North Clin Istanb 2025;12(1):129–137
doi: 10.14744/nci.2024.88785

Original Article EMERGENCY MEDICINE

Analysis of brain scan findings requested from individuals visiting the emergency department outpatient clinic with headache

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ABSTRACT

OBJECTIVE: Many patients visit the emergency department with headaches. The most crucial point in patient management is detecting secondary headaches. Accurate history, detailed physical examination, and appropriate neuroimaging are essential for diagnosis. This study aimed to examine the compatibility of neuroimaging findings with the symptoms of patients presenting to the emergency department with non-traumatic headaches.

METHODS: The data regarding the reasons for application, demographic information, accompanying symptoms, and neuroimaging results of patients who visited the green area of Goztepe Prof. Dr. Suleyman Yalcin City Hospital Emergency Medicine Clinic with headache complaints from June 2022 to June 2023 were analyzed.

RESULTS: The study included 4,908 individuals, with 38.33% identifying as male and 61.67% as female. The mean age was 42.34±19.13 years. Additionally, 75.28% of participants experienced issues beyond headaches, while 78.71% had no prior medical diagnoses. High blood pressure was the most reported condition, affecting 6.66% of those studied. Among the patients, 23.68% were advised to undergo a non-contrast CT scan, and 96.78% did not require further imaging. Thirty-two individuals (0.65%) were found to have underlying conditions that could lead to secondary headaches. Among these, 27 cases (84.37%) showed no additional symptoms (p=0.0001). A total of 99.61% of individuals were discharged from the emergency room. The age distribution did not correlate with the identified pathologies responsible for secondary headaches (p=0.058).

CONCLUSION: Our neuroimaging rates exceeded those found in the literature. Women were more likely to visit the emergency department for headaches. Three out of five patients experienced additional symptoms, predominantly hypertension. Approximately four out of five patients had no previous diagnosis. CT scanning was considered the gold standard for diagnosis. The occurrence of secondary headaches and associated symptoms was low. There was no correlation between increasing age and secondary headaches.

Keywords: Emergency department; headache; neuroimaging; outcome.

Cite this article as: *Buzluk T, Torun E, Al B, Altay TS, Buzluk MG. Analysis of brain scan findings requested from individuals visiting the emergency department outpatient clinic with headache. North Clin Istanb 2025;12(1):129–137.*

Received: October 20, 2024 *Revised:* December 19, 2024 *Accepted:* December 23, 2024 *Online:* January 06, 2025

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Istanbul Provincial Directorate of Health - Available online at www.northclinist.com

Headaches can be divided into two categories, primary and secondary, representing about 1-4% of visits to emergency rooms [1, 2]. The occurrence rate over a lifetime is 52%, with a greater frequency observed among females [3]. Primary headaches can often be treated and released through medical methods like pain relievers after a thorough history and physical assessment. In contrast, secondary headaches, accounting for 4% of headache instances, necessitate more complex diagnostic tests and imaging techniques. A non-contrast brain CT scan is the most frequently ordered imaging technique for identifying secondary headaches in urgent care settings. Furthermore, diagnostic procedures such as contrast CT (Computed Tomography), MRI (Magnetic Resonance Imaging), angiography, venography, and lumbar puncture are employed in medical evaluations [1, 3, 4]. A thorough assessment of the patient's medical background and a physical check-up, combined with imaging techniques such as CT or MRI scans, lumbar puncture, serum erythrocyte sedimentation rate, or measurements of carbon monoxide levels, can assist in ruling out secondary conditions. Approximately 80% of individuals receiving care in emergency rooms can leave without requiring further complex tests. A typical neurological assessment decreases the chance of underlying conditions to just 2.4% [5].

Numerous elements contribute to the elevated frequency of unwarranted examinations in emergency rooms, such as the convenience of access [6], technological progress [4], heightened anxiety over legal repercussions, a meticulous mindset in medical practice, incentive structures in private healthcare facilities, demands for specialist assessments, and a lack of sufficient patient interaction time [6, 7].

Demanding superfluous and overly extensive examinations can lead to wasted time for doctors, delays in patient discharges, increased congestion in emergency rooms, and negative impacts on the national economy [8].

While asking for these examinations might fulfill the desires of patients and their families, it tends to frustrate healthcare professionals. This complex problem poses a considerable obstacle. To reduce the drawbacks associated with unwarranted examinations, it is essential to standardize diagnostic practices, recognize societal factors that lead to over-testing, leverage existing research in clinical assessments, create more balanced alternative diagnostic approaches, and implement patient-focused diagnostic and decision-making processes [7].

Highlight key points

- High blood pressure is the leading cause of headaches.
- Neuroimaging performed on approximately one in five patients who presented to our emergency department with a headache.
- The proportion of patients with secondary headache causes was high, with the most common being an intracranial mass.
- History-taking, physical examination and imaging requests are inadequate according to guidelines for patients with headaches.

The analysis in this study focused on the demographic data, chronic health issues, associated complaints, neuroimaging results, consultation needs, and pathological conditions of individuals seeking outpatient care for headaches at the Emergency Medicine Department of Goztepe Prof. Dr. Suleyman Yalcin City Hospital from June 15, 2022, to June 15, 2023.

This study examined imaging studies requested for patients presenting to our emergency department with headache complaints over the past three years. It analyzed retrospectively the correlation between the symptoms, examination findings, and neuroimaging studies of patients with headache complaints. The results also indicate how effectively we adhere to the medical history, physical examination, and guideline information gathered from patients with headaches.

MATERIALS AND METHODS

This investigation aims to evaluate the findings from neuroimaging scans requested for individuals experiencing headaches in the emergency room and to analyze the correlation between these findings and the patient's initial symptoms and assessments.

The research was carried out retrospectively from June 15, 2022, to June 15, 2023, by gathering information from patients who visited the outpatient clinic of the Emergency Medicine Department at Goztepe Prof. Dr. Suleyman Yalcin City Hospital, affiliated with Istanbul Medeniyet University, and who reported experiencing "headache," for whom imaging studies were requested to aid in confirming the diagnosis.

The research was authorized by the Clinical Research Ethics Committee of Goztepe Prof. Dr. Suleyman Yalcin CityHospital, part of Istanbul Medeniyet University, with approval reference 2023/0398, dated 21.06.2023. It was conducted according to the ethical guidelines established by the 1964 Helsinki Declaration and its subsequent revisions.

The study included non-traumatic patients aged eighteen and older who had their information logged in the patient registration system of Goztepe Prof. Dr. Suleyman Yalcin City Hospital and visited the outpatient clinic with headache complaints. During the designated timeframe, 5,045 medical records were reviewed. 128 patients (2.54%) were removed from the study as their cases were not pertinent, and an additional nine patients (0.18%) were excluded because of trauma; consequently, the analysis included data from 4,908 patients.

After acquiring the Clinical Research Ethics Committee Report from Goztepe Prof. Dr. Suleyman Yalcin City Hospital, a year's worth of patient records for the designated timeframe were retrieved from the hospital's information system. Information from individuals who visited the "outpatient clinic" was refined. The processed information was sorted based on a previously established "data analysis" framework. The findings were submitted to the Number Cruncher Statistical System for analysis.

The parameters listed below have been documented: information regarding the patients' demographics (such as age and sex), other symptoms apart from headaches, imaging studies requested, any abnormalities found in the imaging, pre-existing health conditions, treatments administered, further imaging requests, consultations sought, and results obtained.

This research seeks to uncover the medical conditions identified through imaging tests requested for patients experiencing headaches at our facility. It aims to link the initial diagnosis with the imaging studies conducted and assess how the findings can enhance existing literature. No competing interests are associated with this study. There is no conflict of interest in this study.

Data Analysis

Statistical analyses in this study were performed using NCSS (Number Cruncher Statistical System) 2007 Statistical Software (Utah, USA). Descriptive statistical methods (frequency and percentage distributions, mean, and standard deviation) were used for data evaluation, along with the Yates-corrected chi-square test for comparisons of qualitative data. Results were evaluated at a significance level of $p<0.05$.

RESULTS

During the period spanning June 15., 2022, to June 15, 2023, a total of 369,561 individuals visited our

Table 1. Distribution of patients by age, gender, and seasons (n=4908)

Age, (%)	
18–35	37.94
36–55	41.75
56–80	18.60
>80	1.71
Gender, (%)	
Male	38.33
Female	61.67
Admission season, (%)	
Spring	23.92
Summer	24.41
Autumn	28.71
Winter	22.96
Complaints accompanying headache (additional complaint), (%)	
Absent	75.28
Nausea	6.34
Nausea- dizziness	0.02
Nausea- flu like symptoms	0.02
Vomiting	2.24
Vomiting- dizziness	0.02
Dizziness	2.57
Diplopia, blurred vision	0.12
Hypertension	6.66
Neck tenderness	0.20
Loss of strength in extremities	0.02
Flu symptoms	6.15
Others	0.35
Confusion	6.25
Loss of balance	6.25
Epistaxis	31.25
Pregnancy	31.25
Diarrhea	6.25
Seizure	6.25
Syncope	12.50
Medical history, (%)	
Absent	78.71
Hypertension	8.68
Hypertension+CKF	0.10
Hypertension+CHD	0.20
Hypertension+DM	1.71
CKF	0.18
CHD	0.22
DM	0.98
DM+migrain	0.02
COPD/asthma	1.00
Migraine	6.05
Cluster headache	0.04
Epilepsy	0.31
Others	1.79

CKF: Chronic kidney failure; CHD: Coronary heart disease; DM: Diabetes mellitus; COPD: Chronic obstructive pulmonary disease.

emergency room. 262,322 visits, representing 71%, were categorized as outpatient. Headaches accounted for 1.9% (n=5.045) of the total visits to the outpatient clinic. A total of 4,908 patients were included in the study. The entire patient group's mean age was 42.34±19.13 years. Headache-related visits to our emergency department were predominantly from women, individuals in the 36 to 55 age brackets, and occurred more frequently in the autumn. 75.28% (n=3.695) of the patients had no complaints other than headaches. The most common accompanying conditions were hypertension (6.66%) and nausea (6.34%). A total of 78.71% of the individuals did not have any prior medical diagnoses. The diagnosis that occurred most commonly was hypertension, representing 6.66% of the total (Table 1).

Of the patients treated in the emergency department, 76.28% were sent home without undergoing any imaging procedures. A non-contrast CT scan was ordered for 23.68% of the individuals in our research. Of the patients who received CT scans, 96.78% did not require additional imaging tests. The most frequently requested supplementary imaging procedure was an MRI, accounting for 2.85% of cases. Among the patients, 32 (0.65%) were discovered to have health conditions that might serve as secondary reasons for their headaches. Nineteen individuals in this group have intracranial masses. A total of 99.61% of individuals were released from the emergency room. (Table 2).

As individuals age, the frequency of CT requests rises significantly (p=0.0001). The analysis revealed that the age distribution did not correlate with the pathologies identified as secondary factors contributing to headaches (p=0.058). However, with advancing age, the occurrence of comorbidities, especially hypertension, rises significantly (p=0.0001) (Table 3).

There was no statistically significant correlation between the demands for CT scans, the request for further testing beyond CT, and the identification of conditions associated with secondary headaches and gender. However, women experiencing headaches reported nausea more frequently (p=0.0001), whereas men were more likely to be admitted to the hospital (p=0.007) (Table 4).

A group of 32 patients was found to have medical issues that served as secondary reasons for their headache symptoms. Out of the thirty-two individuals studied, 27 (84.37%) reported experiencing only headaches without any additional symptoms (p=0.0001) (Table 5).

Table 2. Distribution of CT scans, requested tests with CT, detected pathologies, and results (n=4908)

Requested tests	
Unrequested	76.28
CT without iv contrast	23.68
CT with iv contrast	0.04
Additional imaging	
Absent	96.78
MRI	2.85
CT angiography	0.20
Carotid Doppler USG	0.02
Others	0.14
Detected pathologies	
Normal	89.41
Edema	0.17
Bleeding	0.61
Ischemic infarct	0.26
Mass	1.64
Sinusitis	7.83
Hydrocephalus	0.09
Treatment administered in the emergency department	
No treatment was given	31.38
IM	45.80
IV	17.46
Oral	5.36
Outcome	
Admitted to hospital	0.39
Discharged	99.61

CT: Computed tomography; MRI: Magnetic resonance imaging; IM: Intramuscular; IV: Intravenous; USG: Ultrasonography.

DISCUSSION

In our study, three out of five cases of headaches presented to the emergency department's outpatient clinic were female, and the majority were aged between 18 and 55 (79.69%).

In various studies that involved fewer participants, a slight preference for men was observed [9]. A different research project that examined 462,000 instances of headaches found that approximately 70% of the individuals affected were women, primarily within the age group of 18 to 49 years [1]. In a study conducted in Italy, which has a demographic and cultural structure very similar to Turkiye, 65% of the patients presenting to the emergency department with headaches were female [10]. The average age in that study was 43.32±19.72, which is very

Table 3. Relationship between requested investigations, detected pathologies, comorbidities, and age distribution of results

	18–35, (%)	36–55, (%)	56–80, (%)	>80, (%)	p
Requested tests					**0.0001**
Unrequested	1.560 (83.78)	1.551 (75.70)	583 (63.86)	50 (59.52)	
CT without iv contrast	302 (16.22)	498 (24.30)	329 (36.04)	33 (39.29)	
CT with iv contrast	0 (0.00)	0 (0.00)	1 (0.11)	1 (1.19)	
Detected pathologies					0.058
Normal	275 (91.36)	435 (88.24)	295 (89.94)	27 (81.82)	
Edema	1 (0.33)	1 (0.20)	0 (0.00)	0 (0.00)	
Bleeding	0 (0.00)	2 (0.41)	4 (1.22)	1 (3.03)	
Ischemic infarct	1 (0.33)	1 (0.20)	1 (0.30)	0 (0.00)	
Mass	3 (1.00)	5 (1.01)	8 (2.44)	3 (9.09)	
Sinusitis	21 (6.98)	48 (9.74)	20 (6.10)	2 (6.06)	
Hydrocephalus	0 (0.00)	1 (0.20)	0 (0.00)	0 (0.00)	
Medical history					**0.0001**
Absent	1.682 (90.33)	1.621 (79.11)	520 (56.96)	40 (47.62)	
Hypertension	19 (1.02)	152 (7.42)	223 (24.42)	32 (38.10)	
Hypertension+CKF	0 (0.00)	0 (0.00)	5 (0.55)	0 (0.00)	
Hypertension+CHD	0 (0.00)	2 (0.10)	7 (0.77)	1 (1.19)	
Hypertension+DM	0 (0.00)	29 (1.42)	49 (5.37)	6 (7.14)	
CKF	0 (0.00)	1 (0.05)	7 (0.77)	1 (1.19)	
CHD	1 (0.05)	3 (0.15)	6 (0.66)	1 (1.19)	
DM	5 (0.27)	21 (1.02)	20 (2.19)	2 (2.38)	
COPD/asthma	3 (0.16)	20 (0.98)	26 (2.85)	0 (0.00)	
Migrain	113 (6.07)	162 (7.91)	22 (2.41)	1 (1.19)	
Cluster headache	2 (0.11)	0 (0.00)	0 (0.00)	0 (0.00)	
Epilepsy	7 (0.38)	7 (0.34)	1 (0.11)	0 (0.00)	
Others	30 (1.61)	31 (1.51)	27 (2.96)	0 (0.00)	
Outcome					**0.022**
Admitted to hospital	3 (0.16)	7 (0.34)	8 (0.88)	1 (1.19)	
Discharged	1.859 (99.84)	2.042 (99.66)	905 (99.12)	83 (98.81)	

CKF: Chronic kidney failure; CHD: Coronary heart disease; DM: Diabetes mellitus; COPD: Chronic obstructive pulmonary disease.

similar to the average age in our study. In Turkiye, another investigation discovered that women were more likely to arrive at the emergency department with headaches, accounting for 67% of cases [11].

Studies examining seasonal variations in emergency department visits for headaches show differing results. One investigation [12] found that the occurrence of tension-type headaches was higher in the summer, while another analysis [13] pointed out that winter headaches were exacerbated by increasing air pollution. Although the area surrounding our hospital experiences significant pollution [14], the winter months saw the fewest patient visits.

Headaches are often accompanied by various systemic complaints, which can sometimes correlate with the severity of the underlying pathology causing the headache. Evidence shows that hypertension can trigger headaches, and managing blood pressure effectively can relieve or completely resolve the discomfort [15]. Research indicates that individuals suffering from migraines could be at an increased risk for developing high blood pressure [16]. Nausea is also a common accompanying symptom of headaches [17]. Morgenstern et al. [18] noted that nausea and high blood pressure were the most frequent symptoms accompanying headaches. Goldstein et al. [1] reported that flu-like symptoms accompanied headaches

Table 4. Relationship between requested investigations, presence of additional complaints, detected pathologies, and gender

	Male, (%)	Female, (%)	p
Requested tests			0.449
Unrequested	1.441 (76.61)	2.303 (76.08)	
CT without iv contrast	440 (23.39)	722 (23.85)	
CT with iv contrast	0 (0.00)	2 (0.07)	
Complaints accompanying headache (additional complaint)			**0.0001**
Absent	1.445 (76.86)	2.249 (74.30)	
Nausea	81 (4.31)	230 (7.60)	
Nausea- dizziness	0 (0.00)	1 (0.03)	
Nausea- flu like symptoms	0 (0.00)	1 (0.03)	
Vomiting	31 (1.65)	79 (2.61)	
Vomiting- dizziness	0 (0.00)	1 (0.03)	
Dizziness	52 (2.77)	74 (2.44)	
Diplopia, blurred vision	1 (0.05)	5 (0.17)	
Hypertension	114 (6.06)	213 (7.04)	
Neck tenderness	1 (0.05)	9 (0.30)	
Loss of strength in extremities	1 (0.05)	0 (0.00)	
Flu symptoms	146 (7.77)	156 (5.15)	
Others	8 (0.43)	9 (0.30)	
Additional imaging			0.238
Absent	1.818 (96.65)	2.932 (96.86)	
MRI	52 (2.76)	88 (2.91)	
CT angiography	5 (0.27)	5 (0.17)	
Carotid Doppler USG	1 (0.05)	0 (0.00)	
Others	5 (0.27)	2 (0.07)	
Detected pathologies			0.384
Normal	382 (87.82)	650 (90.28)	
Edema	0 (0.00)	2 (0.28)	
Bleeding	3 (0.69)	4 (0.56)	
Ischemic infarct	2 (0.46)	1 (0.14)	
Mass	10 (2.30)	9 (1.25)	
Sinusitis	37 (8.51)	54 (7.50)	
Hydrocephalus	1 (0.23)	0 (0.00)	
Outcome			**0.007**
Admitted to hospital	13 (0.69)	6 (0.20)	
Discharged	1.868 (99.31)	3.021 (99.80)	

CT: Computed tomography; MRI: Magnetic resonance imaging; USG: Ultrasonography.

in 2.4% of cases. In our study, the most common symptoms accompanying headaches were hypertension, nausea, and flu-like symptoms.

Determining the secondary underlying factors contributing to headaches in individuals who arrive at emergency rooms is crucial. The most frequently used diagnostic tool is non-contrast CT. According to Cerbo et al. [19], merely 2% of headaches seen in emergency rooms are classified as secondary. MRI could be the method for identifying additional conditions, including thrombosis in cerebral veins or intracranial masses. Our investigation revealed that non-contrast CT was ordered for 22.25% of the patients, with MRI being the additional imaging modality requested most often, at a frequency of 2.85%.

Table 5. The relationship between identified pathologies and accompanying symptoms of headache

	Absent	Nausea	Vomiting	Dizziness	Diplopia	HT	Neck tenderness	Flu like symptoms	Others	p
Requested tests										**0.0001**
Unrequested	2.849 (77.10)	232 (74.36)	69 (62.16)	68 (53.97)	1 (16.66)	217 (66.36)	7 (70.00)	290 (95.71)	11 (64.71)	
CT without IV contrast	844 (22.84)	80 (25.64)	42 (37.80)	58 (46.03)	5 (83.33)	110 (33.64)	3 (30.00)	13 (4.29)	6 (35.29)	
CT with IV contrast	2 (0.05)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	
Detected pathologies										**0.0001**
Normal	746 (88.92)	73 (93.59)	41 (97.62)	53 (91.38)	4 (80.00)	97 (88.18)	3 (100.00)	10 (76.92)	4 (66.67)	
Edema	2 (0.24)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	
Bleeding	4 (0.48)	1 (1.28)	1 (2.38)	0 (0.00)	0 (0.00)	1 (0.91)	0 (0.00)	0 (0.00)	0 (0.00)	
Ischemic infarct	2 (0.24)	0 (0.00)	0 (0.00)	1 (1.72)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	
Mass	18 (2.15)	0 (0.00)	0 (0.00)	1 (1.72)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	
Sinusitis	66 (7.87)	4 (5.13)	0 (0.00)	3 (5.17)	1 (20.00)	12 (10.91)	0 (0.00)	3 (23.08)	2 (33.33)	
Hydrocephalus	1 (0.12)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	

HT: Hypertension; CT: Computed tomography; IV: intravenous.

Approximately one in ten of the cases revealed abnormalities through imaging techniques. The incidence of severe medical conditions, excluding sinusitis (n=91), was assessed at 0.65%. While sinusitis was identified as the most prevalent condition, the leading cause of secondary headaches was an intracranial mass. The study by Kuan et al. [20] revealed that sinusitis and intracranial hemorrhage were the prevalent findings. The frequency of imaging requests for patients with headaches in our emergency room exceeds what has been documented in existing studies.

The elevated percentage indicates significant areas for improvement in our ability to gather comprehensive patient histories, conduct thorough physical examinations, adequately decline imaging requests from patients and their families, and adhere to established protocols for treating individuals who present with headaches. Gago-Veiga et al. [21] noted that failing to pay attention to these aspects can increase unnecessary testing rates.

Conversely, the pressures of medico-legal responsibilities, the fear of malpractice, and the desire to share risks are compelling emergency physicians to request more imaging. The biomarkers recommended before imaging to exclude secondary causes of headaches [22, 23] are currently insufficient to address this issue.

As individuals grow older, it is reasonable that there is a rise in the number of neuroimaging requests, as they face a greater likelihood of having multiple health issues simultaneously. Trofimova et al. [24] shared similar thoughts in their study. With advancing age, the rise in long-term health issues, especially in patients experiencing thromboembolic incidents like atrial fibrillation and those on anticoagulant therapy, prompts doctors to order additional neuroimaging studies. However, in our study, the differences in pathological findings among neuroimaging requests across age groups were not statistically significant.

Additional tests were requested in approximately one in ten patients (9.33%) where no secondary pathology was identified. Although it is common practice to order further examinations like CT angiography or MRI when there are signs of masses, swelling, or ischemic strokes, the fact that merely 2% of headaches stem from secondary issues suggests that our figures appear elevated as well. All sinusitis cases requiring further imaging were not classified as complicated sinusitis or sinusitis associated with meningitis. Consequently, the rate at which additional imaging was requested for our sinusitis patients was more significant than in the literature [25].

Limitations

The main limitations of our study include that the study population was only made up of patients presenting to the green zone, it was conducted in a single center, only data from the last year were included, and it was retrospective, meaning it was not possible to directly observe patients' histories, complaints, and physical examinations.

Conclusion

The research involved 4,908 individuals suffering from headaches. Imaging was requested for 22.2% (n=1.092) of these patients. Aside from sinusitis, only 0.65% of our patients were identified as having secondary headache-related disorders. The most frequently detected condition outside of sinusitis was an intracranial mass. The frequency of our direct and supplementary test requests exceeded what has been documented in existing studies. This increased frequency can be attributed to poor history collection, lack of thorough physical assessments, excessive compliance with imaging demands from patients and their families, and the burdens of legal responsibilities faced by doctors.

Physicians should understand that a detailed history and comprehensive physical examination are the gold standards for accurately diagnosing and managing headache cases. The public should be informed that the pressures from patient and family demands for imaging and medico-legal fears harm rather than benefit the patient, physician, and healthcare system.

Ethics Committee Approval: The Istanbul Medeniyet University Goztepe Prof. Dr. Suleyman Yalcin City Hospital Clinical Research Ethics Committee granted approval for this study (date: 21.06.2023, number: 2023/0398).

Authorship Contributions: Concept – TB, BA; Design – TB, BA; Supervision – ET, TSA; Fundings – TB, TSA, MGB; Materials – BA, ET; Data collection and/or processing – TB, BA, ET; Analysis and/or interpretation – TB, ET; Literature review – TSA, ET; Writing – TB, BA; Critical review – TB, BA, MGB.

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

Use of AI for Writing Assistance: The author declared that they did not use artificial intelligence (AI)-assisted technologies (such as Large Language Models [LLMs], chatbots or image generators). Grammarly program was used to adhere to English grammar rules.

Financial Disclosure: The authors declared that this study has received no financial support.

Peer-review: Externally peer-reviewed.

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