensive reallocation of resources had significant repercussions for the care of non-COVID-19 patients who required intensive care services.

During this time, hospital admissions for non-COVID-19 conditions declined markedly. This reduction was likely influenced by government-imposed lockdown measures, patient reluctance to seek hospital care, and the reallocation of healthcare resources prioritizing COVID-19 patients. As a result, many elective procedures were postponed, and routine healthcare services were disrupted, leading to delays in diagnosis and the worsening of chronic conditions. Consequently, non-COVID-19 patients

who eventually required ICU admission often presented with advanced stages of illness due to these delays in accessing appropriate medical care.

By September 27, 2021, the COVID-19 pandemic had resulted in 232,522,770 confirmed cases and 4,748,539 deaths globally. In our country, the total number of confirmed cases reached 7,039,500, with 63,166 reported deaths (1). A comprehensive meta-analysis encompassing 24 observational studies estimated the intensive care unit (ICU) mortality rate among COVID-19 patients at 41.6% (2). The unprecedented demand for critical care beds, coupled with shortages of medical supplies and healthcare personnel, significantly disrupted healthcare services during this period. As a result, a considerable proportion of ICU capacity was designated for COVID-19 patients, compelling many healthcare institutions to expand their ICU facilities to meet the growing demand (2,3).

While the primary focus of healthcare systems was directed toward managing COVID-19 patients, intensive care units (ICUs) designated for non-COVID-19 cases continued to operate. However, these units encountered significant challenges, including shortages of healthcare personnel, stricter infection control protocols, and modifications to standard ICU admission policies. The resulting strain on hospital infrastructure raised concerns regarding shifts in patient demographics, disease severity, and mortality rates within these units (2,3). Several studies have highlighted that the profile of ICU admissions evolved during the pandemic, marked by a higher proportion of elderly patients, greater illness severity, and altered treatment protocols driven by resource limitations.

Beyond the immediate disruptions, the pandemic's long-term effects on ICU patient outcomes remain a critical area of inquiry. Delayed hospital admissions and postponed elective procedures may have led to higher morbidity and mortality rates among non-COVID-19 patients. Furthermore, the heightened workload for healthcare professionals, sustained stress, and limited resources may have indirectly compromised the quality of patient care. Gaining a deeper understanding of these changes is essential for refining healthcare resource distribution and enhancing ICU management strategies in future pandemics.

This study aims to examine the impact of the COVID-19 pandemic on critically ill patients admitted to a tertiary non-COVID-19 ICU by analyzing their clinical characteristics and outcomes. The insights gained from this analysis could inform strategies for optimizing ICU resource allocation and preparedness, ultimately contributing to the development of more resilient healthcare systems capable of withstanding future global health emergencies.

MATERIALS and METHODS

Study Design and environment

This study was approved by the institutional ethics committee, and all procedures were conducted in accordance with the principles of the Declaration of Helsinki. Since the study was retrospective and involved the review of anonymized patient records, informed consent was not required. All patient data were handled in compliance with data protection regulations and were used solely for research purposes. This study was performed per Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) criteria.

This retrospective cohort study was conducted in a tertiary care center and included patients who were admitted to the medical and surgical intensive care units (ICUs) between March 2019 and March 2021. To assess the impact of the COVID-19 pandemic on ICU admissions and outcomes, patients were divided into two groups based on the onset of the pandemic: the Non-COVID group (March 2019–March 2020), consisting of patients admitted before the pandemic, and the COVID group (March 2020–March 2021), which included patients admitted during the pandemic period.

Study data

Patient data were collected retrospectively from the hospital information management system and ICU assessment forms. The following variables were recorded for each patient: demographic characteristics (age and gender), comorbidities (hypertension, diabetes mellitus, coronary artery disease, arrhythmia, chronic kidney disease, neurologic diseases, respiratory diseases, heart failure, and cancer), and admission details, including ICU admission source (emergency department, hospital wards, or transfers from external centers) and patient type (medical or surgical). The primary ICU admission diagnoses were also noted, including conditions such as sepsis, cardiac diseases, respiratory failure, trauma, and postoperative surgical conditions. Additionally, data on ICU length of stay (LOS) and clinical severity scores, particularly the Acute Physiology and Chronic Health Evaluation II (APACHE II) score, were extracted to assess the severity of illness upon admission.

To evaluate patient outcomes, hospital discharge records were reviewed, and ICU mortality, discharge rates, and interhospital transfers were documented. The study aimed to identify potential differences in patient characteristics, disease severity, and clinical outcomes between the two periods, providing insights into the indirect effects of the pandemic on critically ill patients requiring intensive care.

Ethical statement

Ethics committee approval for this study was received from the Ethics Committee of the Yozgat Bozok University following the Declaration of Helsinki (date: 01.10.2021; no: 189_2021.10.13_08).

Statistical analysis

All statistical analyses were performed using IBM SPSS Statistics for Windows, Version 25.0 (IBM Corp., Armonk, NY, USA). The normality of continuous variables was assessed using

the Kolmogorov-Smirnov test. Normally distributed variables were presented as mean ± standard deviation (SD), while non-normally distributed variables were expressed as median [minimum–maximum]. Categorical variables were summarized as frequencies (n) and percentages (%). Differences between the Non-COVID and COVID groups were analyzed using the independent samples t-test or Mann-Whitney U test for continuous variables and the chi-square (χ^2) test for categorical data. A p-value < 0.05 was considered statistically significant.

RESULTS

A total of 528 patients were included in the study, with 196 patients (37.1%) in the Non-COVID group and 332 patients (62.9%) in the COVID group (Table 1). The mean age of all patients was 72 years (SD = 16), with no significant difference between the two groups (p = 0.561). The overall male-to-female ratio was 52.1% to 47.9%, with a higher proportion of males in the Non-COVID group (57.7% vs. 48.8%, p = 0.049).

Table 1. Demographic and Clinical Characteristics of the Groups

Variables	Overall (n=528)	Non-COVID (n=196)	COVID (n=332)	p value
Age (years)	72 (16)	71 (17)	72 (15)	0.561[b]
Gender, Female/Male	253/275 (47.9/52.1)	83/113 (42.3/57.7)	170/162 (51.2/48.8)	**0.049**[a]
Length of ICU stay (days)	7 [1 to 22]	9 [2 to 27]	6 [1 to 20]	**0.048**[c]
Patient type				
Medical	431 (81.6)	152 (77.6)	279 (84.0)	0.063[a]
Surgical	97 (18.4)	44 (22.4)	53 (16.0)	
Referring unit				
Emergency service	341 (64.6)	83 (42.3)	258 (77.7)	**<0.001**[a]
Wards	61 (11.6)	40 (20.4)	21 (6.3)	
External transfers	126 (23.9)	73 (37.2)	53 (16.0)	
Admission diagnosis				
Sepsis	36 (6.8)	11 (5.6)	25 (7.5)	-
Post-CPR	115 (21.8)	45 (23.0)	70 (21.1)	-
Respiratory diseases	103 (19.5)	37 (18.9)	66 (19.9)	-
Cardiac diseases	29 (5.5)	10 (5.1)	19 (5.7)	-
Neurological diseases	98 (18.6)	39 (19.9)	59 (17.8)	-
Renal failure	42 (8.0)	11 (5.6)	31 (9.3)	-
Trauma	34 (6.4)	21 (10.7)	13 (3.9)	-
Cardiac surgery	1 (0.2)	1 (0.5)	0 (0.0)	-
Abdominal surgery	3 (0.6)	1 (0.5)	2 (0.6)	-
Other surgical conditions	15 (2.8)	9 (4.6)	6 (1.8)	-
Other medical conditions	46 (8.7)	7 (3.6)	39 (11.7)	-
Intoxication	6 (1.1)	4 (2.0)	2 (0.6)	-
Outcomes				
Mortality	433 (82.3)	162 (82.7)	271 (82.1)	0.245[a]
Discharge	26 (4.9)	13 (6.6)	13 (3.9)	
Transfer	67 (12.7)	21 (10.7)	46 (13.9)	

Data are presented as the mean ± SD and median [interquartile range] for continuous variables and number and percentage for categorical variable. [a]Compared by Pearson's chi-square test. [b]Compared by independent sample t-test. [c]Compared by Mann-Whitney U test. P values in bold text indicate statistical significance at P < 0.05. CPR: cardiopulmonary resuscitation; ICU: intensive care unit.

Comparison of clinical characteristics between the COVID and Non-COVID group

The median ICU length of stay (LOS) was significantly shorter in the COVID group (6 days, IQR: 1–20) compared to the Non-COVID group (9 days, IQR: 2–27), p = 0.048. In terms of patient type, the majority of ICU admissions were medical patients (81.6%), with a slightly higher proportion in the COVID group (84.0% vs. 77.6%, p = 0.063), though this difference did not reach statistical significance.

The ICU admission source differed significantly between the groups (p < 0.001). The proportion of patients admitted from the emergency department was notably higher in the COVID group (77.7%) compared to the Non-COVID group (42.3%). In contrast, patients transferred from hospital wards were significantly more common in the Non-COVID group (20.4% vs. 6.3%). Moreover, the proportion of patients transferred from external centers was markedly higher in the Non-COVID group (37.2% vs. 16.0%).

Regarding primary ICU admission diagnoses, the most common reasons for admission were post-cardiopulmonary resuscitation (21.8%), respiratory diseases (19.5%), and neurological diseases (18.6%). There were no statistically significant differences between the groups for these primary diagnoses. However, trauma-related ICU admissions were significantly more frequent in the Non-COVID group (10.7% vs. 3.9%), whereas patients admitted for "other medical conditions" were more common in the COVID group (11.7% vs. 3.6%).

Comorbidities of the Groups

In terms of comorbidities, the COVID group had significantly higher rates of hypertension (35.2% vs. 16.3%, p < 0.001), diabetes mellitus (28.1% vs. 8.7%, p < 0.001), and coronary artery disease (25.0% vs. 7.2%, p < 0.001) (Table 2). Similarly, the prevalence of arrhythmia, chronic kidney disease, neurological disease, respiratory disease, and heart failure was significantly greater among patients in the COVID group (p < 0.01 for all comparisons). There was no statistically significant difference in the prevalence of cancer (p = 0.575) between the groups.

ICU outcomes were comparable between the two groups. The overall mortality rate was 82.3%, with no significant difference between the Non-COVID (82.7%) and COVID (82.1%) groups (p = 0.245). Similarly, the proportion of patients discharged from the ICU (4.9%) and those transferred to another facility (12.7%) did not differ significantly between the groups.

DISCUSSION

The findings of this study reveal substantial differences in the clinical characteristics and outcomes of patients admitted to a tertiary non-COVID-19 ICU before and during the COVID-19 pandemic, aligning with previous literature. Kömürcü et al. and Shankar et al. highlighted that the pandemic posed significant challenges to hospital operations, particularly in ICU settings (1,4).

A notable increase in ICU admissions from emergency departments during the pandemic (77.7% vs. 42.3%) was observed, reflecting resource reallocation towards COVID-19 care, as highlighted by Al-Omari et al. (5). In another study, Ozguner et al. attributed this shift to constrained healthcare resources and altered admission protocols, resulting in fewer admissions from hospital wards and external transfers (6).

The median ICU length of stay (LOS) was significantly shorter during the pandemic (6 vs. 9 days), a finding mirrored by Lee T. et al. and Divya A. et al, who linked this reduction to the

Table 2. Comorbidities of the Groups

Comorbidities	Overall (n=528)	Non-COVID (n=196)	COVID (n=332)	p value[a]
Hypertension	69 (35.2)	54 (16.3)	123 (23.3)	**<0.001**
Diabetes mellitus	55 (28.1)	29 (8.7)	84 (15.9)	**<0.001**
Coronary artery disease	49 (25.0)	24 (7.2)	73 (13.8)	**<0.001**
Arrhythmia	19 (9.7)	10 (3.0)	29 (5.5)	**0.001**
Chronic kidney disease	28 (14.3)	21 (6.3)	49 (9.3)	**0.002**
Neurologic disease	80 (40.8)	48 (14.5)	128 (24.2)	**<0.001**
Respiratory disease	34 (17.3)	20 (6.0)	54 (10.2)	**<0.001**
Heart failure	37 (18.9)	15 (4.5)	52 (9.8)	**<0.001**
Cancer	9 (4.6)	19 (5.7)	28 (5.3)	0.575
Others	93 (47.4)	65 (19.6)	158 (29.9)	**<0.001**

Data are presented as the number and percentage for categorical variable. [a]Compared by Pearson's chi-square test. P values in bold text indicate statistical significance at p < 0.05. CPR: cardiopulmonary resuscitation; ICU: intensive care unit.

necessity for rapid patient turnover due to high ICU occupancy rates (4,7). Despite shorter LOS, ICU mortality remained high in both periods, emphasizing the severity of illness and the strain on critical care services. Kömürcü et al. noted that mortality rates were influenced by the influx of critically ill patients with multiple comorbidities, leading to complex management challenges (1).

Higher rates of comorbidities, including hypertension, diabetes, and coronary artery disease, were prevalent among pandemic admissions, similar to findings by Ulusoy O. et al. and another study (1,8). This trend reflects a selection bias where only the most critically ill non-COVID patients were prioritized for ICU care during resource-limited times. Al-Omari et al. emphasized that patients with pre-existing conditions faced delayed care during the pandemic, exacerbating their severity upon ICU admission (5).

A significant shift in admission diagnoses was also noted, with fewer trauma cases and an increase in 'other medical conditions,' attributed to lockdown measures and reduced mobility, as reported by Kömürcü et al. (1). In another study, highlighted that patients with chronic diseases often deferred medical visits during the pandemic, leading to worsened conditions upon hospital admission (7).

The consistently high ICU mortality rates during both periods, despite operational adjustments, underscore the need for resilient ICU strategies, as emphasized by Shankar et al. (4). Kömürcü et al. and Divya A. et al. stressed the importance of optimizing resource allocation, enhancing staff training, and implementing adaptive protocols during health crises (1,4). Another analysis further suggested that future pandemics necessitate robust contingency plans for both COVID and non-COVID patient management (9). Notably, in a recent study, in-hospital and 30-day mortality rates of elderly patients undergoing surgery for hip fracture were not different between pandemic and prepandemic periods. Rates of delayed hospital admission, length of hospital stay, and refusal of treatment were higher in the pandemic. Patients tended to avoid routine outpatient appointments (10).

This study, supported by findings from Terry L. et al. and Ozguner Y. et al., contributes to the growing body of evidence on the pandemic's impact on non-COVID ICU patients, highlighting the critical need for enhanced ICU management strategies and resource allocation during health crises (6,7). Future research should focus on developing adaptable critical care frameworks to improve patient outcomes under similar challenges. Studies advocate for multicenter trials to assess the long-term effects of pandemic-induced changes on ICU operations and patient outcomes, ensuring that healthcare systems are better prepared for future global emergencies (1,8).

Limitations

This study has several limitations that should be acknowledged. First, as a retrospective single-center study, the findings may not be generalizable to other healthcare settings, especially those with different resource allocations during the pandemic. Additionally, the study did not assess functional outcomes or long-term survival beyond ICU discharge, which limits our understanding of the broader impact of the pandemic on non-COVID critical care patients. Finally, potential unmeasured confounders, such as differences in treatment protocols, ICU staffing, and the availability of advanced life-support measures, may have influenced the observed outcomes. For this purpose, we believe that the results of our study will contribute to the literature.

Conclusions

This study provides valuable insights into how the COVID-19 pandemic reshaped ICU admissions, patient demographics, and clinical outcomes for non-COVID critically ill patients. The findings suggest that during the pandemic, ICU patients were more likely to have pre-existing comorbidities, present through the emergency department, and have shorter ICU stays. Despite these changes, the high ICU mortality rates persisted, highlighting the need for more resilient critical care strategies in future health crises. Further research, including multicenter studies and long-term outcome analyses, is essential to fully understand the indirect impact of the pandemic on non-COVID critical care and to develop improved ICU resource allocation strategies in future global emergencies.

Author contributions

This study was approved by the institutional ethics committee, and all procedures were conducted in accordance with the principles of the Declaration of Helsinki. Since the study was retrospective and involved the review of anonymized patient records, informed consent was not required. All patient data were handled in compliance with data protection regulations and were used solely for research purposes. This study was performed per Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) criteria.

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Ethics Committee Approval: Ethics committee approval for this study was received from the Ethics Committee of the Yozgat Bozok University following the Declaration of Helsinki (date: 01.10.2021; no: 189_2021.10.13_08). (Chairperson Prof S. Dinç). All participants signed a written informed consent to participate in the study.

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ACADEMIC JOURNAL OF HEALTH

ORIGINAL ARTICLE

The Relationship Between Lysophosphatidylcholine Levels and Morbidity and Mortality in Covid Pneumonia

ABSTRACT

INTRODUCTION: The aim of this study was to investigate the relationship between serum Lysophosphatidylcholine (LPC) levels and mortality in patients diagnosed with Covid-19 admitted to the emergency department and hospitalised.

METHODS: The study was designed as a prospective, cross-sectional study. The effect of serum LPC levels taken on days 1 and 5 on prognosis in patients diagnosed with Covid 19 in the emergency department was investigated.

RESULTS: The average age of the patients included in our study was 73.9, with males constituting 56.8%. The most common comorbidities were hypertension (72.7%) and diabetes mellitus (43.2%). The most common presenting symptoms were fatigue and widespread body pain, cough, and dyspnoea, consistent with the cardinal symptoms of the disease. After the emergency department visit, 77.3% of the patients were hospitalized, while 22.7% were admitted to the intensive care unit. 79.5% were discharged, while 20.5% died. In the group with fatal outcomes, the day 1 LPC level was significantly lower ($p < 0.05$) compared to the discharged group. A significant [Area under the curve (AUC): 0.830; Confidence Interval (CI): 0.683-0.977)] effectiveness of the 10000-cut-off value of LPC on the 1st day was observed in distinguishing between patients discharged and deceased. The sensitivity was 88.9%, positive predictive value 50.0%, specificity 77.1%, and negative predictive value 96.4%.

DISCUSSION AND CONCLUSION: We found that the day 1 LPC level may be a valuable biomarker for prognosis in patients presenting to the emergency department with Covid pneumonia due to its high sensitivity, moderate specificity, and advanced negative predictive value for mortality.

Keywords: COVID-19 pneumonia, Lysophosphatidylcholine levels, mortality

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Introduction

2019 coronavirus disease (COVID-19) is an infectious respiratory disease. It is caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and affects humans. The disease was first discovered in Wuhan, China in 2019 and has since spread worldwide, leading to the coronavirus pandemic from 2019 (1). The novel coronavirus infection (COVID-19) is characterised by an exaggerated inflammatory response. It is usually associated with pulmonary pneumonia in adults and can lead to serious consequences such as adult respiratory distress syndrome, sepsis, coagulation disorders and death (1). Studies have indicated that specific biochemical parameters may be associated with mortality risk in hospitalized patients diagnosed with COVID-19 (2).

Lysophosphatidylcholine (LPC) is a bioactive lipid group extensively studied for its role in inflammation and atherosclerosis (3). While it is naturally present in plasma under normal physiological conditions, its levels can rise significantly during inflammatory responses. LPC promotes the release of inflammatory mediators, including Interleukin (IL)-1β, IL-5, IL-6, IL-8 and Interferon (IFN)-γ (4). Although LPC has traditionally been regarded as a proinflammatory and potentially harmful molecule,

recent studies suggest it may also have beneficial effects under certain pathological conditions (5). Given that LPC is the most abundant lysophospholipid in plasma, understanding its physiological functions and clarifying the conflicting findings in the literature is crucial.

This study aims to investigate the prognostic significance of serum LPC concentrations in predicting mortality among patients with COVİD-19 pneumonia.

Methods:

The study included cases who applied to the emergency department of our tertiary care hospital, met the COVID-19 case definition, and were hospitalised in the ward or intensive care unit. It was designed as a single-center, prospective study, approved by the Ethics Committee on April 19, 2022 (Approval No: 3519) under the University of Health Sciences Şişli Hamidiye Etfal Training and Research Hospital Health Application and Research Center, Clinical Research Ethics Committee. Written informed consent was obtained from all conscious patients, while consent for unconscious patients was provided by their legal representatives.

Patients who met the criteria for a probable or confirmed COVID-19 case were included in the study. Blood was collected from 60 patients for the study. Data from a total of 44 patients aged 18 years and over who met the inclusion criteria were analysed (Figure 1).

Flow Diagram of the study

After obtaining informed consent, blood samples were collected on the first and fifth days for LPC analysis. Venous blood samples were collected from all participants using gel vacuum tubes (BD, Plymouth, UK). Samples were kept at room temperature for two hours before being centrifuged at 1000 × g for 20 minutes at +4°C using a refrigerated centrifuge. The separated serum samples were then transferred to Eppendorf tubes and stored at -80°C until analysis. Prior to testing, samples were thawed at -20°C for 12 hours, followed by storage at +4°C for another 12 hours. On the test day, samples were brought to room temperature, homogenized by vortexing, and analyzed using the ELK General LPC (Lysophosphatidylcholine) enzyme-linked immunoassay (ELISA) kit (Wuhan East Lake, Catalogue No: ELK8145). Washing steps were performed with a DAW 50 Biotek washer, and readings were recorded using a DAR800 TS Biotek reader. Measurement range of the kit was 31.5–20,000 ng/ml, with a sensitivity of 92.4 ng/ml. The inter-assay coefficient of variation was <10% and the intra-assay coefficient of variation was <8%.

Statistical analysis: Mean, standard deviation, median minimum, maximum, frequency and ratio values were used in descriptive statistics of the data. The distribution of variables was measured with the Kolmogorov Simirnov test. Independent sample t test, mann-whitney u test were used to analyse quantitative independent data. Wilcoxon test was used to analyse dependent quantitative data. Chi-square test was used to analyse qualitative independent data, and Fisher's test was used when chi-square test conditions were not met. Effect level and cut off value were analysed with ROC curve. A value of

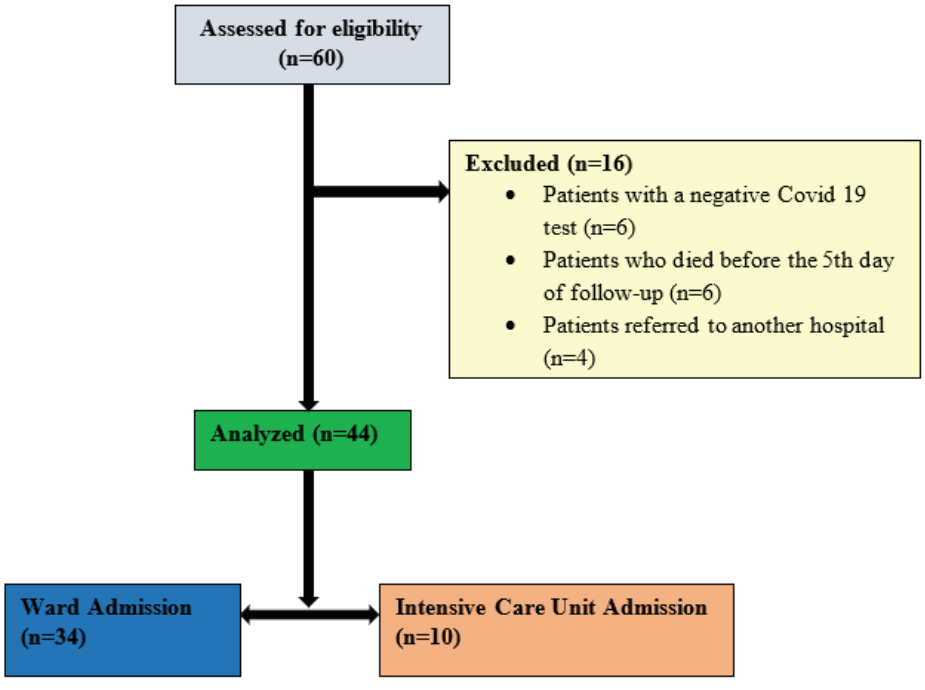

Figure 1. Flow Diagram of the study

Table 1. Analysis of Socio-demographic Characteristics. Vaccination. Vital Parameters. and Clinical Conditions of All Patients

		Min - Max		Median	Mean±sd/n-%	
Age		34.0 - 97.0		74.5	73.9 ± 13.6	
Length of Stay (Days)		5.0 - 44.0		11.0	13.0 ± 7.2	
		n	**%**		**n**	**%**
Gender	Female	19	43.2 %	**Initial CT Findings and Symtomps**		
	Male	25	56.8 %	High	13	29.5 %
HT	(-)	12	27.3 %	Moderate	25	56.8 %
	(+)	32	72.7 %	Low	6	13.6 %
CAD	(-)	26	59.1 %	Fever (-)	16	36.4 %
	(+)	18	40.9 %	Fever (+)	28	63.6 %
DM	(-)	25	56.8 %	Dyspnoea (-)	6	13.6 %
	(+)	19	43.2 %	Dyspnoea (+)	38	86.4 %
COPD	(-)	36	81.8 %	Cough (-)	3	6.8 %
	(+)	8	18.2 %	Cough (+)	41	93.2 %
CRF	(-)	37	84.1 %	Sputum (-)	8	18.2 %
	(+)	7	15.9 %	Sputum (+)	36	81.8 %
CHF	(-)	35	79.5 %	Diarrhoea (-)	39	88.6 %
	(+)	9	20.5 %	Diarrhoea (+)	5	11.4 %
Alzheimer	(-)	32	72.7 %	Fatigue-Myalgia (-)	3	6.8 %
	(+)	12	27.3 %	Fatigue-Myalgia (+)	41	93.2 %
CVD	(-)	41	93.2 %	Loss of Smell and Taste (-)	30	68.2 %
	(+)	3	6.8 %	Loss of Smell and Taste (+)	14	31.8 %
Malignancy	(-)	37	84.1 %	Throat-Headache (-)	12	27.3 %
	(+)	7	15.9 %	Throat-Headache (+)	32	72.7 %
Vaccination Status				General Condition Disorder (-)	2	4.5 %
No		17	38.6 %	General Condition Disorder (+)	42	95.5 %
Biontech		6	13.6 %	**Mechanical Ventilator** (+)	10	22.7 %
Sinovac		18	40.9 %	**Mechanical Ventilator** (-)	34	77.3 %
Biontech+Sinovac		3	6.8 %	**High-flow oxygen (O_2)** (+)	15	34.1 %
Disease Severity				**High-flow oxygen (O_2)** (-)	29	65.9 %
Severe Clinical Patient		19	43.2 %	**Emergency Service Outcomes**		
Mild Clinical Patient		25	56.8 %			
Latest Status	Discharged	35	79.5 %	Hospital Admissions	34	77.3 %
	Deceased	9	20.5 %	ICU Admissions	10	22.7 %

HT: Hypertension; CAD: Coronary Artery Disease; DM: Diabetes Mellitus; COPD: Chronic Obstructive Pulmonary Disease; CRF: Chronic Renal Failure; CHF: Congestive Heart Failure; CVD: Cerebrovascular disease; ICU: Intensive Care Unit

$p < 0.05$ was considered statistically significant. All statistical analyses were conducted using SPSS software (version 28.0, IBM, Armonk, NY, USA).

Results

Our study included 44 patients. The mean age of the patients was 73.9 years and 56.8% were male. The most common comorbidities were hypertension (HT) (72.7%) and diabetes mellitus (DM) (43.2%), while the least common comorbidity was cerebrovascular disease (CVD) (6.8%) (Table 1).

When we evaluated the vaccination status of the patients, we found that 38.6% had never been vaccinated, 40.9% preferred Sinovac vaccine, and only 6.8% had both vaccines. At the time of presentation to the emergency department, 56.8% of patients presented with mild clinical conditions, while 43.2% had severe clinical conditions. The most common complaints at the time of admission were general condition disorder, cough, weakness and body pain with rates exceeding 90%. We found that 22.7% of our patients required mechanical ventilation, while 34.1% received high-flow nasal oxygen. When we looked at the results in the emergency department, 77.3% were hospitalised, while 22.7% needed to be followed up in the intensive care unit (ICU). The patients were followed up in the hospital for an average of 11 days, 79.5% were discharged and 20.5% died (Table 1).

When the LPC levels of the patients were evaluated, it was observed that 63.6% of the patients had LPC levels above 10,000 on admission (day 1) and 43.2% had LPC levels above 10,000 on day 5 (Table 2).

There was no significant difference in age and gender distribution between the deceased patient group and the discharged patient group ($p > 0.05$). The rate of HT and coronary artery disease (CAD) was significantly lower in the deceased patient group than in the discharged patient group ($p < 0.033$, $p < 0.041$). No statistically significant difference was found in the rates of DM, chronic obstructive pulmonary disease (COPD), chronic kidney disease (CKD), chronic heart failure (CHF), Alzheimer's disease, cardiovascular disease and malignancy between the deceased patient group and the discharge group ($p>0.05$). A p-value greater than 0.05 indicates that there was no significant difference between the deceased patient group and the discharged patient group in terms of vaccination rates. While 66.7% of non-vaccinated patients died, no deaths were observed between Pfizer and vaccinated patients (Table 3).

In the deceased patient group, the rate of high findings on the first chest computed tomography (CT) scan was significantly higher than in the discharged group ($p < 0.001$). The rate of fever was significantly higher in the deceased patient group compared to the discharged group ($p < 0.011$). There was no significant difference between the deceased patient group and discharged group in the rates of symptoms such as dyspnoea, cough, sputum, diarrhoea, weakness-myalgia, loss of smell-

Table 2. Haematological parameters and LPC levels of all patients

		Min-Max	Median	Mean±sd/n-%
LPC Level				
1st Day (x10³)		5.4 - 70.0	13.8	22.2 ± 20.2
LPC Level 1st Day	< 10000 ng/ml			16 36.4 %
	> 10000 ng/ml			28 63.6 %
5st Day (x10³)		1.2 - 31.0	8.6	10.7 ± 6.9
LPC Level 5st Day	< 10000 ng/ml			25 56.8 %
	> 10000 ng/ml			19 43.2 %
Initial Oxygen Saturation		75.0 - 96.0	90.0	88.2 ± 6.4
Pulse (/min)		60.0 - 160.0	90.0	93.1 ± 20.4
Fever (C°)		36.0 - 39.7	37.0	37.1 ± 1.0
Respiratory Rate (/min)		14.0 - 35.0	20.0	21.0 ± 5.4
C-Reactive Protein (mg/L)		9.0 - 668.0	120.5	141.7 ± 121.6
Ferritin (ng/ml)		30.0 - 6714.0	430.0	610.1 ± 1009.1
Lactate (mmol/L)		0.8 - 9.1	2.0	2.5 ± 1.6
PaO_2/FiO_2		100.0 - 460.0	290.0	282.6 ± 94.3
NLR		0.5 - 32.0	7.0	8.9 ± 6.3
D-dimer (ng/ml)		200.0 - 19200	974.0	2384.7 ± 3602.9
Troponin (ng/ml)		3.5 - 178.0	19.5	34.6 ± 36.9

LPC: Lysophosphatidylcholine; NLR: Neutrophil to lymphocyte ratio; PaO_2/FiO_2: Partial pressure of oxygen to the fraction of inspiratory oxygen concentration ratio

Table 3. The analysis of socio-demographic data between the discharged and deceased groups

		Discharged (n:35)			Deceased (n:9)			p	
		Mean±sd/n-%		Median	Mean±sd/n-%		Median		
Age		72.8 ± 11.3		73.0	78.2 ± 20.4		83.0	0.463	t
Gender	Female	15	42.9 %		4	44.4 %		0.932	X^2
	Male	20	57.1 %		5	55.6 %			
Hypertension	(-)	7	20.0 %		5	55.6 %		**0.033**	X^2
	(+)	28	80.0 %		4	44.4 %			
CAD	(-)	18	51.4 %		8	88.9 %		**0.041**	X^2
	(+)	17	48.6 %		1	11.1 %			
DM	(-)	18	51.4 %		7	77.8 %		0.155	X^2
	(+)	17	48.6 %		2	22.2 %			
COPD	(-)	28	80.0 %		8	88.9 %		1.000	X^2
	(+)	7	20.0 %		1	11.1 %			
CKD	(-)	30	85.7 %		7	77.8 %		0.619	X^2
	(+)	5	14.3 %		2	22.2 %			
CHF	(-)	26	74.3 %		9	100.0%		0.167	X^2
	(+)	9	25.7 %		0	0.0 %			
Alzheimer	(-)	27	77.1 %		5	55.6 %		0.195	X^2
	(+)	8	22.9 %		4	44.4 %			
CVD	(-)	32	91.4 %		9	100.0%		1.000	X^2
	(+)	3	8.6 %		0	0.0 %			
Malignancy	(-)	30	85.7 %		7	77.8 %		0.619	X^2
	(+)	5	14.3 %		2	22.2 %			
Vaccination Status									
No		11	31.4 %		6	66.7 %		0.053	X^2
Biontech		6	17.1 %		0	0.0 %			
Sinovac		16	45.7 %		2	22.2 %			
Biontech+Sinovac		2	5.7 %		1	11.1 %			

[t] Independent sample t-test / X^2 Chi-square test

CAD: Coronary Artery Disease; DM: Diabetes Mellitus; COPD: Chronic Obstructive Pulmonary Disease; CKD: chronic kidney disease CHF: Congestive Heart Failure CVD: Cerebrovascular disease

taste, sore throat-headache and deterioration of general condition ($p > 0.05$). The rate of mechanical ventilator and high-flow oxygen (O□) use was significantly higher in the deceased patient group compared to the discharged group ($p < 0.001$). The rate of severe disease severity was significantly higher in the deceased patient group compared to the discharged group ($p < 0.019$). Intensive Care Unit (ICU) hospitalisation rate was significantly higher in the deceased patient group compared to the discharged group ($p < 0.05$). There was no significant difference between the deceased and discharged patient groups in terms of length of hospital stay ($p > 0.05$) (Table 4).

There was no significant difference in initial oxygen saturation, pulse rate, fever, C reactive protein (CRP), lactate, neutrophil/lymphocyte ratio (NLR) and troponin values between the deceased and discharged patient groups ($p > 0.05$). Respiratory rate, ferritin and D-dimer levels were significantly higher in the deceased patient group than in the discharged group ($p < 0.022$). The ratio of partial pressure of oxygen in arterial blood (PaO2) to fraction of inspiratory oxygen concentration (FiO2) was significantly lower in the deceased patient group than in the discharged group ($p < 0.020$) (Table 5).

In the deceased patient group, day 1 LPC level was significantly lower than in the discharged group ($p < 0.005$). There was no significant difference in day 5 LPC level between the group that deceased and the discharged patient group ($p > 0.05$). In the discharged group, there was a significant decrease in day 5

Table 4. Analysis of Clinical Data Between Discharged and Deceased Groups

		Discharged (n:35)			Deceased (n:9)			p	
		Mean±sd/n-%		Median	Mean±sd/n-%		Median		
Initial CT Findings									
High		6	17.1 %		7	77.8 %			
Moderate		24	68.6 %		1	11.1 %		**<0.000**	X^2
Low		5	14.3 %		1	11.1 %			
Fever	(-)	16	45.7 %		0	0.0 %		**0.011**	X^2
	(+)	19	54.3 %		9	100.0%			
Dyspnoea	(-)	5	14.3 %		1	11.1 %		1.000	X^2
	(+)	30	85.7 %		8	88.9 %			
Cough	(-)	3	8.6 %		0	0.0 %		1.000	X^2
	(+)	32	91.4 %		9	100.0%			
Sputum	(-)	7	20.0 %		1	11.1 %		1.000	X^2
	(+)	28	80.0 %		8	88.9 %			
Diarrhoea	(-)	33	94.3 %		6	66.7 %		0.050	X^2
	(+)	2	5.7 %		3	33.3 %			
Fatigue-Myalgia	(-)	3	8.6 %		0	0.0 %		1.000	X^2
	(+)	32	91.4 %		9	100.0%			
Loss of Smell and Taste	(-)	24	68.6 %		6	66.7 %		0.913	X^2
	(+)	11	31.4 %		3	33.3 %			
Throat-Headache	(-)	10	28.6 %		2	22.2 %		0.703	X^2
	(+)	25	71.4 %		7	77.8 %			
General Cond. Disorder	(-)	2	5.7 %		0	0.0 %		1.000	X^2
	(+)	33	94.3 %		9	100.0%			
Mechanical Ventilator	(+)	1	2.9 %		9	100.0%		**<0.000**	X^2
	(-)	34	97.1 %		0	0.0 %			
High-flow oxygen (O_2)	(+)	7	20.0 %		8	88.9 %		**<0.000**	X^2
	(-)	28	80.0 %		1	11.1 %			
Disease Severity									
Severe Clinic Patient		12	34.3 %		7	77.8 %		**0.019**	X^2
Mild Clinical Patient		23	65.7 %		2	22.2 %			
Emergency Service Outcomes									
Hospital Admissions		30	85.7 %		4	44.4 %		**0.008**	X^2
ICU Admissions		5	14.3 %		5	55.6 %			
Length of Stay (Days)		12.5 ± 7.4		11.0	14.8 ± 6.6		13.0	0.243	m

m Mann-Whitney u test / X^2 Chi-square test ICU: Intensive Care Unit

Table 5. Analysis of Vital and Haematological Data Between Discharged and Deceased Groups

	Discharged (n:35)		Deceased (n:9)		p	
	Mean±sd	Median	Mean±sd	Median		
Initial Oxygen Saturation	88.9 ± 6.1	90.0	85.6 ± 7.3	85.0	0.231	m
Pulse (/min)	90.9 ± 19.3	90.0	101.4 ± 23.4	105.0	0.170	t
Fever (C°)	37.1 ± 1.0	37.0	36.9 ± 0.7	37.0	0.658	m
Resp. Rate (/min)	20.3 ± 5.5	20.0	23.6 ± 4.2	25.0	**0.031**	m
CRP (mg/L)	140.0 ± 127.1	123.0	148.2 ± 103.2	110.0	0.727	m
Ferritin (ng/ml)	412 ± 288	339	1382 ± 2068	477.0	**0.043**	m
Lactate (mmol/L)	2.5 ± 1.7	2.0	2.1 ± 1.0	2.2	0.705	m
PaO_2/FiO_2	299.1 ± 88.7	297.0	218.1 ± 92.4	200.0	**0.020**	t
NLR	7.7 ± 4.5	7.0	13.2 ± 10.1	7.0	0.231	m
D-Dimer (ng/ml)	1732 ± 2225	694	4925 ± 6293	2375	**0.022**	m
Troponin(ng/ml)	35.0 ± 40.4	18.0	33.2 ± 19.9	26.0	0.344	m

[t] Independent Samples t-test / [m] Mann-Whitney u test NLR: Neutrophil Lymphocyte Ratio; CRP: C-Reactive Protein

Table 6a. The change in LPC level between days 1 and 5 in the discharged and deceased groups.

	Discharged (n:35)		Deceased (n:9)		p	
	Mean±sd	Median	Mean±sd	Median		
LPC Level	($x10^3$)					
1st Day	25.2 ± 21.2	16.5	10.6 ± 9.4	7.7	**0.005**	m
5st Day	11.4 ± 7.4	9.6	8.1 ± 4.0	7.0	0.367	m
1/5. Day Change	-13.8 ± 18.1	-6.3	-2.5 ± 10.4	0.5	**0.006**	m
Intra-Group Change p	**< 0.000**[w]		0,953[w]			

[m] Mann Whitney U test/ [w] Wilcoxon test

Table 6b. ROC analysis of LPC levels for mortality on the day 1

	Under-Curve Area	95% Confidence Interval	p
LPC Level Day 1	0.803	0.632 - 0.974	**0.005**
Day 1 Cut Off 10000	0.830	0,683 - 0.977	**0.002**

		EX (-)	EX (+)
LPC Level Day 1	> 10000	27	1
	< 10000	8	8

	%
Sensitivity	88.9 %
Pos. Predictive Value	50.0 %
Specificity	77.1 %
Neg. Predictive Value	96.4 %

LPC level compared to day 1 ($p < 0.006$). In the group with unfavorable outcome, there was no significant change in day 5 LPC level compared to day 1 ($p > 0.05$). The decrease in day 5 LPC in the discharged group was higher than in the group with unfavorable outcome ($p < 0.001$) (Table 6a).

In distinguishing patients between discharged and deceased patients, day 1 LPC level showed significant efficacy [AUC: 0.803; Confidence Interval (CI): 0.632-0.974] (Figure 2). In distinguishing patients between discharged and deceased, day 1 LPC level with a cut-off value of 10000 showed significant efficacy. Sensitivity was 88.9%, positive predictive value was 50.0%, specificity was 77.1% and negative predictive value

Discussion

The COVID-19 pandemic, which began in 2019 in China and spread worldwide, resulted in the loss of millions of lives (6). To predict the prognosis, many biomarkers have been studied. In this study, we examined the serum LPC levels of our patients for the prognosis of COVID pneumonia and found that low LPC levels were predictive of mortality.

The studies conducted have shown that being male and over 50 years old increases mortality (7). In the study, it was found that the majority of deceased patients were elderly and male.

Studies have shown that the most common symptoms seen in Covid pneumonia are shortness of breath (53-80%), cough (60-86%), and changes in taste or smell (64-80%). It has been shown that 20-99% of patients had a complaint of high fever during the course of the disease (8,9). In a study conducted on 140 patients in China, the complaints of patients presenting to the hospital were examined. When the results were examined, it was found that the most common symptom encountered was fever with 91.7%, followed by cough with 75% (10). In this study, in line with the literature, patients presented with widespread symptoms such as cough, weakness, fatigue, shortness of breathing, and fever.

In our study, our patients were in the elderly age group, and hypertension, diabetes, and coronary artery disease were seen as the most common chronic diseases. This result was consistent with a retrospective study conducted on 191 hospitalized patients in China (9). Approximately half of our patients were not vaccinated. We analysed our patients in two groups, discharged and deceased. We determined no statistical difference between the groups in terms of age, gender, presenting symptoms (except for fever), chronic diseases (other than hypertension and coronary artery disease), and vaccination status. Furthermore, in the discharged group, HT and coronary artery disease (CAD) were higher compared to the deceased patient group. This contradicted the literature because a meta-analysis in COVID-19 patients in China found that HT and CAD were strongly associated with mortality (11). We speculated that this could be due to differences in patient

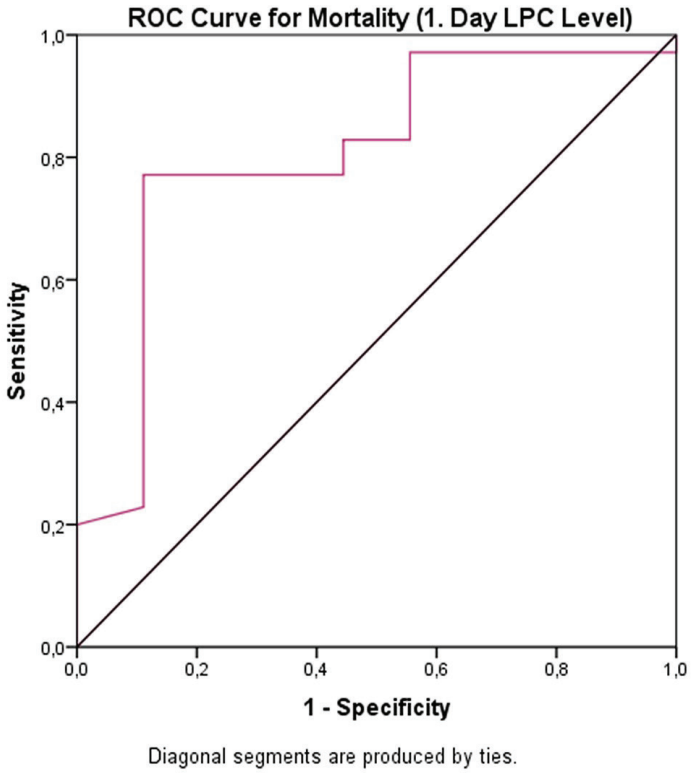

Figure 2. ROC curve for Mortality.

treatments and milder thoracic CT involvement and vaccination status.

Prognostic value of serum LPC level was evaluated in 56 community-acquired pneumonia (CAP) patients. LPC concentrations on days 1 and 7 were significantly lower in the group with death. A cut-off LPC level of < 29.6 (μmol/L) on day 1 was associated with mechanical ventilation, vasopressor use, ICU admission, and mortality. In this study, it was found that serum LPC levels in CAP patients presenting to the emergency department were more predictive of outcomes than previously validated biomarkers like procalcitonin (PCT) and scoring systems like CURB-65 or PSI (12). In our study, similarly, LPC values were examined on days 1 and 5. It was found that in individuals with LPC values below the 10,000 ng/ml cut-off on day 1, there was a higher mortality rate, as well as an increased need for mechanical ventilation and high-flow oxygen.

In a study of 105 sepsis patients, serum LPC concentration was found to decrease with the severity of sepsis, especially in the presence of bacteraemia. It was noted that on the first day, serum LPC concentration was remarkably low (13). In our study as well, patients with low LPC levels on the first day had a more severe course leading to higher mortality rates.

In a study conducted on 74 patients monitored in the intensive care unit of a tertiary hospital due to sepsis and/or septic shock, the LPC levels on days 1 and 7 were compared with procalcitonin, CRP, and WBC counts. The concentrations on day 7 were found to be higher in survivors. The study showed that decreasing LPC levels on day 7, along with procalcitonin values 1.5 times higher than the initial value, were useful in predicting 28-day mortality. In this study, the patients' LPC levels were evaluated in conjunction with the treatments they received. It was observed that in patients receiving appropriate antibiotics, LPC levels increased, while in those receiving inappropriate antibiotics, they did not increase (14). In our study, it was found that high ferritin levels, along with low LPC levels, could be significant for mortality in terms of biochemical parameters. A meta-analysis on ferritin found it to be high in individuals with chronic diseases and those experiencing severe illness, correlating with the need for intensive care (15). In our study, we found that ferritin could be negatively correlated with LPC. However, compared to LPC, haematological parameters such as PO2/FiO2, D-dimer, troponin, lactate, and CRP showed lower predictive value for mortality in determining COVID prognosis. Consistent with this predictive value, we observed that the need for high-flow oxygen and mechanical ventilation was higher in individuals with low LPC levels compared to those with high LPC levels. The most significant factor contributing to a poor prognosis is the exaggerated, uncontrolled, and severe inflammatory response caused by infection. This response leads to abnormal values in many parameters in laboratory tests. In many studies, lymphopenia has been found to be associated with a poor prognosis and mortality. Therefore, monitoring lymphocyte levels is recommended for tracking the progression of the disease. The neutrophil-to-lymphocyte ratio increases in severe illness and can be used as a poor prognostic indicator. Lymphopenia and an increased neutrophil-to-lymphocyte ratio have been found to be associated with severe illness and mortality (16). Other parameters include the elevation of C reactive protein (CRP), procalcitonin (PCT) levels, erythrocyte sedimentation rate (ESR), tumour necrosis factor-alpha (TNF-α), ferritin, interleukin-6 (IL-6), and interleukin-10 (IL-10) (17). While D-dimer is a test commonly used for clinical conditions like deep vein thrombosis (DVT), pulmonary embolism (PE), and disseminated intravascular coagulation (DIC), its elevation has also been observed during COVID-19 infection (18). Individuals with COVID-19 face a risk of deep vein thrombosis (DVT) and a potential risk of pulmonary embolism (PE) of up to 25% (19). High D-dimer levels and a low PO2/FiO2 ratio are associated with increased mortality (20). In our study, significant statistical differences were determined between the groups in terms of haematological parameters, with ferritin and D-dimer levels and the PO2/FiO2 ratio being statistically significant against the deceased patient group. We observed findings in line with the literature.

We evaluated our patient groups based on their LPC levels. The decrease in LPC has been shown to be associated with an increase in arterial atherosclerosis, cerebral ischemia, and inflammatory cell activation (21). In t study, we found that in the deceased patient group, the LPC levels on days 1 and 5 were lower than those in the discharged group. In this study, we hypothesized that the high mortality in the group with low LPC levels is related to the insufficient formation of the inflammatory reaction.

In the study, we identified the LPC cut-off value as <10,000 for distinguishing between the deceased patient group and the discharged group. We evaluated patient groups that were above and below the cut-off value. We didn’t observe any significant differences in terms of age, gender, vaccination status, or chronic diseases between these two groups. The lack of variation in chronic diseases causing low LPC levels between the groups, apart from the infection, led us to believe that the severity of COVID pneumonia is associated with LPC levels. This is because the patients with high CT involvement had lower LPC levels on the first day.

It was observed that out of 10 patients with LPC levels below the cut-off who were admitted to the ward, mortality occurred in 4 during their ward stay. Patients with low LPC levels have prolonged care durations and increased mortality rates. As a result, it was considered that patients with low LPC levels should receive more aggressive monitoring and treatment, potentially requiring intensive care.

The levels of LPC on the first and fifth days were examined between the discharged and deceased patient groups. In the deceased patient group, the LPC levels on the first day were below the average for all patient groups and decreased further on the fifth day. However, in the deceased patient group,

although there was a decrease in LPC levels between the first and fifth days, the overall average level did not drop below the average. The group of patients with LPC levels below the cut-off showed a mortality rate of 50%, whereas the group with LPC levels above the cut-off had a mortality rate of 3.5%. All these results indicate that LPC levels have high sensitivity and negative predictive value.

Limitations

There were several limitations in our study, the most significant being the absence of a healthy control group. Additionally, the small sample size was another limitation, as it may have introduced selection bias and restricted the generalizability of the findings.

Conclusion

In the study, we established that the 1st-day LPC levels of patients with thoracic CT involvement who presented to the emergency department had high sensitivity, moderate specificity, and advanced negative predictive value for mortality in patients with COVID pneumonia, indicating that LPC levels could be a valuable biomarker for prognosis in patients presenting to the emergency room with COVID pneumonia. Our study is a prospective pilot study, and while it provides valuable insights, larger studies are needed to further assess the reliability and clinical significance of the test.

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The datasets used and/or analyzed during the current study are available for sharing by the corresponding author upon request.

Author Contributions:

- Conception and design of the research: Dehmen S, Melekoğlu A, Altınbilek E;
- Acquisition of data: Dehmen S, Yağcı S;
- Analysis and interpretation of the data: Melekoğlu A, Ceritli S;
- Writing of the manuscript: Melekoglu A, Altınbilek E;
- Statistical analysis: Melekoğlu A, Ceritli S;
- Critical revision of the manuscript for content:Kahveci U, Altınbilek E.

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Corresponding Author:

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Ethics Approval and Consent to Participate:

The study was conducted with the approval of the Institutional Ethics Committee (University of Health Sciences Şişli Hamidiye Etfal Training and Research Hospital Health Application and Research Center Clinical Research Ethics Committee, date: 19/04/2022, no: 3519) and adhered to the principles of the Declaration of Helsinki. Informed consent was obtained from all eligible patients after they were provided with detailed information about the study.

Consent for Publication:

Not applicable.

Clinical Trial Number:

Not applicable.

Competing Interests:

The authors declare that they have no competing interests.

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ACADEMIC JOURNAL OF HEALTH

ORIGINAL ARTICLE

The Role of Hematologic Parameters in Predicting Intracranial Hemorrhage in Emergency Department Patients With Head Trauma

ABSTRACT

Background:

Traumatic brain injury (TBI) is a critical public health issue, particularly among young adults, and the presence of intracranial hemorrhage (ICH) has a direct impact on clinical outcomes. In patients presenting with mild head trauma, early prediction of ICH remains challenging. In recent years, hematologic biomarkers such as platelet indices have attracted increasing interest as potential diagnostic tools in trauma evaluation.

Objective:

This study aimed to investigate the association between platelet indices including mean platelet volume (MPV), platelet distribution width (PDW), platelet-large cell ratio (P-LCR) and the presence of ICH in patients presenting to the emergency department (ED) with isolated head trauma.

Methods:

This retrospective observational study included adult patients aged ≥18 years who presented to the ED with isolated head trauma between March 1, 2023 and March 1, 2024. Patients were divided into two groups based on the presence or absence of ICH on brain computed tomography. Hematological and biochemical parameters were recorded and comparisons between the groups were conducted using appropriate parametric and non-parametric tests (significance level set at $p < 0.05$).

Results:

A total of 215 patients were included in the study, of whom 45 (20.9%) had confirmed ICH. White blood cell (WBC) counts were significantly higher in the ICH group (11.6 ± 4.0 vs. 9.6 ± 3.5; $p = 0.003$). No significant differences were observed between groups for MPV ($p = 0.484$), PDW ($p = 0.724$) or P-LCR ($p = 0.567$). Similarly, no significant associations were found between platelet indices and emergency department disposition.

Conclusion:

While WBC count was associated with both the presence of ICH and hospital admission, MPV, PDW and P-LCR did not demonstrate predictive value for ICH in patients with isolated head trauma. Further prospective, multicenter studies with serial measurements are needed to clarify the clinical utility of these indices in neurotrauma.

Keywords: Head Injuries, Intracranial Hemorrhages, Platelet Indices, Emergency Service

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1. Introduction

Traumatic brain injury (TBI) remains a significant public health issue in both developed and developing countries, particularly affecting young adults and is associated with high rates of morbidity and mortality. According to data from the World Health Organization (WHO), as of 2020, TBI ranks as the leading cause of trauma-related deaths among individuals under the age of 45. Moreover, neurological sequelae that develop following TBI can lead to permanent impairments in quality of life [1,2].

Intracranial hemorrhage (ICH), a serious complication that may arise after head trauma, represents a critical condition requiring rapid clinical assessment and intervention. While non-contrast computed tomography (CT) of the brain remains the gold standard imaging modality for diagnosing ICH, there are clinical scenarios, such as delayed access to imaging or patients presenting with borderline symptoms, where there is a growing need for early, laboratory-based biomarkers that could indicate the presence of hemorrhage. In this context, platelet indices derived from complete blood count (CBC) parameters have emerged as promising biomarkers for early diagnosis and prognostication of ICH [3].

Platelets play a pivotal role not only in hemostasis but also in inflammation, endothelial dysfunction and the maintenance of microvascular integrity. Mean platelet volume (MPV) reflects the average size of circulating platelets platelet distribution width (PDW) indicates size heterogeneity; and platelet-large cell ratio (P-LCR) reflects the proportion of large, reactive platelets thus indirectly offering insight into platelet activation status [4,5].

Several recent studies have reported associations between elevated MPV and PDW values and various neurologic conditions such as ischemic stroke, subarachnoid hemorrhage and traumatic brain injury. These findings suggest that platelet indices may reflect both the systemic inflammatory response and vascular injury mechanisms [6,7]. However, studies specifically evaluating the relationship between ICH secondary to head trauma and platelet indices are limited and existing data are inconsistent due to methodological heterogeneity. While some reports suggest significant associations between MPV or PDW and ICH presence, others indicate limited diagnostic utility for these parameters [8,9].

In light of this knowledge, investigating the relationship between platelet indices and ICH in patients presenting to the emergency department with isolated head trauma is important for both identifying potential early biomarkers and addressing gaps in the current literature. This study aimed to evaluate the association of various platelet indices particularly MPV, PDW, and P-LCR—with the presence of intracranial hemorrhage and to assess their diagnostic value in the emergency setting.

2. Materials and Methods

Study Design and Ethical Approval

This study was designed as a single-center, retrospective, descriptive observational analysis. Ethical approval was obtained from the Clinical Research Ethics Committee of Etlik City Hospital (Approval No: AEŞH-BADEK-2024-308). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Participants and Inclusion Criteria

The study included adult patients (aged ≥18 years) who presented to the Emergency Medicine Department of Ankara Etlik City Hospital with isolated head trauma between March 1, 2023, and March 1, 2024. Eligible cases were identified retrospectively using the hospital information management system. Patients were included if they presented to the trauma area and had undergone brain CT regardless of whether intracranial hemorrhage (ICH) was detected.

Exclusion Criteria

- Pregnancy
- History of anticoagulant therapy
- Penetrating head trauma
- Liver or splenic laceration
- Concurrent hemorrhages in other organ systems
- Active external bleeding

These exclusion criteria were defined to ensure sample homogeneity and to isolate the evaluation of intracranial hemorrhage.

Data Collection Process

The patients' age, sex, mode of presentation, vital signs, laboratory parameters and cranial CT findings were evaluated. Laboratory data included CBC parameters (WBC, hemoglobin, hematocrit, MCV, MCH, platelet count, MPV, PDW, RDW-CV, P-LCR), blood gas analyses (pH, base excess, lactate) and INR.

The laboratory parameters were obtained from blood samples collected during the patients' initial presentation to the emergency department, specifically within the first hour following triage and physical examination. This timing reflects the early phase of the traumatic pathophysiological response and provides a homogeneous dataset for clinical interpretation.

CT evaluations were performed upon the request of emergency medicine physicians in accordance with clinical practice protocols and were reported by radiology specialists. However, the images were reviewed in a systematic manner by observers blinded to the laboratory data. This approach theoretically reduces the potential for observer bias.

Patients with missing data particularly those lacking CBC parameters or cranial CT reports were excluded from the analysis. All cases included in the study were selected according to the predefined inclusion and exclusion criteria. No data imputation was performed.

Only the cranial CT findings obtained at the time of ED admission were considered. Follow-up CT scans performed for monitoring purposes were not included in the analysis. Therefore, patients who initially had no evidence of ICH but developed lesions during the clinical course were excluded.

Patients were categorized based on the presence or absence of ICH. Additionally, ED outcomes (discharge, ward admission, intensive care unit admission) and mortality status were recorded. The severity of trauma was assessed using the

Glasgow Coma Scale (GCS), and patients were classified according to Advanced Trauma Life Support (ATLS) criteria.

Statistical Analysis

All statistical analyses were performed using the Jamovi software package (version 2.5.7). Descriptive statistics for categorical variables were presented as counts and percentages and comparisons between categorical variables were conducted using the chi-square test. The normality of continuous variables was assessed using the Kolmogorov–Smirnov test and histogram plots. Continuous variables that did not follow a normal distribution were presented as median and interquartile range (IQR: 25th–75th percentiles), whereas normally distributed variables were expressed as mean ± standard deviation (SD). Differences between two independent groups with normally distributed variables were evaluated using the Student's t-test or Welch's t-test, depending on the homogeneity of variances assessed by the Levene's test. For non-normally distributed variables, the Mann–Whitney U test was applied. A p-value of less than 0.05 was considered statistically significant.

Table 1. Distribution of patient demographics, laboratory parameters, and clinical characteristics

Sex	
Male	138 (64,2 %)
Female	77 (35,8 %)
Age	49 (29 – 68)
Laboratory Parameters	
WBC, 10^9/L	10.1 ± 3.7
Hemoglobin, g/dL	14.1 (12.6 – 15.8)
Hematocrit, %	42.7 (38.4 – 46.3)
MCV, fL	88 ± 6
MCH, pg	29.8 (27.5 – 30.9)
Platelet, 10^9/L	244 ± 77
MPV, fL	10.4 ± 0.9
PDW, %	11.7 (10.7 – 13.2)
RDW-CV, %	13.0 (12.4 – 13.9)
P-LCR, fL	28.3 ± 7.1
pH	7.41 ± 0.04
Base excess	(-0.3) [(-1.7) – (1.2)]
Lactate, mmol/L	1.7 (1.4 – 2.4)
INR	1.01 (0.96 – 1.07)
Intracranial presence	45 (20,9 %)
Emergency Department Outcome	
Discharge	168 (78,1 %)
Ward Admission	18 (8,4 %)
ICU Admission	29 (13,5 %)
Mortality	5 (2,3 %)

All data are presented as n (%), median (IQR) or mean ± SD.

WBC, white blood cells; MCV, mean corpuscular volüme; MCH, mean corpuscular hemoglobin;

MPV, mean platelet volüme; PDW, platelet distribution width; RDW-CV, red cell distribution width-coefficient of variation; P-LCR, platelet-large cell ratio; INR, international normalized ratio; ICU, intensive care unit

3. Results

A total of 215 patients were retrospectively evaluated. Of these, 138 (64.2%) were male and 77 (35.8%) were female. The median age was 49 years (interquartile range [IQR]: 29–68). ICH was detected in 45 patients (20.9%). Regarding ED outcomes, 168 patients (78.1%) were discharged, 18 (8.4%) were admitted to the general ward and 29 (13.5%) were transferred to the intensive care unit (ICU). Mortality occurred in 5 patients (2.3%) (Table 1).

Association Between ICH and Laboratory Parameters

When comparing patients with and without ICH, WBC count was found to be significantly higher in the ICH-positive group (11.6 ± 4.0 vs. 9.6 ± 3.5 ×10⁹/L; p = 0.003). No statistically significant differences were observed between the groups in terms of other hematologic or biochemical parameters (table 2).

Regarding platelet indices, no significant differences were found between patients with and without ICH in: MPV: 10.3 ± 0.8 vs. 10.5 ± 0.9; p = 0.484, PDW: 11.5 [10.6–13.6] vs. 11.8 [10.7–13.1]; p = 0.724, P-LCR: 27.8 ± 6.9 vs. 28.5 ± 7.2; p = 0.567 (table 2).

Lactate levels were similar between the groups (1.7 [1.4–2.2] vs. 1.7 [1.4–2.4] mmol/L; p = 0.984) and no significant difference was observed in INR values either (1.00 [0.95–1.10] vs. 1.02 [0.96–1.06]; p = 0.999) (table 2).

Comparison Between Discharged and Admitted Patients

Patients discharged from the emergency department were compared with those admitted to the general ward or intensive care unit. WBC levels were found to be significantly higher in the admitted group (11.9 ± 3.8 vs. 9.5 ± 3.5 ×10⁹/L; p <0.001). Additionally, MCH value was also significantly elevated in admitted patients compared to those discharged (30.2 [28.4–31.4] vs. 29.4 [27.1–30.7]; p = 0.024) (table 3).

Regarding platelet indices, no statistically significant differences were observed between the groups for MPV, PDW, RDW-CV or P-LCR (p> 0.05 for all). Similarly, no significant differences were found in other laboratory parameters such as pH, base

Table 2. Relationship Between Age and Laboratory Parameters and the Presence of Intracranial Hemorrhage

	Intracranial Hemorrhage		***p value***	***Mean Difference***
	Present (n=45)	**Absent (n=170)**		***(%95 CI)***
Age, years	52 (32 – 75)	48 (29 – 66)	0.248[1]	4 (-3, 12)
WBC, 10⁹/L	11.6 ± 4.0	9.6 ± 3.5	0.003[2]	1.9 (0.7, 3.2)
Hemoglobin, g/dL	14.1 (12.9 – 15.5)	14.1 (12.5 – 15.8)	0.672[1]	0.2 (-0.6, 0.9)
Hematocrit, %	42.7 (40.6 – 45.7)	42.6 (38.3 – 46.3)	0.705[1]	0.5 (-1.5, 2.5)
MCV, fL	88 ± 8	88 ± 6	0.609[3]	1.1 (-1.6, 3.8)
MCH, pg	30.2 (28.3 – 31.4)	29.6 (27.4 – 30.7)	0.136[1]	0.6 (-0.1, 1.4)
Platelet, 10⁹/L	235 ± 87	247 ± 73	0.372[2]	-11 (-37, 14)
MPV, fL	10.3 ± 0.8	10.5 ± 0.9	0.484[2]	-0.2 (-0.4, 0.2)
PDW, %	11.5 (10.6 – 13.6)	11.8 (10.7 – 13.1)	0.724[1]	-0.2 (-0.7, 0.5)
RDW-CV, %	13.1 (12.7 – 13.7)	13.0 (12.4 – 13.9)	0.471[1]	0.1 (-0.3, 0.5)
P-LCR, fL	27.8 ± 6.9	28.5 ± 7.2	0.567[2]	-0.7 (-3.3, 1.5)
pH	7.40 ± 0.03	7.41 ± 0.04	0.378[2]	-0.01 (-0.02, 0.01)
Base Excess	(-0.8) [(-2.5) – (0.9)]	(-0.2) [(-1.3) – (1.2)]	0.131[1]	-0.7 (-1.7, 0.2)
Lactate, mmol /L	1.7 (1.4 – 2.2)	1.7 (1.4 – 2.4)	0.984[1]	0.1 (-0.3, 0.3)
INR	1.00 (0.95 – 1.10)	1.02 (0.96 – 1.06)	0.999[1]	-0.1 (-0.1, 0.1)

1: Data are presented as median (IQR) and Mann Whitney U test was used.

2: Data are presented as mean ± SD and Student t test was used.

3: Data are presented as mean ± SD and Welch t test was used.

CI, confidence interval; WBC, white blood cells; MCV, mean corpuscular volume; MCH, mean corpuscular hemoglobin; MPV, mean platelet volume; PDW, platelet distribution width; RDW-CV, red cell distribution width-coefficient of variation; P-LCR, platelet-large cell ratio; INR, international normalized ratio

excess, lactate, or INR with respect to hospital admission status (Table 3).

Notably, WBC count was significantly elevated in both patients with intracranial hemorrhage and those requiring hospital admission. In contrast, platelet indices (MPV, PDW, P-LCR) did not demonstrate any statistically significant association with the presence of ICH or the need for hospitalization. MCH was the only parameter found to be significantly higher exclusively in admitted patients (Table 3).

4. Discussion

This study aimed to evaluate the relationship between ICH and platelet indices in adult patients presenting to the ED with isolated head trauma. Our findings demonstrated that WBC counts were significantly higher in patients with ICH; however, no statistically significant differences were observed in platelet indices such as MPV, PDWor P-LCR. Similarly, patients who required hospital admission also exhibited significantly elevated WBC levels. Nevertheless, platelet indices did not show predictive value for either the presence of ICH or the need for hospital admission.

TBI is one of the leading causes of morbidity and mortality, and the presence of ICH directly influences the clinical course of the disease. In clinical practice, CT is considered the gold standard for diagnosing ICH. However, particularly in cases of mild trauma, hemorrhages that are not initially detected on imaging may still carry significant clinical implications over time [2]. Therefore, a need for laboratory-based diagnostic markers remains, especially in the pre-imaging period or in cases where hemorrhage can not be identified radiologically. In this context, platelet indices derived from CBC data have recently gained attention as potential biomarkers for both diagnostic and prognostic evaluation [5].

Platelets are not only the initiating cells of the coagulation cascade, but also play an active role in several key pathophysiological processes, including endothelial activation, increased vascular permeability and the release of proinflammatory cytokines. Specifically, MPV reflects the population of large and reactive platelets, thereby providing insight into platelet activity. PDW indicates the variation in platelet size while P-LCR represents the proportion of larger platelets in circulation [10,3].

In our study, the lack of a statistically significant association between MPV, PDWand P-LCR values and the presence of ICH contrasts with findings reported in some previous studies. In a retrospective study by Palabıyık et al., decreased platelet count and increased MPV were found to be associated with 30-day mortality in patients with TBI [11]. This finding suggests that MPV may have prognostic value, particularly in severe TBI cases requiring ICU admission. However, in our cohort, MPV levels did not differ significantly between patients with and without ICH. This discrepancy may be explained by the predominance of mild-to-moderate head trauma cases in our study population.

Similarly, in a prospective study conducted by Lippi et al., MPV levels were found to be significantly lower in patients with mild head trauma and positive CT findings for intracranial lesions compared to healthy controls [12]. This observation suggests that MPV may not only reflect platelet activation or inflammation, but also indicate platelet consumption or sequestration in the setting of trauma.

On the other hand, several studies have proposed that MPV may possess diagnostic value in conditions such as gastrointestinal bleeding, aortic dissection and mesenteric ischemia [13,14]. However, these studies exhibit considerable heterogeneity in terms of patient populations, comorbidities and laboratory methodologies. In some investigations focusing on thoracic pathologies such as traumatic hemothorax, the clinical relevance of platelet indices has also been questioned. Nevertheless, there remains a lack of high-quality studies conducted on homogeneous patient populations specifically evaluating the association between platelet indices and the presence of intracranial hemorrhage following head trauma [15].

One of the notable findings of our study was the significant association between elevated WBC count and the presence of ICH, which likely reflects the systemic inflammatory response inherent to traumatic injury. Previous studies have reported that WBC levels tend to rise in proportion to trauma severity, in conjunction with neutrophilic activation and the release of proinflammatory cytokines [16]. Therefore, the observation that WBC count was significantly associated not only with ICH but also with the need for hospital admission suggests that this parameter may serve as a practical surrogate marker of post-traumatic inflammatory burden.

Nevertheless, the absence of significant differences in platelet indices with respect to ICH suggests that these parameters may serve more as supportive markers rather than definitive diagnostic tools. In a study by Nydam et al., persistent post-traumatic thrombocytopenia was found to be associated with increased rates of organ failure and mortality; however, its direct relationship with the presence of ICH was not clearly established [17]. It has been proposed that platelet indices may gain greater clinical value in dynamic monitoring context such as through serial measurements—rather than from single time-point assessments.

5. Conclusion

In this study, we examined the relationship between ICH and platelet indices derived from CBC parameters in patients presenting to the emergency department with isolated head trauma. The findings revealed that WBC levels were significantly elevated in patients with ICH; however, no statistically significant association was observed between platelet indices and the presence of ICH.

While the increase in WBC count can be interpreted as an indicator of the inflammatory response triggered by trauma, the predictive value of platelet indices for detecting ICH appears to be limited. Nevertheless, the observation that WBC levels were also elevated in patients requiring hospital admission supports the potential role of this parameter as a surrogate marker reflecting the clinical severity of trauma in the emergency setting.

6. Limitations

This study has several methodological limitations inherent to its retrospective design. First, the use of hospital information systems for data retrieval may carry the risk of incomplete or inaccurate records, potentially limiting the standardization of laboratory and imaging parameters. Additionally, being a single-center study restricts the generalizability of the findings, as it may not account for demographic and clinical variations specific to other patient populations. Furthermore, the evaluation of platelet indices was limited to a single time point upon admission, which fails to reflect their potential dynamic fluctuations over time. Therefore, prospective, multicenter studies incorporating serial measurements are warranted to validate these findings.

Author contributions

We declare that all authors have accepted the submission and that the manuscript has not been published in whole or in part or submitted elsewher

Declarations

Ethics Committee Approval: This study was designed as a single-center, retrospective, descriptive observational analysis. Ethical approval was obtained from the Clinical Research Ethics Committee of Etlik City Hospital (Approval No: AEŞH-BADEK-2024-308).

The study was conducted in accordance with the principles of the Declaration of Helsinki.

Conflict of Interest: No conflict of interest was declared by the authors.

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ACADEMIC JOURNAL OF HEALTH

CASE REPORT

Foot Drop as an Atypical Presentation of Rectal Cancer: The Importance of Digital Rectal Examination in Early Diagnosis

ABSTRACT

Rectal cancer is a major health concern with an increasing incidence in the younger population. It is typically diagnosed through screening or through common symptoms, such as rectal bleeding and changes in bowel habits. Rarely, rectal cancer may present with atypical symptoms such as neurological deficits. We report the case of a 77-year-old female with a history of abdominal pain and constipation, who presented with foot drop, a rare neurological manifestation. Clinical examination and imaging revealed an irregular mass in the rectum and metastatic lymphadenopathy. Digital rectal examination (DRE) plays a crucial role in identifying primary malignancies despite the absence of typical symptoms. The patient was diagnosed with moderately differentiated adenocarcinoma of the rectum, which was confirmed by colonoscopy and biopsy. Further staging with PET-CT revealed metastatic lymph nodes. Owing to obstructive symptoms, she underwent palliative loop sigmoid colostomy and started chemotherapy. This case highlights the importance of considering rare neurological presentations such as foot drop in the diagnosis of rectal cancer. Early recognition through DRE and imaging can lead to timely diagnosis and intervention, and improve patient outcomes.

Keywords: Foot drop, digital rectal examination, neurological symptoms, lumbosacral plexopathy, colorectal adenocarcinoma, metastatic lymphadenopathy.

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Introduction

Rectal cancer is a significant public health concern, ranking as the third most common cancer in men and the second most common in women globally [1]. Despite advancements in screening and early detection, colorectal cancer, including rectal cancer, remains a major cause of morbidity and mortality worldwide. The incidence of rectal cancer increases with age, with individuals over 50 years of age being at a higher risk, although there is an alarming rise in cases among those aged less than 50 [2].

The clinical presentation of rectal cancer is typically characterized by symptoms, such as rectal bleeding, changes in bowel habits, abdominal discomfort, weight loss, and anemia [3]. Early diagnosis through routine screening, such as colonoscopy, remains the cornerstone of effective treatment strategies. In patients with more advanced disease, symptoms may include obstructive gastrointestinal signs and neurological manifestations in rare instances. These presentations are less commonly associated with colorectal cancers but should not be overlooked, as they may delay diagnosis and treatment.

Foot drop, a form of peripheral neuropathy characterized by difficulty in dorsiflexion of the foot, is a rare but documented complication of lumbosacral plexopathy (LSP) that can occur in the setting of malignancies. LSP can result from direct tumor infiltration or metastatic spread, typically from cancers located near the plexus, such as colorectal

cancer [4]. Although neurological complications are uncommon in rectal cancer, there have been case reports linking foot drop and other motor deficits to advanced colorectal malignancies [5]. Lumbosacral plexopathy, when associated with metastatic colorectal cancer, is often caused by the compression of pelvic structures by enlarged lymph nodes, as observed in advanced stages of the disease [6].

In this report, we present the case of a 77-year-old female who exhibited foot drop as an initial and atypical presenting symptom of rectal cancer. Despite the absence of more typical gastrointestinal symptoms, the patient's diagnosis was expedited through thorough clinical examination, including digital rectal examination (DRE), which revealed a mass suggestive of rectal malignancy. The aim of this report was to emphasize the importance of considering rare neurological presentations in the diagnosis of rectal cancer and to highlight the continuing relevance of DRE as an essential diagnostic tool, even in the presence of non-specific symptoms.

Case Report

A 77-year-old female patient with a history of hypertension, type 2 diabetes mellitus, and hyperlipidemia presented to the Surgical Oncology outpatient clinic with complaints of persistent abdominal pain and constipation that had persisted for the past two years. The patient had multiple visits to the emergency department for these symptoms, but no long-term follow-up was initiated, and no screening for colorectal cancer had been performed. Her medical history included coronary artery bypass surgery three years prior and right hip replacement surgery 20 years prior. The patient had a family history of colon cancer. She had no history of smoking or alcohol consumption.

Upon initial presentation to the clinic, the patient was found to have notable weakness and numbness in her right leg, characterized by foot drop. Neurological examination revealed strength loss of 2/5 in the right leg and paresthesia. This unusual symptom prompted further investigations. In addition to her abdominal complaints, the patient's blood tests indicated a leukocyte count of 11,000/μL, hemoglobin of 7.4 g/dL, platelet count of 140,000/μL, creatinine of 0.91 mg/dL, and an elevated C-reactive protein (CRP) of 78 mg/L. The patient's clinical status was related to anemia and signs of infection.

Physical examination revealed tenderness and minimal distension on abdominal examination, but no guarding or rebound tenderness. The patient underwent digital rectal examination (DRE), which revealed an irregular mass 5 cm from the anal verge, which significantly narrowed the rectal lumen. Given the presence of the mass and the patient's symptoms, an abdominal CT scan was performed for further investigation.

The CT tomography revealed significant wall thickening of the rectum and multiple metastatic lymph nodes in the mesorectum. A mass, approximately 5 cm in size, was identified in the right iliac region, extending into the obturator fossa, consistent with a metastatic lymph node (Figure 1). This finding was concerning for an advanced malignancy, prompting further diagnostic workups.

Subsequently, colonoscopy was performed. The procedure revealed a mass that significantly narrowed the rectal lumen and obstructed endoscope passage (Figure 2).

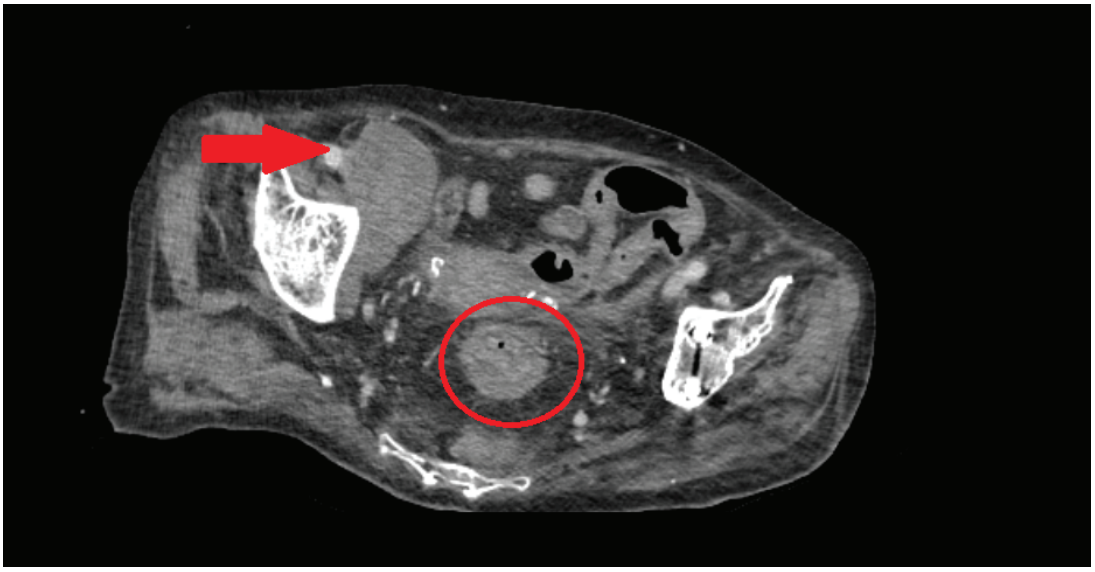

Figure 1: CT image: A mass extending from the right iliac region to the obturator fossa (indicated with an arrow) and thickened rectal wall (circled)

Biopsy specimens were obtained from the mass, and pathological evaluation identified the lesion as a moderately differentiated adenocarcinoma of the rectum. Because colonoscopy could not assess the entire colon due to mass obstruction, a PET-CT scan was conducted for staging purposes (Figure 3).

PET-CT confirmed that the rectal mass was the primary malignancy, with perirectal lymphadenopathy and a right inguinal lymph node suggestive of metastatic spread. On the basis of these findings, the patient was diagnosed with advanced-stage rectal cancer with metastasis. Given the severity of the luminal narrowing and obstructive symptoms caused by the mass, the patient underwent palliative loop sigmoid colostomy to relieve the obstruction. The patient was then referred to the Medical Oncology unit for chemotherapy initiation. The decision for palliative care was made because of the advanced nature of the disease, with the goal of improving the patient's quality of life.

Discussion

Colorectal cancer, particularly rectal cancer, remains a significant public health concern worldwide despite advances in early detection and treatment strategies. It is the third most common cancer in men and the second most common cancer in women worldwide [1]. The clinical presentation of rectal cancer typically includes symptoms, such as rectal bleeding, changes in bowel habits, abdominal pain, weight loss, and anemia. However, in some cases, patients may present with atypical or vague symptoms that complicate the early diagnosis. This case highlights a rare and unexpected presentation of rectal cancer with neurological symptoms, specifically foot drop, which is an uncommon manifestation of colorectal malignancy.

Foot drop resulting from lumbosacral plexopathy (LSP) is a rare neurological complication that occurs in various clinical settings. It is often associated with malignancies involving the pelvic region, including colorectal cancer. The mechanism underlying LSP in the context of rectal cancer is thought to be metastatic

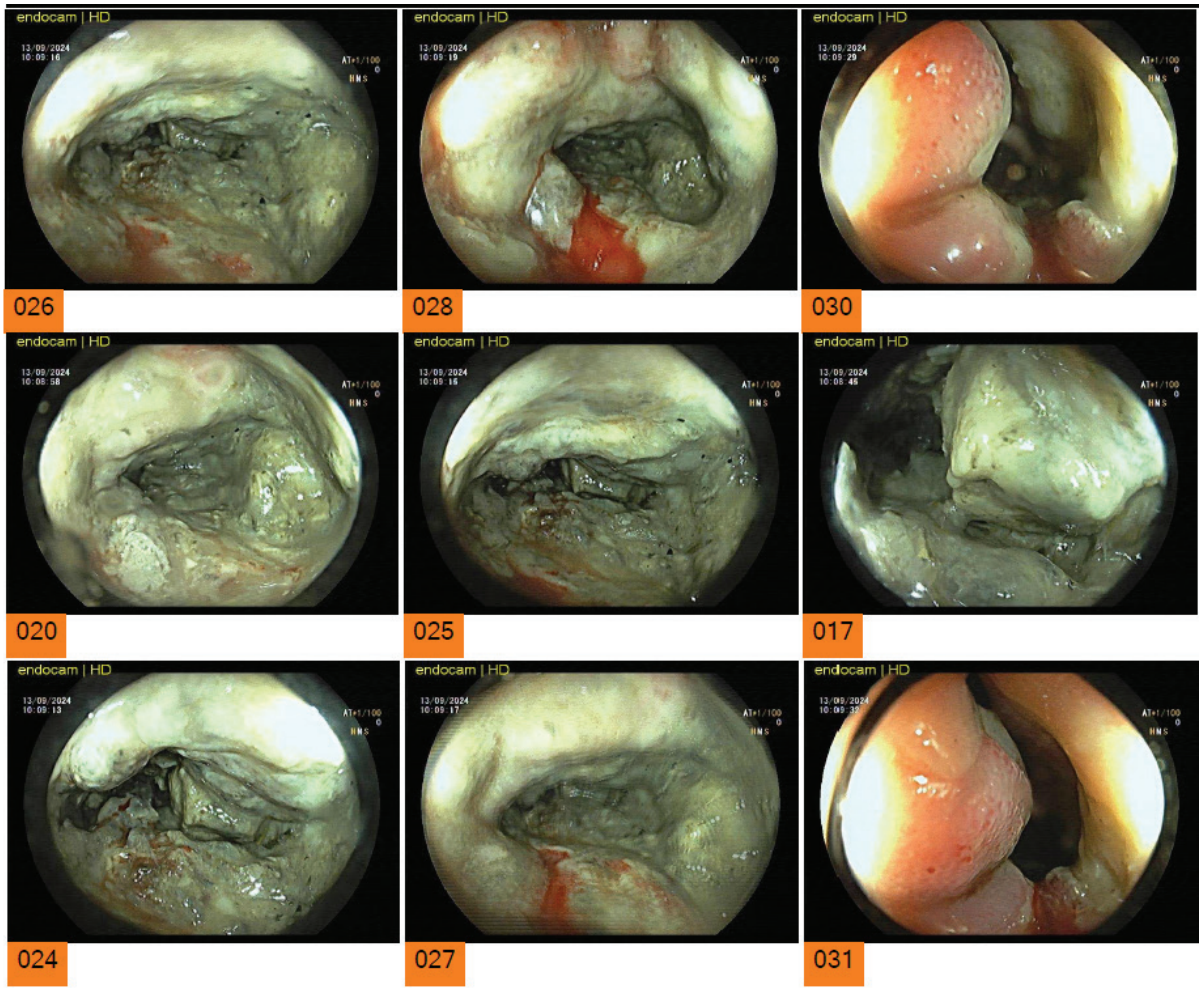

Figure 2: Colonoscopy image

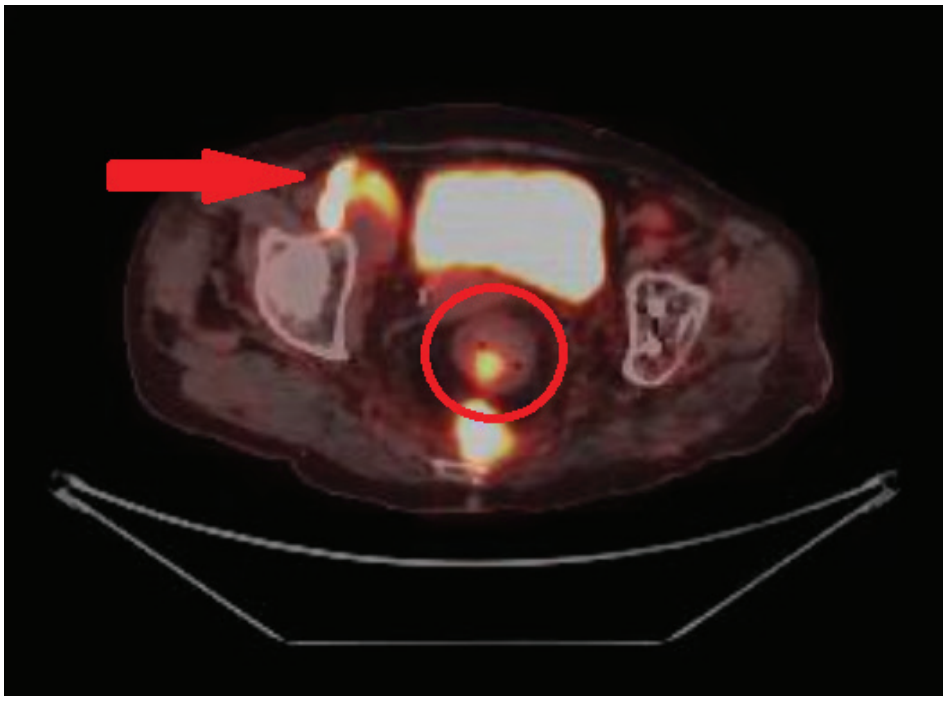

Figure 3: PET-CT image: A mass extending from the right iliac region to the obturator fossa (indicated with an arrow) and thickened rectal wall (circled)

lymphadenopathy or direct tumor infiltration compressing the lumbosacral plexus. While LSP is typically seen in metastatic disease, it has been reported in a variety of cancers, including colorectal cancer, where it can manifest as asymmetric muscle weakness, numbness, and sensory changes in the lower limbs [5,6].

In the present case, foot drop was the initial symptom that led to the discovery of advanced rectal cancer. This rare presentation underscores the importance of considering the full spectrum of potential symptoms when evaluating patients with rectal cancers. Neurological symptoms, although infrequent, should not be dismissed, particularly in patients with other risk factors or vague abdominal complaints. Our patient, who had a family history of colon cancer and other risk factors such as advanced age and diabetes, was ultimately diagnosed with rectal cancer after thorough evaluation, including digital rectal examination (DRE), CT imaging, colonoscopy, and biopsy.

Although DRE remains one of the most important physical examination techniques for detecting rectal cancer, it is often underutilized, particularly in patients presenting with atypical or vague symptoms. Studies have shown that DRE can detect 70-80% of tumors located in the distal rectum, making it a critical tool for the early detection of rectal malignancy, especially in older patients who may not exhibit typical symptoms [7,8]. In this case, DRE was crucial in identifying an irregular mass in the rectum, which led to further diagnostic imaging and ultimately confirmed the diagnosis.

This case highlights the importance of a multidisciplinary approach for managing colorectal cancer, particularly in the advanced stages. In this patient, a combination of surgery, palliative care, and chemotherapy was implemented to address disease progression and to manage the patient's symptoms. Palliative colostomy was performed to relieve the obstruction caused by the mass, and chemotherapy was initiated to treat metastatic disease.

In rare cases, such as this, the diagnosis of rectal cancer may be delayed due to atypical symptoms such as neurological deficits. Therefore, healthcare providers should remain vigilant and consider the possibility of cancer in patients with unexplained neurological signs, particularly those with known risk factors for colorectal malignancy.

Conclusion:

This case report emphasizes a rare but critical presentation of foot drop as a neurological symptom in a patient with rectal cancer. The prompt recognition of foot drops as an early warning sign led to the timely diagnosis of rectal cancer, despite the absence of common symptoms, such as rectal bleeding or changes in bowel habits. This underscores the importance of performing thorough physical examinations, including digital rectal examinations, even in patients presenting with vague or non-specific symptoms. Early detection, aided by appropriate diagnostic tools and a multidisciplinary approach, remains key to improving outcomes in CRC patients with colorectal cancer.

Healthcare providers should be aware of the possibility of rare neurological symptoms in colorectal cancer, as they may provide crucial clues for diagnosis, especially in patients with risk factors or unexplained symptoms. This case serves as a reminder of the need for comprehensive clinical evaluation in patients with atypical presentations, which can lead to earlier detection and improved management of colorectal malignancies.

Author contributions

We declare that all authors have accepted the submission and that the manuscript has not been published in whole or in part or submitted elsewher

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CASE REPORT

A Case with Deep Brain Stimulation and Cardiac Pacemaker

ABSTRACT

In recent years, deep brain stimulation (DBS) has emerged as a frequently preferred method for the treatment of late-stage Parkinson's disease (PD). Both Parkinson's disease (PD) and cardiac disease rise with age. DBS and a cardiac pacemaker may be employed in the same patient. The objective of this case is to present both DBS and cardiac pacemaker in conjunction with the existing literature on the subject.

Keywords: deep brain stimulation, cardiac pacemaker, Parkinson's disease

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Introduction

Deep Brain Stimulation (DBS) represents a safe and effective treatment option for patients diagnosed with Parkinson's Disease (PD) who have reached the late stages of the disease and have not achieved adequate symptom control or a satisfactory quality of life through medical therapy. Additionally, DBS may be considered when dopaminergic drugs have resulted in severe adverse effects, such as dyskinesia. The procedure entails the transmission of high-frequency electrical current by an implantable neuropacemaker through electrodes that are permanently placed at specific points in the motor circuits of the basal ganglia (1). The implanted pulse generator is typically situated in the left or right subclavicular region according to the preferences of the surgeon and the condition of the patient.

Cardiac pacemakers have constituted the primary treatment for bradycardia resulting from sinus node dysfunction or atrioventricular block. The objective is to identify the optimal ventricular pacing site that emulates normal human ventricular physiology and conduction in the most effective manner (2). Since the need for a cardiac pacemaker may rise in PD, it is generally not known whether these two pacemakers can be used in the same patient. The objective of this article is to present a case in which two pacemakers were used in conjunction, with a review of the relevant literature.

Case

A 78-year-old male patient was admitted to the outpatient clinic with a complaint of slowed movements. The patient had previously undergone implantation of a cardiac pacemaker in 2019. Mother and father of the patient were not in relative to each other and the father had a diagnosis of PD. It was learned that his complaints had started 15 years ago with tremor in his left arm. A diagnosis of PD was made and dopaminergic treatments were initiated. Although the patient initially responded well to the treatment, the effective period of the drugs was relatively short and the patient freezing. Consequently, the patient underwent lesion surgery and then DBS to the subthalamic nucleus at another clinic in 2015. The patient did not provide any information regarding the cardiac pacemaker in his history.

When the magnet of the DBS device was put on the patient his cardiac pacemaker has been recognized. The patient's general condition remained stable with a regular and

rhythmic pulse. An electrocardiogram (ECG) was conducted, and he has been consulted to cardiology and the patient was discharged without undergoing any cardiac procedure or further monitoring. In Figure 1, both pacemakers are seen on the chest X-ray.

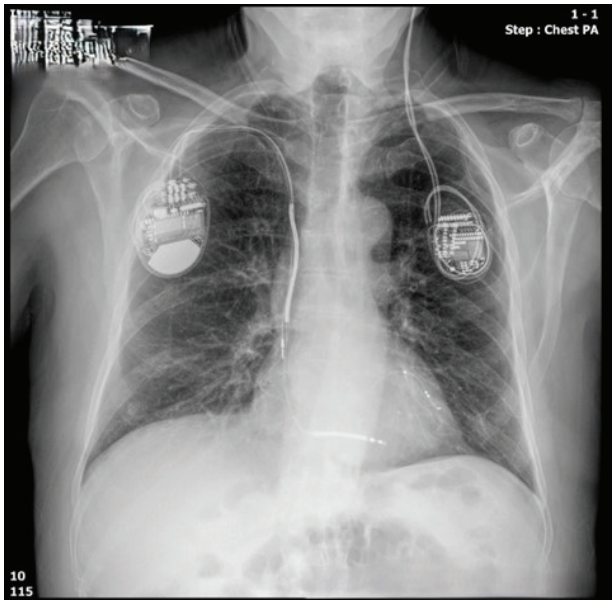

Figure 1, both pacemakers are seen on the chest X-ray.

Discussion and Conclusion

The first report of a DBS procedure being performed on a patient with a cardiac pacemaker was published in 2004 (3). It has been documented that the necessity for cardiac device implantation has increased in patients who have undergone deep brain stimulation (DBS). As reported by Elliot et al. (2019), both DBS and a cardiac pacemaker or implantable cardioverter defibrillator (ICD) were present in 13 patients (4). In the meta-analysis of Akhoundi et al. reviewing the literature on the association of DBS and cardiac implantable electronic devices (CIED), information on 34 patients was found and device-device interactions were reported in 6 patients (5). This has shown that two type of devices can safely coexist without interference when certain precautions like inter-device distance (4), bipolar configuration (4), low stimulation amplitude (6), regular system control, and informing of the patient are taken (5).

It is important to emphasise that PD is frequently a disease of patients over 60 years of age. The frequency of cardiac disease history increases in this age group. It is possible for both a DBS and a cardiac pacemaker to be present in the same patient. It is essential to take the patient's history into consideration before battery adjustment in order to avoid increasing the anxiety of both the patient and the doctor. It is also important to note that DBS is not a contraindication to a cardiac pacemaker and a cardiac pacemaker is not a contraindication to DBS..

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