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Head computed tomography findings in relation to red flag signs among patients presenting with non-traumatic headache in the emergency services

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Abstract

Introduction: Non-traumatic headaches are a common presentation in emergency services. A non-contrast computed tomography (NCCT) scan of the head is done when there is suspicion of intracranial abnormalities. Such intracranial abnormalities are indicated by "red flag" signs. This study aimed to determine the prevalence of intracranial abnormalities in patients with non-traumatic headaches and its association with the red flag signs.

Method: A total of 106 patients presenting with a non-traumatic headache to the emergency services of TUTH from Aug 2019 to Aug 2020, who underwent head CT were included in the study. The association of head CT positivity with the presence of red flag signs was studied by bivariate analysis using the chi-square test or Fisher exact test.

Result: Among 106 patients, 46(43.4%) were male and the rest were female. The mean age of the patient was 43.69±17.46. All the patients who had positive findings in head CT had at least one red flag sign. Out of 16 red flag signs included in this study, 10 signs showed a significant association ($p<0.05$) with head CT positivity. These are sudden onset of headache, age of onset >50 years, significant change in pattern or severity of headache, “worst headache ever”, vomiting, neck stiffness, seizures, altered sensorium, papilledema, and focal neurological deficits.

Conclusion: Red flag signs of headache are helpful to determine whether head CT is needed or not to look for significant intracranial abnormalities in a patient presenting with non-traumatic headache in an emergency.

Keywords: Headache, head NCCT, red flag signs

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Introduction

Headache is localized or diffuse pain in various parts of the head, eventually irradiating to the face or the neck.[1] Headache is one of the most common complaints of patients presenting to the emergency services accounting for 2-3% of all emergency visits.[2,3]Headaches affect people across all ethnic, geographic, and economic levels, with an estimated global prevalence of 50% in adults.[4] Headaches are classified into primary and secondary depending on the presence and absence of an underlying cause respectively.[5]

Recognizing headaches secondary to intracranial pathology is critical not only because such headaches may be life-threatening but also the treatment of the underlying problem usually cures the headache. The initial imaging in patients presenting with non-traumatic headache in the emergency setting is Head CT.[6,7] Head CT may relieve the patient's anxiety about having an underlying pathology[8] but is a costly investigation and poses a radiation hazard.[9] A study showed that a third of projected cancers due to radiation from CT scans were from scans taken in adults between the ages of 35 and 54.[10]

While there are guidelines for performing head CT for headaches in trauma patients, there are no clear guidelines for the same in non-trauma patients. “Red flag signs” help clinicians to indicate headache secondary to significant intracranial abnormalities.[1,11-14] This study was done to show the relation of red flag signs as a clinical predictor for significant intracranial abnormalities in head CT in patients with non-traumatic headaches in emergency services.

Method

This was an observational cross-sectional study done in individuals of different age groups who presented to the emergency department of Tribhuvan University Teaching Hospital with non-traumatic headache and underwent head Non-Contrast CT for diagnosis from Aug 2019 to Aug 2020. This study was done to find the relation of red flag signs as a clinical predictor for significant intracranial abnormalities in head CT in patients with non-traumatic headaches. The decision for ordering head CT in the patients was taken by the treating doctor responsible for the patient in the emergency and the researcher was not involved in this decision making.

Approval of ethical clearance was obtained from the Institutional Review Committee, Institute of Medicine. The individuals were explained about the study by the researcher and were included in the study after receiving the written informed consent. Patients more than 16 y of age presenting to the emergency and undergoing head CT for the evaluation of non-traumatic headache were included. Patients having headaches after head trauma, patients already diagnosed with some known intracranial pathology before presentation, and patients unable to answer the structured questionnaire were excluded.

Individuals meeting the inclusion criteria were interviewed and examined to determine the presence or absence of red flag signs and their head CT finding was noted. This information was recorded in a pre-structured proforma. The proforma was pretested to check its validity and reliability. Non-probability convenience sampling was done.

Data obtained were compiled and analyzed using standard statistical analysis. SPSS statistics software version 21 was utilized for data analysis and presentation. Continuous variables are presented as mean or median depending on the presence or absence of normal distribution respectively and categorical variables are presented as absolute numbers and percentages. Bivariate analysis was done to test the association of individual red flag signs of headache with the presence of significant intracranial abnormalities using the chi-square test or Fisher exact test. A p-value less than 0.05 was considered statistically significant.

Result

A total of 106 participants were included in the study. Regarding the sociodemographic findings, the mean age of the participants was 43.69±17.46 y. The minimum age was 17 y and the maximum age was 98 y. Among the 106 participants, 46(43.4%) were males and 60(56.6%) were females. Age distribution showed, 28 (26.42%) were in the age group of <30 y, 17(16.04%) in the age of 30-39 y, 21 (19.81%) in the age group of 40-49 y, 23(21.70%) were in the age group of 50-59 y and 17(16.4%) were in the age group of ≥60y. Analysis regarding the association of gender with head CT showed a higher percentage of males i.e. 15(32%) of 46 males as compared to 16(26%) of 60 females had positive findings in head CT. However, this difference was not statistically significant (p value=0.5). At least one or more red flag signs of headache were present in 67(63%) participants, Table 1. Thirty-one (29%) of the participants had significant intracranial abnormalities in head CT, Figure 1. Upon evaluation of the frequency of different significant intracranial abnormalities, Subarachnoid hemorrhage (SAH) was the commonest finding present in 16(15%) cases, Figure 2.

Among 16 red flag signs, 10 signs were found to have a positive association with positive head CT findings, Table 2. Red flag signs like Sudden onset of headache, Altered Sensorium, and focal neurological deficit are found to have a high positive predictive value for the diagnosis of secondary nontraumatic headache, Table 3.

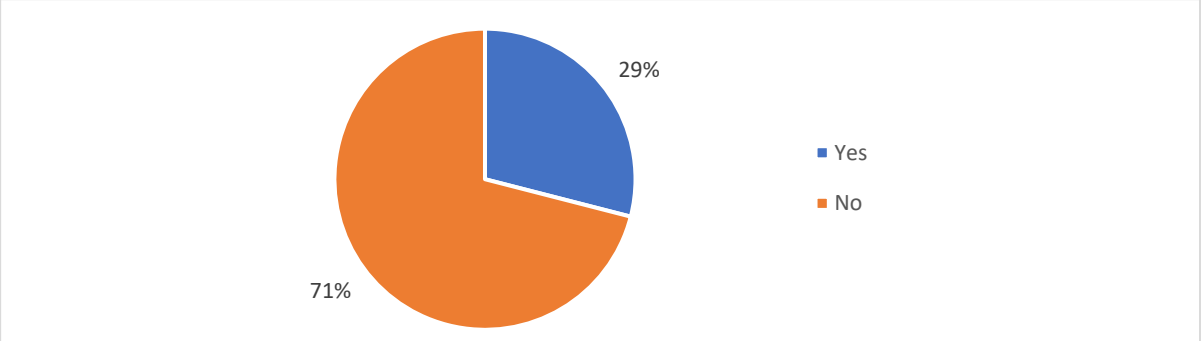

Figure 1. Significant intracranial abnormalities in head CT in patients with headache having red flag sign (N=106)

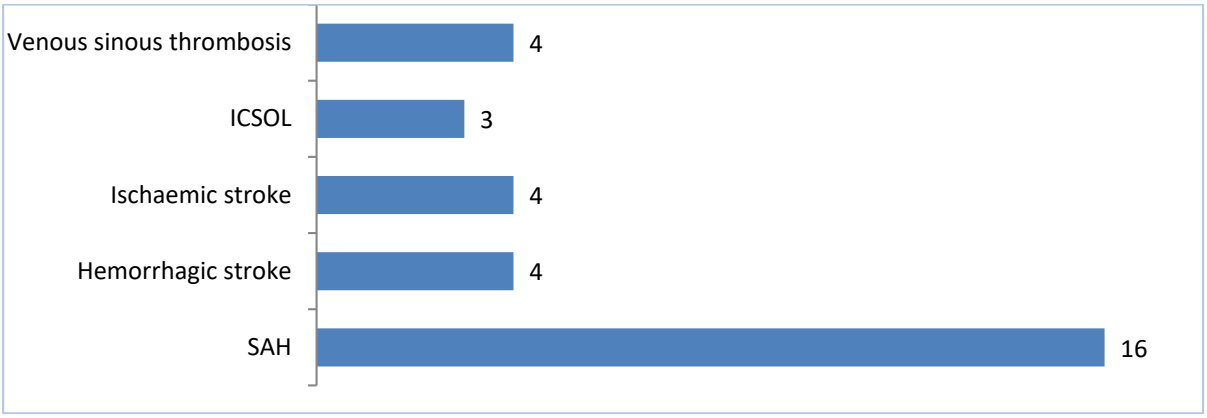

Figure 2. Frequency of different significant intracranial abnormalities in patients with headache having red flag sign (N=106)

Table 1. Association of red flag signs with head CT positivity in patients with headache (N=106)

Variables		Head CT positivity				p-value
		Yes		No		
		N	%	N	%	
Presence of red flag sings	Yes	31	46.27	36	53.73	<0.001*
	No	0	0	39	100	

Table 2. Bivariate association of red flag sign in patients with headache who had head CT positivity (n=106)

Variables		Head CT positivity				p-value
		Yes		No		
		N	%	N	%	
Sudden onset headaches	Yes	22	88	3	12	<0.001*
	No	9	11.11	72	88.89	
Worst headache ever experience	Yes	23	38.98	6	61.02	0.014*
	No	8	17.02	39	82.98	
Onset of headache after age of 50 y	Yes	14	45.16	17	54.84	0.021*
	No	17	22.67	58	77.33	
Significant changes in pattern or severity	Yes	8	40	12	60	0.240
	No	23	26.74	63	73.26	
Fever	Yes	2	13.33	13	86.67	0.221
	No	29	31.87	62	68.13	
Neck stiffness	Yes	11	84.62		15.38	<0.001*
	No	20	21.51	73	78.49	
Rash	Yes	0	0		100	1.000
	No	31	29.81	73	70.19	
Vomiting	Yes	25	54.35	21	45.65	<0.001*
	No	6	10	54	90	
Seizures	Yes	4	100	0	0	0.006*
	No	27	26.47	75	73.53	
Altered sensorium	Yes	10	90.91	1	9.09	<0.001*
	No	21	22.11	74	77.89	
Known case of HIV or Cancer	Yes	0	0	1	100	1.000
	No	31	29.52	74	70.48	
Focal neurological deficit	Yes	14	93.33	1	6.67	<0.001*
	No	17	18.68	74	81.32	
Papilledema	Yes	12	100	0	0	<0.001*
	No	19	20.21	75	79.79	
Worsened by coughing, sneezing, straining, bending	Yes	15	55.56	12	44.44	<0.001*
	No	16	20.25	63	79.75	
Personality changes	Yes	0		2	100	1.000
	No	31	29.81	73	70.19	
Use of thrombolytics or anticoagulants	Yes	1	100	0	0	0.292
	No	30	28.57	75	71.43	

[1]chi-square test or Fisher exact test; *denotes for statically significant at p<0.05

Table 3. Sensitivity, specificity and positive predictive value in patients with headache having red flag sign (N=106)

Variables	Sensitivity (95% CI)	Specificity (95% CI)	PPV (95% CI)
Sudden onset of headache	70.96% (60.52-81.41)	96% (93.1-98.9)	88% (79.67-96.32)
Worst headache ever experience	80.48% (72.55-88.41)	52% (44.60-59.39)	47.82% (40.11-55.53)
Onset of headache after age of 50 y	45.16% (33.70-56.61)	77.33 (71.13-83.52)	45.16% (33.70-56.61)
Past history	19.35% (10.26-28.44)	80% (74.08-85.91)	28.57% (15.93-41.20)
Significant changes in pattern or severity	25.80% (15.73-35.87)	84% (78.75-89.42)	40% (25.96-54.03)
Fever	6.45% (0.7-12)	82.66% (77.06-88.26)	13.33% (1.2-24.58)
Neck stiffness	35.48% (24.47-46.49)	97.33% (94.94-99.71)	84.61% (71.97-97.44)
Vomiting	80.64% (71.55-89.73)	72% (65.35-78.64)	54.34% (44.93-63.76)
Altered sensorium	32.25% (21.49-43.01)	98.66% (96.96-100)	90.90% (79.80-98.76)
Focal neurological deficit	45.16% (33.70-56.61)	98.66% (96.96-99.45)	93.33% (85.07-97.89)
Worsened by coughing, sneezing, straining, bending	48.38% (36.88-59.89)	84% (78.57-89.42)	55.55% (43.3-67.81)

Discussion

Out of 106 patients with non-traumatic headaches who had head CT. Most of the time a detailed history and physical examination are all that are required to differentiate primary and secondary headaches and it is the most important part of the assessment of a patient with headache.[15] When a secondary cause is suspected, ahead NCCT is ordered as urgent intervention is required in such cases. However, in the absence of significant findings in the history and clinical examinations, head CT is usually unnecessary.

Out of 106 patients in this study, 60(57%) were females and 46(43%) were males, i.e. a female preponderance was seen. This is similar to a study[16] done on patients with non-traumatic headaches presenting to the emergency in which 190(77.8%) were female. The higher percentage of females presenting with non-traumatic headaches may be because females tend to be more sensitive to their symptoms and seek consultation more often than men do. However, head CT positivity was higher among males i.e. 15 out of 46(32%) than in females i.e. 16 out of 44(26%) in our study. This is in concordance with a study in which the percentage of positive neuroimaging outcomes was higher among males than in females.[12] However, there was no statistically significant association between the gender of the patient and positive head CT findings.

In this study, the mean age of patients was 43.69±17.46 y ranging from 17 y to 98 y. Age of onset of headache more than 50 had a significant association with head CT positivity ($p<0.021$). A similar result was seen in a study done in Minnesota, the USA in which age of onset more than 55 was found to be significantly associated with positive neuroimaging findings.[17] The similar findings from two different geographical locations signify that geography and lifestyle do not affect the occurrence of head CT positivity.

In our study, 31(29%) cases with non-traumatic headaches presenting to emergency services had significant intracranial abnormalities in head CT. In a study done in Chitwan Medical

College, Nepal, on patients with headache referred from out-patient and emergency to radiology for head CT, 26(10.1%) patients with headache showed some form of brain parenchymal pathology in head CT. [18] Higher positivity in head CT is seen in our study, probably because our study only included patients presenting with headache in the emergency services.

In our study, 67(63%) patients had one or more red flag signs of headache and the remaining did not have any red flag signs. Among those who had red flag signs, 31 cases were found to have positive findings in head CT. Among those who had no red flag signs, none of the cases had positive findings in head CT. Though not all patients with red flag signs had a positive head CT, all cases that had a positive head CT had at least one red flag sign. The presence of at least one red flag sign was found to have a significant association with head CT positivity ($p < 0.01$). This finding is in concordance with a study done in California[19] in which all of the patients with significant head CT findings had an abnormal physical or neurologic exam or unusual clinical symptoms. Similarly, in a study done in Cameroon, Central Africa, abnormal results in the neurological examination were found to be the best clinical predictors of structural intracranial pathology in head CT in an adult patient experiencing headache disorder.[20] It was concluded that routine computed tomography of the brain in headache patients with normal physical and neurologic exams and no unusual clinical symptoms has a low likelihood ratio for discovering significant intracranial disease.

Among the 16 red flag signs, 10 signs had a statistically significant association with positive findings on head CT on bivariate analysis. They were sudden onset of headache, worst headache ever, the onset of headache after the age of 50 y, neck stiffness, vomiting, seizures, altered sensorium, presence of focal neurological deficits, papilledema, and worsening of headache with coughing, straining, sneezing, bending. However, a multivariate analysis couldn't be done because of the small sample size of our study. In the study done in Malaysia[12,] the presence of 3 red flag signs proved to be statistically significant with the p-value of less than 0.05% on both univariate and multivariate analysis. These were paralysis, papilledema, and altered sensorium. However other red flags when individually analyzed were not found to be clinically significant. This difference in results could be because in our study only bivariate analysis was done. Similarly, a retrospective chart review study conducted from 2013 to 2018 in Thailand in acute non-traumatic headache patients who visited the emergency department concluded that abrupt onset, awakening pain, duration of headache >1 week, fever, worst headache ever, alteration of consciousness, and localizing neurological deficit were the significant predictive factors for the serious intracranial cause of acute nontraumatic headache.[21] However, in our study we haven't studied the duration of headache, and pain awakening from sleep was not included as a red flag sign.

Red flag signs like 'known case of HIV/Cancer with a headache', 'patient under thrombolytic or anticoagulant', 'headache associated with rash', 'headache associated with personality change' had a very low prevalence in our study population. So even though they were found to be statistically insignificant in our study, their presence in a patient with a non-traumatic headache needs to be taken seriously. Significant intracranial abnormalities which may not be evident in the head CT may have been missed.

Conclusion

Patients presenting with non-traumatic headaches in the emergency services may have one or more red flag signs of headache which can be identified by a proper history and physical examination. Patients who do not have any of the red flag signs of headache usually do not require NC Head CT to rule out significant intracranial abnormalities.

Ten red flag signs had a statistically significant association with positive findings on head CT

on bivariate analysis. They were sudden onset of headache, worst headache ever, the onset of headache after the age of 50 y, neck stiffness, vomiting, seizures, altered sensorium, presence of focal neurological deficits, papilledema, and worsening of headache with coughing, straining, sneezing, bending.

Conflict of Interest

None

Funding

None

Author Contribution

Concept, design, planning: IG, YLS; Literature review: IG, BS, SG; Data collection: IG, SG; Data analysis: YLS, RPN, SK; Draft manuscript: IG, SG; Revision of draft: YLS, RPN, SK; Final manuscript: IG, BS; Accountability of the work: IG, YLS, RPN, BS, SG, SK.

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