

Prevalence of abnormal cranial CT scan in nontraumatic headache patients with red flag symptoms at the emergency department in Hospital Universiti Sains Malaysia

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ABSTRACT

Introduction: Data on the prevalence of nontraumatic headaches with red flag symptoms in Asia are sparse. Therefore, the objectives of this study were to determine the final diagnosis and prevalence of abnormal CT scans in patients who presented to the emergency department (ED) with red flag symptoms.

Materials and Methods: This was a retrospective study based on the Radiology Department database of patients who presented to the ED with complaints of nontraumatic headache, had red flag symptoms, and underwent cranial CT scans. The inclusion criteria were adult patients presenting through the ED with nontraumatic headache who underwent cranial CT scans. Multivariate analysis was performed based on logistic regression to analyse the significance of the predictive value for abnormal CT scans.

Results: A total of 216 patients underwent cranial CT scans in the ED. More than half of the cases (53.7%) were male. A total of 146 patients (67.6%) had no obvious abnormalities in the CT scans, while 41 patients (19.0%) had cranial infarction, 9 patients (4.2%) had intracranial bleeding, and 20 patients (9.3%) had brain tumours. The most common diagnosis was primary headache syndrome, followed by cerebral vascular accident (CVA). Multivariate analysis showed that three factors were associated with abnormal CT scans: age, systolic blood pressure (SBP), and mean arterial pressure (MAP). New onset of headache at the age of 50 years or older (Odds Ratio, OR 3.21, 95% Confidence Interval, CI 1.15, 8.94), SBP (OR 4.82, 95%CI 2.29, 10.40) and MAP (OR 6.21, 95%CI 2.71, 14.70) were significant.

Conclusion: The prevalence of abnormal CT scan findings in nontraumatic headache patients with red flag symptoms was 32%. Primary headache syndrome is the most common diagnosis. An age greater than 50 years old during the onset of headache, SBP greater than 180mmHg and MAP greater than 120mmHg were associated with a higher risk of abnormal cranial CT scans.

KEYWORDS:

nontraumatic headache, red flag symptoms, CT scan, emergency department

INTRODUCTION

Headache is a common presenting complaint in the emergency department (ED). It accounts for 1-4% of all ED visits.¹ Over time and centuries, the approaches to nontraumatic headache have become more systematic. Since 1992, the classification of headache by the International Headache Society has been incorporated into the 10th edition of the International Classification of Diseases (ICD-10) by the World Health Organization (WHO).² Based on the classification, all headache-related disorders are classified into three main classes: primary headaches, secondary headaches, and central neuralgias – central, primary facial pain, and other headaches.³ Each class of headache contains explicit diagnostic criteria, and the specific meaning includes quantities rather than vague terms such as several or usually, which are based on clinical and laboratory observations.⁴

Deciding which adult patients have potentially life-threatening conditions can be challenging.⁵ The term red flag was used to act as a screening tool to help identify headache patients who would benefit from urgent neuroimaging.^{6,7} In 2003, 'SSNOOP' mnemonic (systemic symptoms/signs and disease, neurologic symptoms or signs, onset sudden or onset after the age of 40 years, and change of headache pattern) was introduced by Dodick to assist in identifying these symptoms.⁸ Since then, many guidelines have provided more characteristics for the red flags, leading to the current SNNNOOP10.⁹

Nevertheless, not all red flag symptoms are associated with abnormal computed tomography (CT) scan findings. For example, 80% of severe and rapid onset headaches have a final diagnosis of primary headache syndromes.¹⁰ Another study in The Netherlands found that the number needed to scan to detect an intracranial cause of the headache was 7.6.¹¹ Some studies also revealed that most scans of headache patients with sinister features or red flag symptoms had low predictive value.^{9,12} However, data on the final diagnosis of headache with red flag symptoms who presented through ED in Asia are sparse. Therefore, the objectives of this study were to determine the final diagnosis and prevalence of abnormal CT scans in patients who presented to the ED with 'SSNOOP' - red flag symptoms.

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Table I: Demographic data and variable results collected (n=216)

Independent variables		Frequency (%)	Mean (SD)
Gender	Male	116 (53.7)	49.5 (\pm 0.99) 151.97 (\pm 1.2) 88.7 (\pm 0.62) 109.83 (\pm 0.70)
	Female	100 (46.3)	
Race	Malay	213 (98.7)	
	Chinese	3 (1.3)	
Age			
SBP (mmHg)			
DBP (mmHg)			
MAP (mmHg)			
CT Scan Findings	No abnormality detected	146 (67.6)	
	Abnormal CT scan	70 (32.4)	
	• Infarction	41 (19.0)	
	• Bleeding	9 (4.2)	
	• Tumours	20 (9.3)	
Disposition	Admission to the ward	104 (48.1)	
	• Neuromedical	44 (20.4)	
	• Neurosurgical	30 (13.9)	
	• Otorhinolaryngology	8 (3.7)	
	• Ophthalmology	1 (0.5)	
	• Medical	19 (8.8)	
	Discharge	112 (51.9)	
	• Referral to specialist clinic	103 (34.2)	
	• General clinic referral	9 (4.2)	
	Diagnosis given in ED	Primary HA syndrome	134 (62.5)
BPPV		7 (3.2)	
Ischaemic stroke		41 (19.0)	
Brain tumours		20 (9.3)	
ICB group		9 (4.2)	
• Intraparenchymal - 1			
• Intraventricular - 4			
• Epidural - 2			
• Subarachnoid - 2			
TIA		4 (1.8)	
Viral Fever		1 (0.5)	

BPPV: Benign Postural Vertigo, CT: Computed Tomography, DBP: Diastolic Blood Pressure, HA: Headache, ICB: Intracerebral bleeding, MAP: Mean Atrial Pressure, SBP: Systolic Blood Pressure, SD: Standard Deviation, TIA: Transient Ischaemic Attack

Table II: Frequency table of ('SSNOOP') red flag symptoms in nontraumatic headache patients

Red flags symptoms*	Complaint	n (%)
Systemic symptoms	Fever	26 (12.0)
	Weight loses	2 (0.9)
Systemic disease	Infection	6 (2.8)
	HIV	4 (1.9)
	Suspect malignancy	2 (0.9)
Neurologic symptom	Generalised weakness	56 (25.9)
	Numbness	32 (14.8)
	AMS	33 (15.3)
	Seizures	16 (7.4)
	Severe Giddiness	87 (40.3)
	Visual disturbances	35 (16.2)
	Paralysis (limbs or facial)	68 (31.5)
	Severe headache in life	78 (36.1)
	Onset sudden (thunderclap headache)	126 (58.3)
	Onset after age 40 years	79 (36.6)
Previous headache history (first, worst, or different headache)	Persistent vomiting with headache	79 (36.6)
	New abnormal headache	61 (28.2)

*Based on patients' complaints and history. All of the patients had more than one complaint.
AMS: Altered mental status, HIV: Human immunodeficiency virus

Table III: Associated factors of patients with abnormal computed tomography (CT) scan by univariate logistic regression analysis and multivariate logistic regression

	Univariate analysis				Multivariate analysis				
	CT Normal n (%)	CT Abnormal n (%)	Fraction f (%)	OR	95% CI	p	OR	95% CI	p
Age									
>50	146 (67.6)	70 (32.4)	216 (100)	1		0.001			0.024
<50	110 (50.9)	66 (30.5)	176 (81.4)	3.13	1.60, 6.13		3.21	1.15, 8.94	
Gender									
Male	36 (16.7)	4 (1.9)	40 (18.6)	1	0.34, 1.22	0.170			
Female	78 (36.1)	38 (17.6)	116 (53.7)	0.64	1.28, 6.52	0.010	4.82	2.29, 10.40	<0.001
SBP	68 (31.5)	32 (14.8)	100 (46.3)	1		0.070			
>180	110 (50.9)	54 (25.3)	164 (76.2)	2.88	0.90, 6.74		6.21	2.71, 14.70	<0.001
<180	36 (16.7)	16 (7.1)	52 (23.8)	1	1.09, 6.63	0.040			
DBP	125 (57.8)	60 (28.3)	185 (86.1)	1					
>110	21 (9.3)	10 (4.6)	31 (13.9)	2.46					
<110	113 (52.3)	55 (25.5)	168 (77.8)	1					
MAP	33 (15.3)	15 (6.9)	48 (22.2)	2.67					
>120									
<120									

OR: odds ratio, CI: confidence interval, DBP: diastolic blood pressure, MAP: mean atrial pressure, SBP: systolic blood pressure

MATERIALS AND METHODS

This was a retrospective study based on the Radiology Department database of patients who presented to the ED with nontraumatic headache as one of the complaints, had red flag symptoms, and underwent cranial CT scans. The data were collected from 2009 to 2012 in Hospital Universiti Sains Malaysia (USM), Kelantan, Malaysia. The inclusion criteria were adult patients (more than 12 years old) presenting through the ED with nontraumatic headache who had either one or more red flag symptoms and underwent cranial CT scans. The exclusion criteria were any patient who was known to have any intracranial lesion and referred cases from district hospitals or clinics with suspected intracranial lesions. The cranial CT scan findings were categorised as normal findings or abnormal findings based on the report by the radiologist.

The data collection started from reviewing the database. The request for the CT scan must be made by the ED doctors of Hospital USM. From the database, case notes were traced. All cases were reviewed based on the inclusion and exclusion criteria. A format sheet was created for the documentation and data collection. Demographic data, vital signs, history taking documentation, physical examination findings, cranial CT scan findings, diagnosis, and disposition from the ED were recorded. The collected data and variables from the samples were categorised accordingly by statistical analyses using SPSS™ 22. Multivariate analysis was performed based on logistic regression to analyse the significance of the predictive value from the univariate analysis. Ethical approval was obtained from the Ethical Board Review and Hospital Ethics Committee on 29 July 2013 (Reference USMKK/PPP/JEPeM [270.4(1)]). The sample size was determined using the single proportion method and based on the prevalence of headache in a renowned international study by Goldstein et al., in 2006.¹³ The power sample was significantly calculated with the value of 92 samples for this study.

RESULTS

A total of 216 patients who presented with red flag symptoms underwent cranial CT scans in the ED, Hospital USM. The flow of the study and number of patients distribution are summarised in Figure 1. More than half of the cases (53.7%) were male. The mean age was 49.5 (SD±0.99) years old, with the youngest patient being 16 years old and the oldest patient being 83 years old.

The mean systolic blood pressure (SBP) was 151.97mmHg (SD±1.2), and the diastolic blood pressure (DBP) was 88.7mmHg (SD±0.62), with a mean atrial pressure (MAP) of 109.83mmHg (SD±0.70). A total of 146 (67.6%) patients had no obvious abnormalities, 41 (19.0%) patients had cranial infarction, 9 (4.2%) patients had intracranial bleeding, and 20 (9.3%) patients had brain tumours. Details of the factors and diagnosis are presented in Table I.

Table II shows the most common 'SSNOOP' - red flag symptoms are the first onset of headache in a patient more than 40 years old. It accounted for 58.3% of all cases. The second and third most common red flag symptoms were

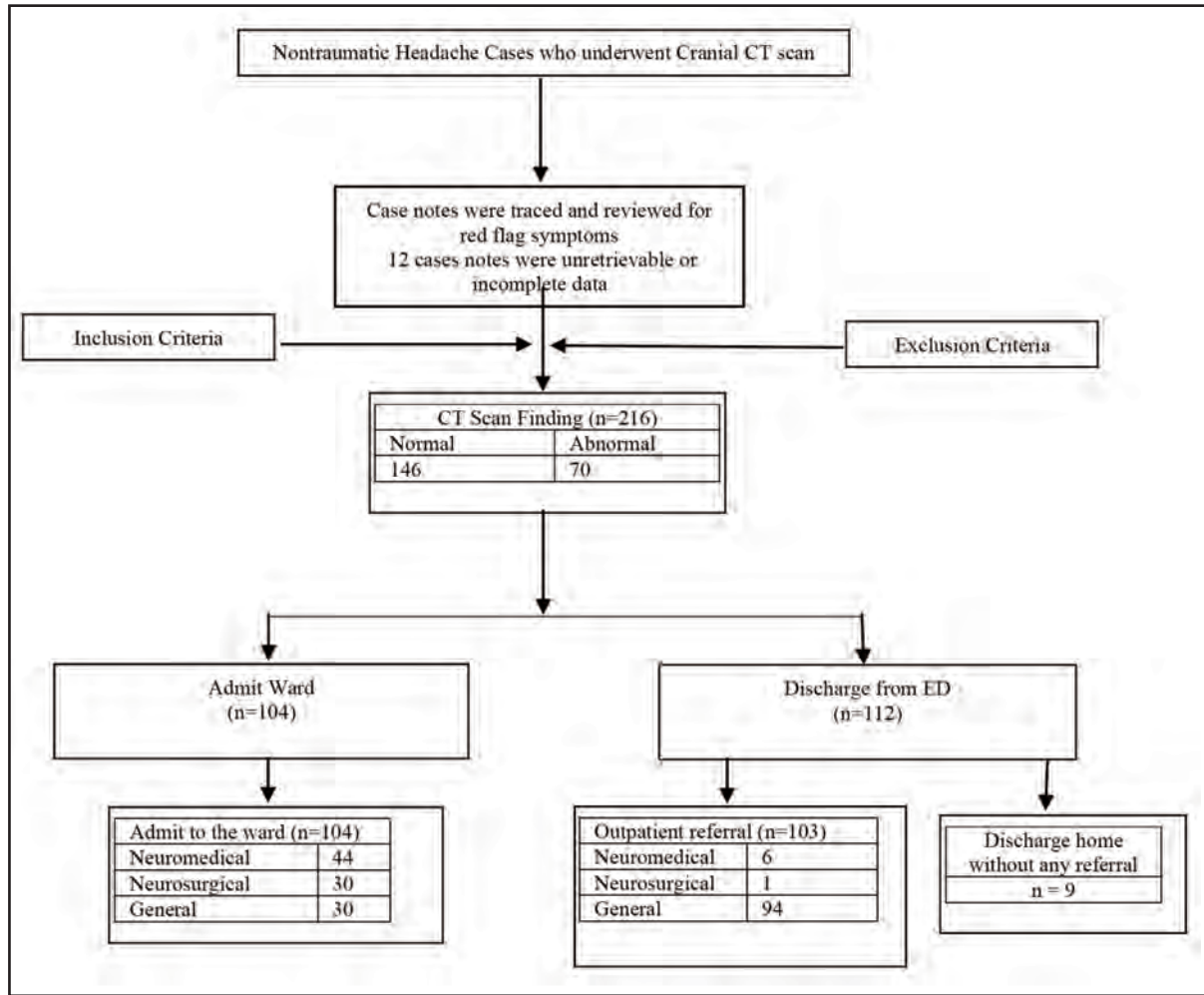


Fig. 1: The flow of the study and number of patients distribution

severe giddiness and persistent vomiting, which accounted for 40.3% and 36.6%, respectively. However, all the patients had more than one red flag symptom.

Table III shows three significant factors associated with abnormal CT scans among nontraumatic headache patients with red flag symptoms. The odds for abnormal CT scans for patients aged 50 years or older who had a new onset of headache were 3.21 times higher than those under 50 years old. The odds for abnormal CT scans for patients with SBP and MAP above 180mmHg and 120mmHg were 4.82 and 6.71 times higher than those with lower readings.

DISCUSSION

There was no sex difference in nontraumatic headache patients with red flag symptoms. This finding is similar to a previous study that found that 55.9% of the nontraumatic headache patients with red flags were female.⁶ On the other hand, data have shown that most headache patients who present to the ED are female. The range is from 64 to 77.8%.^{1,14} This is understandable, as the data covered all nontraumatic headaches, and some patients might not have any red flag symptoms. A community-based study in

Malaysia also showed a higher prevalence of primary headaches, such as migraine and tension headache, in females than in males.¹⁵

Table III shows that a patient who was more than 50 years old and presented with a new onset of nontraumatic headache had a higher risk of abnormal CT scan findings. This finding is comparable with other studies that identified significant predictors based on age group for abnormal CT scans.^{11,14,16} Another study found that patients who were older than 50 years old and complained of the worst headache could have serious underlying intracranial pathology.¹⁷ Another study in Rostock, Germany, showed that the mean age for abnormal findings was 52 years old.¹ Multivariate analysis shows that age greater than 50 years old has an OR of 3.21 of having an abnormal cranial CT scan. Advancing age in headache patients (onset more than 65 years old) has also been shown to increase the risk of abnormal CT scans by 10-fold.⁹

Table III also shows a significant association of high SBP and MAP in a nontraumatic headache patient with at least one red flag symptom. An SBP of more than 180 mmHg and a MAP of more than 120 mmHg had ORs of 4.82 and 6.21,

respectively, for abnormal CT scan findings. The possible explanation for these findings is that there were 50 cerebral vascular accident (CVA) patients (41 patients had ischemic stroke and 9 patients had haemorrhagic stroke) who had abnormal CT scan findings. From a review, headache is a feature in CVA patients, presented in 16-65% of them, and more often involves posterior circulation stroke.⁹

With regard to the red flag symptoms, more than one-third of the patients had sudden onset of severe nontraumatic headache (thunderclap headache). This description of headache is known to be associated with spontaneous subarachnoid haemorrhage (SAH). However, a systematic review and meta-analysis found that only 7.5% of thunderclap headache patients had a final diagnosis of SAH.¹⁸ However, it is unsure whether the history taking was properly done. A better clue for a thunderclap headache is a sudden onset headache, which peaks within 1 minute to 1 hour, is active during the onset and is accompanied by additional symptoms.¹⁰ From this study, only 2 (2.6%) patients had SAH from 78 patients with thunderclap headache. This finding is much lower than that of a multi-centre cohort study in Canadian EDs.¹⁹ An old study in Malaysia also estimated that the annual incidence of SAH in Malaysia was half that in Western countries, which was 3-4 per 100,000 population.²⁰

Cranial CT scan findings showed that most of the patients had normal scans. Only 32.4% of the patients had abnormal cranial CT scan findings. Most of the abnormal findings were infarction, followed by tumours and intracranial bleeding. The lower percentage of abnormal cranial CT scans among red flag symptoms of headache patients is comparable with a previous study performed by Sobri et al., which found that 35.1% of the patients had abnormal CT scan findings.⁶ However, this result is much higher than that in a study from the ED in The Haque, where only 13.2% had abnormal CT scan findings.¹¹ In general, CT scans have a low yield, approximately 2% for abnormal CT scan findings for patients with a sole indication of headache.^{21,22}

Unless we have more evidence, 'SSNOOP' can still be used as a risk stratification tool based on clinical criteria. Any misdiagnosis of secondary headache disorders has severe consequences, leading to disability or even mortality. With the added clinical criteria in SSNOOP10, we hope for better detection and care for headache patients with red flag symptoms, thus avoiding diagnostic pitfalls. However, this may also lead to low specificity and a higher percentage of negative CT scans. Additional criteria based on biomarkers have been investigated, such as copeptin for SAH. Nevertheless, the data are too limited to be included as part of a clinical recommendation.²³

LIMITATIONS

As a retrospective study, some medical records were unretrievable or had incomplete data. In the majority of the cases, the description or nature of the headache, such as the site, character, radiation, exacerbation factors, relieving factors, and association with other symptoms, were

inadequate. In addition, some cases had poor documentation on funduscopic and neurological examinations. However, these limitations are not unknown in the retrospective nature of a study. Somehow, selection bias was unlikely since the individual medical records were collected over a long period. Since there was also no cause-effect relationship, the study design was considered appropriate. A prospective study is required to determine the full spectrum of clinical characteristics in nontraumatic headaches with abnormal CT scans, including each feature from the SSNOOP. Another limitation is that the study was limited to a single tertiary ED in Malaysia.

CONCLUSION

The prevalence of abnormal CT scan findings in nontraumatic headache patients with red flag symptoms is 32%. Primary headache syndrome is the most common diagnosis, and CVA is the most common disease associated with abnormal scans. An age greater than 50 years old during the onset of headache, SBP greater than 180mmHg and MAP greater than 120mmHg have 3.21 times, 4.82 times, and 6.21 times higher risks of abnormal cranial CT scans among nontraumatic headache patients with red flag symptoms.

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AUTHORS' CONTRIBUTION

The conception and design of the work and data acquisition by FAMN and KAB. Analysis and interpretation of data by FAMN, MMM, NY, and ASS. Manuscript writing by FAMN, KAB, and NY. All authors edited and approved the final manuscript.

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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