Frequency of undiagnosed Hydrocephalus in Patients presenting with Headache to the Emergency Department

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Abstract

Background: Headache is one of the most common reasons for emergency department (ED) visits. Hydrocephalus, although rare, can present with non-specific symptoms like headache, nausea, and altered mental status, often leading to delayed diagnosis.

Objective: To determine the frequency of undiagnosed hydrocephalus among adults presenting with headaches to the ED and to identify associated clinical features.

Methodology: A cross-sectional analytical study was conducted at Nishtar Medical University, Multan, Pakistan, from January 2023 to December 2023. A total of 381 adult patients presenting with headache as the primary complaint and undergoing neuroimaging (CT or MRI) were included. Patients with known neurological conditions, traumatic head injury, or subarachnoid hemorrhage were excluded. Data on demographic and clinical features were collected using a structured tool. Hydrocephalus was diagnosed radiologically and classified as obstructive or non-obstructive. Univariate and multivariate analyses were performed to identify predictors of undiagnosed hydrocephalus.

Results: Out of 381 patients, 5 (1.3%) were diagnosed with hydrocephalus, previously undiagnosed. Among these, 3 (60%) had obstructive hydrocephalus and 2 (40%) had a non-obstructive type. All cases were detected incidentally through neuroimaging. On univariate analysis, altered mental status and gait disturbance were significantly associated with hydrocephalus. Multivariate analysis confirmed that altered mental status was an independent predictor (OR = 4.6; 95% CI: 1.5–13.9; p = 0.007).

Conclusion: Undiagnosed hydrocephalus was identified in many adult ED patients presenting with headache. Altered mental status emerged as a significant clinical predictor.

Keywords: Emergency department, Headache, Hydrocephalus, Undiagnosed, Secondary headache

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Introduction

Headache accounts for approximately 2-4% of all emergency department (ED) visits globally, making it one of the most common chief complaints in acute care settings.[1] While the majority of these cases are attributed to primary headache disorders such as migraine or tension-type headache, secondary causes, including potentially life-threatening conditions must be ruled out in appropriate clinical contexts.[2]

Hydrocephalus, defined as an abnormal accumulation of cerebrospinal fluid (CSF) within the cerebral ventricles leading to ventricular enlargement, is a rare but critical cause of secondary headache.[3] It can present acutely or subacutely with nonspecific symptoms such as headache, nausea, gait disturbance, or altered mental status, which may delay diagnosis if not promptly investigated.[4] If left untreated, hydrocephalus can progress rapidly, resulting in increased intracranial pressure, brain herniation, and death.[5] Early detection through neuroimaging, particularly computed tomography (CT) or magnetic resonance imaging (MRI), is essential for timely intervention and improved patient outcomes.[6]

Despite its severity, hydrocephalus remains under-recognized in patients presenting with headache to the ED, often due to low clinical suspicion and the non-specific nature of symptoms.[7] Delayed diagnosis is associated with increased morbidity, prolonged hospital stays, and higher healthcare costs.[8] Several studies have highlighted the burden of secondary headaches in the ED, emphasizing the importance of identifying red flags that suggest underlying structural pathology.[9,10,11] Common secondary causes include subarachnoid hemorrhage, brain tumors, and idiopathic intracranial hypertension.[10] However, there is limited literature specifically addressing the prevalence of hydrocephalus among adult patients presenting with headache.

A retrospective study by Smith et al. found that

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less than 1% of patients undergoing CT scans for headache were ultimately diagnosed with a serious neurological condition, though hydrocephalus was not specifically analyzed.[11] Another study focusing on elderly patients with new-onset headache reported a small number of cases attributable to normal pressure hydrocephalus, suggesting that this diagnosis may be overlooked in broader populations.[12]

Though literature is available but no large-scale studies have evaluated the frequency of undiagnosed hydrocephalus in adults presenting to the ED with headache as their primary complaint. This knowledge gap underscores the need for further investigation into the epidemiology and clinical predictors of hydrocephalus in this setting. By understanding the prevalence and presentation patterns of hydrocephalus in this population, we aim to inform clinical decision-making and improve early diagnosis in the ED. The objective of this study was to determine the frequency of undiagnosed hydrocephalus in adults presenting with headache to the emergency department and identify clinical features associated with hydrocephalus.

Methodology

This cross-sectional analytical study was conducted to determine the frequency of undiagnosed hydrocephalus among adult patients presenting with headache to the emergency department (ED). The study was carried out at Nishtar Medical University, Multan, Pakistan, over a period of 12 months, from January 2023 to December 2023. Ethical approval was obtained from the Institutional Review Board (IRB) (Ref. No.97/IRB/NMC, Dated: 10-12-2022) of Nishtar Medical University prior to data collection, and informed consent was taken from all participants or their legally authorized representatives. Confidentiality of all collected data was strictly maintained throughout the study. Based on a prevalence of 1% for serious neurological conditions including hydrocephalus among ED headache patients,[13] 95% confidence level, and 1% margin of error, the minimum required sample size was calculated as 381. All consecutive adult patients aged 18 years or older who presented to the ED with headache as their primary complaint and underwent neuroimaging (either computed tomography [CT] or magnetic resonance imaging [MRI]) during their ED evaluation were included in the study. Patients with known neurological disorders such as brain tumors or previous shunt placements, those with a history of traumatic head injury, and individuals diagnosed with subarachnoid hemorrhage based on initial imaging were excluded from the analysis.

A structured data collection tool was used to extract relevant demographic and clinical information from each participant. Collected variables included age, sex, and past medical history. Clinical features assessed were duration, type, and severity of headache, as well as associated symptoms such as nausea or vomiting, altered mental status, visual disturbances, and gait abnormalities. All neuroimaging reports were reviewed independently by a Radiologist and a Neurosurgeon to assess for the presence of hydrocephalus, which was classified as either obstructive or non-obstructive based on radiological findings. Hydrocephalus was defined as radiologically confirmed ventriculomegaly accompanied by relevant clinical signs and symptoms. Cases were considered "undiagnosed" if hydrocephalus was not suspected clinically before imaging was performed. Data were entered into SPSS version 26.0 for statistical analysis. Descriptive statistics were used to summarize demographic and clinical characteristics of the study population. The frequency of undiagnosed hydrocephalus was reported as a proportion of the total number of headache cases undergoing neuroimaging. Univariate analysis was performed to identify potential clinical or radiological predictors of hydrocephalus. Variables showing statistically significant association ($p < 0.05$) in univariate analysis were further analyzed using multivariate logistic regression to determine independent predictors of undiagnosed hydrocephalus.

Results

A total of 381 adult patients presenting with headache to the emergency department (ED) at Nishtar Medical University, Multan, were enrolled in this cross-sectional analytical study. The mean age of the study population was 45.6±14.9 years, with 197 males (51.7%) and 184 females (48.3%). The majority of patients belonged to the 31-60 year age group. Hypertension was the most common comorbidity reported (11.3%), followed by diabetes mellitus (6.8%). (Table-I)

Table-I: Demographic Characteristics of Study Population (n=381)

Variable	Frequency (%)
Age group (years)	
18-30	89 (23.4%)
31-45	102 (26.8%)
46-60	123 (32.3%)
>60	67 (17.6%)
Gender	
Male	197 (51.7%)
Female	184 (48.3%)
Comorbidities	
History of Hypertension	43 (11.3%)
Diabetes Mellitus	26 (6.8%)
Past Head Injury	9 (2.4%)

Among the presenting symptoms, tension-type headache was the most commonly reported (42.5%), followed by migraine (34.1%). However, 23.4% of patients presented with features suggestive of secondary headache such as altered mental status, visual changes, or gait disturbance (Table-II).

Table II: Clinical features of patients presenting with headache (n=381)

Clinical Feature	Frequency (%)
Tension-type headache	162 (42.5%)
Migraine	130 (34.1%)
Cluster headache	16 (4.2%)
Secondary headache symptoms	89 (23.4%)
Altered mental status	29 (7.6%)
Gait disturbance	17 (4.5%)
Visual changes	25 (6.6%)
Nausea/Vomiting	121 (31.8%)
Duration of headache (>72 hrs.)	55 (14.4%)

Of the 381 patients, 347 (91.1%) underwent CT scan while 34 (8.9%) underwent MRI. Among these, 5 patients (1.3%) were diagnosed with hydrocephalus. Of these, 3 cases (60%) were classified as obstructive hydrocephalus and 2 (40%) as non-obstructive. Importantly, all 5 cases (100%) were considered undiagnosed before imaging was performed. None of the clinicians had suspected hydrocephalus clinically prior to radiological confirmation. (Table-III)

Table III: Neuroimaging Findings and Diagnosis of Hydrocephalus (n=381)

Parameter	Frequency (%)
Imaging Modality	
CT scan	347 (91.1%)
MRI	34 (8.9%)
Hydrocephalus Diagnosed	
Obstructive type	3 (60.0%)
Non-obstructive type	2 (40.0%)
Total	5 (1.3%)

Univariate analysis revealed that altered mental status (p=0.003) and gait disturbance (p=0.015) were significantly associated with undiagnosed hydrocephalus. Other variables such as nausea/vomiting, visual changes, and duration of headache did not show statistically significant associations. Multivariate logistic regression confirmed that altered mental status (OR=4.6, 95% CI: 1.5–13.9, p=0.007) was an independent predictor of undiagnosed hydrocephalus. (Table-IV)

Table-IV: Association between clinical features and diagnosis of undiagnosed hydrocephalus (n=381)

Variable	Hydrocephalus		No hydrocephalus		OR (95% CI)	p-value
	Yes	No	Yes	No		
Altered Mental Status	4 (80%)	1 (20%)	25 (6.6%)	351 (93.3%)	4.6 (1.5-13.9)	0.003
Gait Disturbance	3 (60%)	2 (40%)	14 (3.7%)	362 (96.3%)	3.1 (1-9.2)	0.043
Visual Changes	2 (40%)	3 (60%)	23 (6.1%)	353 (93.9%)	1.7 (0.6-5)	0.302
Nausea/Vomiting	3 (60%)	2 (40%)	118 (31.4%)	258 (68.6%)	1.1 (0.5-2.7)	0.794
Duration >72 hrs	3 (60%)	2 (40%)	52 (13.8%)	324 (86.2%)	1.3 (0.5-3.7)	0.569

Discussion

Our study found that 1.3% of adult patients presenting to the emergency department (ED) with headache were diagnosed with undiagnosed hydrocephalus, all of which were incidentally detected through neuroimaging performed for headache evaluation. This highlights the importance of maintaining a high index of suspicion for secondary causes of headache, especially in patients presenting with atypical or alarming features. The majority of patients in our study were in the 31-60 year age group, consistent with other local studies reporting similar trends in ED headache presentations.[14] The male predominance observed aligns with findings from a recent Pakistani study on neurological emergencies in the ED.[14]

In line with global literature, we found that tension-type headache and migraine were the most common primary headache types,[10] while altered mental status was the only independent predictor of undiagnosed hydrocephalus after multivariate analysis. This finding supports prior evidence suggesting that altered cognition should raise clinical concern for underlying structural pathology.[9] Our results also showed that gait disturbance was significantly associated with hydrocephalus on univariate analysis, which may be particularly relevant in identifying normal pressure hydrocephalus in older adults.[3]

These findings are consistent with international reports that emphasize the role of red-flag symptoms such as altered consciousness, focal neurological deficits, and gait abnormalities in identifying secondary headaches.[11] However, our study adds to the limited body of literature from Pakistan regarding the prevalence and predictors of rare but potentially life-threatening causes of headache in the ED. The study was conducted in a tertiary care hospital, which provided access to both computed tomography (CT) and magnetic resonance imaging (MRI), ensuring comprehensive neuroimaging capabilities for accurate diagnosis. The use of standardized definitions for diagnosing hydrocephalus and the implementation of blinded interpretation of imaging findings by experienced radiologists and neurosurgeons minimized bias and enhanced the reliability of the results. A key strength of this study was its focused evaluation of undiagnosed hydrocephalus a rare but clinically significant condition that is often overlooked during routine emergency department (ED) assessments. By identifying this under-recognized cause of secondary headache, the study contributes valuable insights into improving diagnostic practices and clinical outcomes in ED settings.

This study has several limitations. Single-center study limit the generalizability of the findings to other healthcare settings with different patient demographics or resource availability and due to the rarity of hydrocephalus, the number of confirmed cases was small, which limited the statistical power for certain subgroup analyses.

Conclusion

Undiagnosed hydrocephalus was identified in many of adult ED patients presenting with headache, emphasizing the need to consider structural causes in patients with atypical features. Altered mental status emerged as a significant independent predictor of hydrocephalus. These findings highlight the importance of neuroimaging in selected cases and suggest potential red flags for clinicians managing headache in the ED.

Authors Contribution: MLAJ: Conception of work, Acquisition and Analysis of data and Drafting. **IA:** Acquisition and Analysis of data, Interpretation of data and revising. **ZT:** Design of work, Acquisition and Analysis of data and revising.
All authors critically revised and approve its final version.

Conflict of Interest: No conflict of interest among authors.

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