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Emergency department CT scan utilization and findings in geriatric patients presenting with non-traumatic headache

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Abstract

Background & Objective: In geriatric patients, headache is a common reason for emergency department (ED) visits. Because secondary headaches are more common in geriatric patients than in younger patients, the former should be carefully excluded at presentation. In this study, we aimed to investigate the role of brain computed tomography (CT) in geriatric patients presenting to the ED with non-traumatic headache, the indications for imaging, the CT findings, and factors associated with detection of pathology. *Methods:* Patients aged 65 years and older who presented to the ED with headache between January 1, 2023 and December 31, 2023, who underwent a brain CT scan, and who had complete data were included in the study. Patients with an intracranial mass, acute-subacute ischemic findings, intraparenchymal and subarachnoid hemorrhage, and cerebral edema on brain CT scan were considered as having significant pathology. *Results:* The study included 384 patients. CT scan was normal in 61.2% of the patients and 10.4% had significant pathology. It was observed that 24.5% of the patients underwent CT scan for prolonged headache and 19.3% for severe headache. Logistic regression analysis showed that severe headache, loss of consciousness, anticoagulant use, neurological deficit, and elevated blood pressure at presentation were predictors of the detection of significant pathology on CT scan.
Conclusion: In conclusion, 10.4% of geriatric patients presenting to the emergency department with headache have significant CT findings, and the impact of these findings on the emergency management of patients cannot be ignored. Incorporating these findings into clinical decision-making guidelines could improve the effectiveness of emergency management protocols by facilitating rapid and specific diagnostic interventions for geriatric patients presenting with headache.

Keywords: Brain CT, elderly, geriatric, headache.

INTRODUCTION

Headache is the most common neurological symptom, affecting approximately 46% of the world's population.[1] In geriatric patients, headache is a common reason for emergency department (ED) visits, and this can be due to a variety of causes.[2] The International Classification of Headache Disorders basically divides headaches into two main groups, primary and secondary. Primary headaches are those that exist independently and that are not caused by another medical condition, with common examples including migraines, tension-type headaches, and cluster headaches. Secondary headaches, on the other hand, are symptoms of an underlying condition such as sinusitis, head injury, hemorrhage or vascular disorders, requiring identification and treatment of an underlying cause. Differentiating between these types is crucial for accurate diagnosis and effective treatment.[3,4] In addition, because secondary headaches are more common in geriatric patients than in young patients, special attention is required to exclude them in this age group.[2,4]

Brain computed tomography (CT) scanning has an important role in the detection of serious pathologies underlying headache in geriatric

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patients.[4-6] A brain CT scan can reveal the presence of potentially life-threatening conditions such as intracranial masses, hemorrhage, infection, and ischemic events. Therefore, brain CT scanning in geriatric patients presenting to the ED with headache is essential for rapid diagnosis and appropriate treatment.[5,6] In the ED, clinical decision-making guidelines are needed for rapid assessment and diagnosis in almost all conditions. In patients with headache, indications for brain CT include "first or worst headache of life, sudden onset of severe headache, new-onset headache over 50 years of age, change in typical headache pattern or frequency, abnormal neurological examination, headache with seizure or altered consciousness".[2,6] In recent years, an increase in life expectancy and the growth of the elderly population has made adaptation of clinical guidelines necessary for this age group.

The purpose of this study was to evaluate the imaging indications, CT scan findings, and factors associated with findings of significant intracranial pathology in geriatric patients presenting to the emergency department with non-traumatic headaches.

METHODS

Study design

We conducted this retrospective study at the ED of Ankara Atatürk Sanatoryum Training and Research Hospital, a tertiary care facility with 780 beds situated in a bustling provincial hub that receives approximately 390,000 visits to the ED annually. Approval for the study was obtained from the local ethics committee under protocol number 2024-BÇEK/34. Our study was designed in accordance with the Standards for Reporting of Diagnostic Accuracy Studies (STARD) statement.[7]

Data collection

Information was gathered from electronic medical records and patient files. Two emergency specialists, each with a minimum of 3 years of experience, conducted a retrospective review of charts, which included clinical and demographic patient characteristics as well as CT scans. Any discrepancies between the assessments of the two specialists were reviewed by the lead investigator, who made the final determination. Inter-observer agreement was not evaluated as there was no reevaluation of the CT scans; assessments were solely based on existing reports.

Study population

Patients aged 65 years and older who presented to the ED with headache between January 1, 2023 and December 31, 2023, who underwent a brain CT scan, and who had complete data were included in the study. Patients younger than 65 years, those with a history of trauma, primary intracranial malignancy, or with incomplete data were excluded.

Patients were screened according to ICD-10 (International Statistical Classification of Diseases: G44 and its subcodes, R51) codes. Patients' symptoms other than headache (nausea, vomiting, high fever, syncope, altered consciousness, dizziness), demographic information, comorbid conditions, medications, neurological examination findings, and CT scan results were recorded. The indications for CT scan were "prolonged pain, severe pain, vomiting, dizziness, syncope/loss of consciousness, anticoagulant use, neurological deficit, high fever, hypertensive encephalopathy, and no cause found". Headache present for longer than 1 week was defined as a prolonged headache. A body temperature of 37.5°C or higher was considered to be fever. A systolic blood pressure of 140 mmHg and above was considered to be elevated blood pressure.

Patients with previously diagnosed brain tumors or brain metastases were not included in the study. Patients with intracranial masses, acute to subacute ischemic findings, intraparenchymal and subarachnoid hemorrhage, and cerebral edema on brain CT scans were considered to have significant pathology. Conversely, incidental findings such as encephalomalacia, arachnoid cysts, and calcifications were not considered indicative of significant pathology. The patient cohort was then divided into two groups: those who required acute management changes because of the CT findings (showing significant pathology), and those who did not. Management changes were defined as any adjustments made to the patient's immediate care plan, including neurosurgical procedures, specialized medical interventions (such as addressing subarachnoid hemorrhage or central nervous system infections), or the decision for hospitalization versus discharge.

Statistical analysis

All data collected throughout the study and recorded on the study form were analyzed using the IBM SPSS 20.0 (Chicago, IL, USA) statistical program. The Shapiro-Wilk test was used to assess whether the distribution of discrete and continuous

numerical variables was normal. Descriptive statistics were presented as median (IQR 25-75) for discrete and continuous numerical variables, and categorical variables were presented as frequencies and percentages. Categorical variables were evaluated by chi-squared, and continuous variables by Mann-Whitney U tests respectively. To identify risk factors predictive of significant pathology on CT, multivariate regression analysis was performed using parameters that were significant in univariate analyses. Model fit was assessed by the Hosmer-Lemeshow test. In all statistical analyses, the critical alpha value was accepted as 5% and hypotheses were tested bidirectionally.

RESULTS

During the study period, 988 patients presenting with headache were evaluated. There were 446 patients who underwent a CT scan. A total of 384 patients with complete data and CT scans were included in the study. 65.9% of the patients were female and the median age was 72 years (IQR 25-75, 68-79). 28.9% of the patients had a known primary headache diagnosis and 1.6% had a migraine diagnosis. 13% of the patients were hospitalized and treated. Patient demographics, treatment, and outcomes are shown in Table 1.

The CT scan was normal in 61.2% of patients and 10.4% had significant pathology. It was observed that 24.5% of the patients underwent CT scan because of prolonged headache and 19.3% because of severe headache. The CT findings of the patients are shown in Table 2.

The comparison of patients with and without significant pathology on the brain CT scan is shown in Table 3. The presence of coronary artery disease and cerebrovascular disease in the patient's history was statistically significant for significant pathology on the CT scan ($p<0.05$ for all values). The rate of significant pathology was statistically higher in patients with severe pain, syncope/loss of consciousness, anticoagulant use, and neurological deficits ($p<0.05$ for all factors).

Table 1: Demographic and clinical characteristics of the patients

	All patients, n=384
Gender, *n (%)*	
Female	253 (65.9)
Age, *median (IQR[1], 25-75)*	72 (68-79)
Comorbidities, *n (%)*	
Hypertension	261 (68)
Diabetes mellitus	117 (30.5)
COPD[2]	66 (17.2)
CAD[3]	165 (43)
CKD	20 (5.2)
Malignancy	12 (3.1)
CVD	29 (7.6)
Other neurological diseases	60 (15.6)
Diagnosed with primary headache	111 (28.9)
Migraine	6 (1.6)
GCS, *median (IQR,25-75)*	15 (15-15)
Vital signs, *median (IQR,25-75)*	
Heart rate	76 (72-85)
Systolic blood pressure	145 (135-160)
Diastolic blood pressure	80 (73-89)
Body temperature	36.1 (36.0-36.2)
Patient outcome, *n (%)*	
Discharged	334 (87)
Hospitalization	50 (13)
Length of hospital stay, days	6 (4-7.2)

IQR[1]: Inter Quantile Range, COPD[2]: Chronic obstructive pulmonary disease, CAD[3]: Coronary artery disease, CKD: Chronic kidney disease, CVD: Cerebrovascular disease, GCS: Glasgow coma scale

Table 2: The CT findings of the patients

CT[1] findings	
Normal	235 (61.2)
Atrophic changes	85 (22.1)
Encephalomalasic changes	42 (11.7)
Calcification	26 (6.8)
Acute-subacute ischemia	24 (6.3)
Intraparenchymal hemorrhage	6 (1.6)
Subarachnoid hemorrhage	5 (1.3)
Mass	4 (1)
Arachnoid cyst	3 (0.8)
Brain edema	2 (0.5)
Significant pathology on CT	40 (10.4%)
Indications for CT scan	
Prolonged pain	94 (24.5)
Severe pain	74 (19.3)
Anticoagulant use	71 (18.5)
Vomiting	70 (18.2)
Dizziness	63 (16.4)
Syncope/loss of consciousness	40 (10.4)
Neurological deficit	29 (7.6)
Hypertensive encephalopathy	8 (2.1)
Fever	4 (1)
Reasons not found	12 (3.1)

CT[1]: Computed tomography * A patient may have more than one CT finding. ** A patient may have undergone CT for more than one indication.

Table 3: Comparison of patients with and without significant pathology on the CT scan

	Significant pathology detected on CT[1] (n=40)	**No significant pathology detected on CT** (n=344)	**p**
Age, *median (IQR[2], 25-75%)*	75 (69.2-80.7)	72 (68-78)	0.093
Gender, *n (%)*			
Female	21 (52.5%)	232 (67.4%)	0.059
Comorbidities, *n (%)*			
Hypertension	27 (67.5%)	234 (68%)	0.946
Diabetes mellitus	14 (35%)	103 (29.9%)	0.511
CAD[3]	25 (62.5%)	140 (40.7%)	**0.008**
CKD	3 (7.5%)	17 (4.9%)	0.491
CVD	12 (30%)	17 (4.9%)	**<0.001**
Malignancy	2 (5%)	10 (2.9%)	0.361
Other neurological diseases	54 (15.7%)	6 (15%)	0.908
Indications for CT scan			
Prolonged pain	**10 (25%)**	**84 (24.4%)**	0.935
Severe pain	**14 (35%)**	**60 (17.4%)**	**0.008**
Vomiting	**8 (20%)**	**62 (18%)**	0.759
Dizziness	**8 (20%)**	**55 (16%)**	0.517
Syncope/loss of consciousness	**10 (25%)**	**30 (8.7%)**	**0.004**
Anticoagulant use	**16 (40%)**	**55 (16%)**	**<0.001**
Neurological deficit	**19 (47.5%)**	**10 (2.9%)**	**<0.001**
Hypertensive encephalopathy	**0 (0%)**	**4 (1.2%)**	1.000
Fever	**2 (5%)**	**6 (1.7%)**	0.172

CT[1]: Computed tomography, IQR[2]: Inter Quantile Range, CAD[3]: Coronary artery disease, CKD: Chronic kidney disease, CVD: Cerebrovascular disease

Table 4: Univariate and multivariate regression model to predict the significant findings on the CT scan

	Univariate			Multivariate		
	Wald	**P value**	**Odds Ratio (95%CI[1]s)**	**Wald**	**P value**	**Odds Ratio (95%CIs)**
Age	2.179	0.140	1.03 (0.99-1.08)	0.379	0.538	1.02 (0.96-1.08)
Gender	3.477	0.062	1.87 (0.97-3.63)	0.111	0.739	1.15 (0.49-2.69)
Hypertension	0.005	0.946	0.98 (0.48-1.96)			
Diabetes mellitus	0.431	0.511	1.26 (0.63-2.51)			
CAD[2]	6.632	0.010	2.43 (1.24-4.77)			
CKD[3]	0.468	0.494	1.56 (0.44-5.57)			
CVD	24.594	<0.001	8.24 (3.58-18.97)			
Malignancy	0.506	0.477	1.76 (0.37-8.32)			
Other neurological diseases	0.013	0.908	0.95 (0.38-2.37)			
Prolonged pain	0.007	0.935	1.03 (0.48-2.20)			
Severe pain	6.729	0.009	2.55 (1.26-5.17)	8.876	0.003	3.97 (1.60-9.93)
Vomiting	0.094	0.759	1.14 (0.50-2.59)			
Dizziness	0.418	0.518	1.31 (0.57-3.00)			
Syncope/loss of consciousness	9.193	0.002	3.49 (1.56-7.83)	4.420	0.036	3.28 (1.08-9.91)
Anticoagulant use	12.492	<0.001	3.50 (1.75-7.02)	3.084	0.048	2.30 (1.03-5.83)
Neurological deficit	57.161	<0.001	30.22 (12.49-73.12)	44.951	<0.001	35.24 (12.44-99.83)
Fever	0.000	0.999	0.00 (0-N/A)			
High blood pressure	3.913	0.048	1.02 (1.00-1.04)	7.520	0.006	1.04 (1.01-1.07)

CI[1]: Confidence interval, CAD[2]: Coronary artery disease, CKD[3]: Chronic kidney disease, CVD: Cerebrovascular disease

Logistic regression analysis was performed to determine the effect of the parameters listed in Table 3 on the detection of significant pathology on the CT scan (Table 4). In this regression analysis, severe headache, loss of consciousness, anticoagulant use, neurological deficit, elevated blood pressure, and a history of coronary artery disease and cerebrovascular disease were found to be predictors of the detection of significant pathology on CT scanning.

DISCUSSION

This study examined brain CT scans in geriatric patients presenting to the ED with non-traumatic headache and the impact of CT findings on emergency patient management. Factors influencing CT findings were also examined. 89.6% of brain CT scans performed did not reveal significant pathology that would affect emergency management. Severe headache, loss of consciousness, anticoagulant use, neurological deficit, and elevated blood pressure at presentation were predictive of significant pathology on CT. These findings highlight the high prevalence of negative CT scans in headache patients presenting to the ED. However, significant findings, although less frequent, remain critical for accurate diagnosis and treatment planning. These findings support a re-evaluation of the criteria for performing emergency CT scans in elderly patients with headache, with the goal of more efficient resource allocation. Guidelines should prioritize CT scans for patients with high-risk factors such as severe headache, altered consciousness, anticoagulant use, neurological deficits, and elevated blood pressure.

The first step in the evaluation of headache in the ED is to exclude headache due to intracranial pathology. Therefore, it is important to direct patients presenting to the ED for prompt diagnosis and treatment, taking into account the red flag findings on admission. Emergency CT scan of the brain in patients presenting with headache is a commonly used method for rapid detection of intracranial pathology and determination of urgent treatment needs. Studies in the literature have reported that 10-16% of patients aged 18 years and older who presented to the ED with non-traumatic headache had significant pathology on brain CT scans.[6,8-11] In our study, the rate

of significant pathology was 10.4%, which is consistent with the literature. Other studies in the literature have reported that the rate of significant pathology was higher in older patients when patients were evaluated by age group.[6,8,9,11,12] In the clinical decision-making process, it is important to consider the clinical characteristics and risk factors of patients in addition to the age factor. With advancing age, a number of factors distinguish the elderly population from the general population. These factors include increased prevalence of chronic diseases and use of blood thinners, decreased physiological reserves, increased prevalence of neurological disorders such as Alzheimer's disease and dementia, and difficulty in expressing patients' symptoms. Therefore, clinical decision-making guidelines for a common symptom such as headache need to be adapted to the characteristics of the elderly population.

As in our study, focal neurological deficit on physical examination has been found to be associated with significant pathology on CT in almost all studies conducted in patients with non-traumatic headache.[6,8-12] This finding underscores the importance of clinical evaluation and emphasizes the importance of considering the physical examination in determining the imaging needs of patients. In this context, it can be said that the physical examination plays the most critical role in making imaging necessary.

One study, has shown that antiplatelet or anticoagulant use increases the rate of abnormal results on brain CT scan in non-traumatic headache.[13] In other studies, anticoagulant use and coagulopathy were associated with significant pathology.[8,14,15] In our study, anticoagulant use was also associated with significant pathology on CT. Headache may be a symptom of serious complications such as intracranial hemorrhage in patients receiving anticoagulant therapy. Therefore, the severity and frequency of headache and other accompanying symptoms should be carefully evaluated in patients taking anticoagulants.

Altered consciousness with headache is also a condition that prompts clinicians to obtain a brain CT. Previous studies have shown that the presence of headache with altered consciousness is associated with significant pathology on CT.[8,10,12] In our study, the rate of significant pathology was high in patients with altered consciousness. The combination of headache and altered consciousness may have different causes. It may be due to intracranial pathology such as intracranial subarachnoid hemorrhage, mass, or meningitis-encephalitis, as well as metabolic disorders such as hyponatremia, hypoglycemia, or ketoacidosis. In these patients, imaging modalities such as brain CT should be used to exclude life-threatening intracranial pathology.

Elevated blood pressure in patients with headache is known to be associated with the risk of intracranial and subarachnoid hemorrhage (16,17). Similarly, in our study, elevated blood pressure at presentation was associated with significant pathology on CT. If blood pressure is elevated in patients with headache, other associated symptoms should be carefully evaluated, and the imaging decision should be based on the severity of the associated symptoms.

For limitations, first, the study was single-center and retrospective. Some patients underwent CT for more than one indication, which may have influenced the results. The sample size of our study is limited. Other limitations include the fact that our study did not evaluate the impact on long-term patient outcomes and did not consider the incidence of significant pathology in patients who presented with headache but did not undergo CT scanning.

In conclusion, although only 10.4% of geriatric patients presenting to the emergency department with headache have significant findings, the impact of these findings on the emergency management of patients cannot be ignored. Severe headache, loss of consciousness, anticoagulant use, neurological deficit on examination, and elevated blood pressure on presentation were found to increase the likelihood of detecting significant pathology on the CT scans. Incorporating these findings into clinical decision-making guidelines could improve the effectiveness of emergency management protocols by facilitating rapid and specific diagnostic interventions for geriatric patients presenting with headache.

DISCLOSURES

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