

## Original Research Article

# THE UTILITY OF COMPUTED TOMOGRAPHY OF THE BRAIN IN ADOLESCENT CHILDREN WITH HEADACHES

Durga Mahita Boppana<sup>1</sup>, Raghu Teja Sadineni<sup>2</sup>

<sup>1</sup>Assistant Professor, Department of Paediatrics, Nimra Institute of Medical Sciences, Jupudi(V), Ibrahimpatnam (M), Andhra Pradesh, India.

<sup>2</sup>Assistant Professor, Department of Radiology, Nimra Institute of Medical Sciences, Jupudi(V), Ibrahimpatnam (M), Andhra Pradesh, India

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**Corresponding Author:**

**Dr. Raghu Teja Sadineni,**  
Assistant professor, Department of  
Radiology, Nimra Institute of medical  
sciences, Jupudi(V), Ibrahimpatnam  
(M), Andhra Pradesh, India  
Email: sadineniraghu@gmail.com

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**ABSTRACT**

**Background:** Headache is one of the most common ailments in humans, with diverse origins and symptoms. Primary headache syndromes—including migraine, tension-type, and cluster headaches—are far more common than secondary headaches caused by underlying pathology (e.g., tumors). In primary care, most patients presenting with headaches have no serious underlying condition. Consequently, the routine use of neuroimaging, such as computed tomography (CT), to rule out underlying causes is often questioned. The aim is to evaluate the efficacy of CT in identifying causal factors for headache. To determine whether imaging of the paranasal sinuses (PNS) following a brain CT provides additional diagnostic benefit.

**Materials and Methods:** Nimra Hospital, Jupudi, Vijayawada, Andhra Pradesh.

**Results:** The study included 75 patients (38 females, 37 males), aged 12–18 years. The most common indications for CT were isolated headache and headache with vomiting. Pathological findings were observed in 17 patients: 13 had intracranial pathology and 4 had PNS disease. Among these, there were 6 space-occupying lesions (SOLs), 2 acute ischemic strokes (AIS), 1 subarachnoid hemorrhage (SAH), 4 cases of cortical vein thrombosis, and 4 cases of sinusitis. The diagnostic yield for primary headache was low, with a positive likelihood ratio of less than 1.

**Conclusion:** Adding PNS imaging to brain CT can help differentiate intracranial from paranasal sinus causes of headache, though routine imaging for primary headache remains of limited diagnostic value.

**Keywords:** Head-ache, computed tomography, tumors, tension-type, migraine, paranasal sinus.

## INTRODUCTION

Headache is one of the most common conditions experienced by humans. Approximately 90% of people experience a headache at least once a year, and up to 40% report severe headaches annually. Headaches account for about 4% of all hospital visits and are estimated to cost the United States \$150 million in lost workdays per year. Patients typically seek medical attention for headaches due to the intensity of pain or anxiety about potential serious causes, such as brain tumors or aneurysms.<sup>[1-5]</sup>

Headaches can arise from a wide variety of causes. Primary headache disorders—including migraine, cluster, and tension-type headaches—are much more common than secondary headaches, which are caused

by underlying pathology such as tumors, aneurysms, or infections. The majority of patients presenting with headaches in primary care settings do not have serious underlying disease. Consequently, the routine use of neuroimaging, such as computed tomography (CT), to exclude secondary causes of headaches has been increasingly questioned.<sup>[6,7]</sup>

The primary purpose of neuroimaging is to identify significant, treatable intracranial pathologies that may impair a patient's quality of life. However, imaging can also provide reassurance to patients and their families by ruling out serious conditions. Patient or family requests for imaging are additional reasons for performing these studies. In practice, very few patients are referred for cranial CT solely due to headache severity; most are referred to rule out

intracranial or paranasal sinus (PNS) pathologies, including meningitis, space-occupying lesions, or sinus disease.<sup>[8,9]</sup>

With the increasing availability of CT scans, these investigations are now commonly used to rule out significant neurological diseases in patients presenting with headache. Assessing both the efficacy of CT brain scans and the additional value of PNS imaging can help optimize diagnostic strategies and patient care.

#### Objectives:

1. To determine the effectiveness of CT brain scans in identifying underlying causes of headaches.
2. To evaluate the additional benefit of obtaining limited PNS images after brain imaging in patients with headaches.

## MATERIALS AND METHODS

**Study Design:** Cross-sectional, hospital-based prospective study

**Study Setting:** Department of Paediatrics and Department of Radiodiagnosis, Nimra Hospital, Jupudi, Andhra Pradesh

**Study Duration:** 18 months

**Study Population:** This study was conducted on 75 adolescent patients presenting with complaints of headache.

#### Inclusion Criteria:

- All male and female patients aged <12 years
- Patients with acute or chronic headache, with or without other neurological signs or symptoms

#### Exclusion Criteria:

1. Headache due to ophthalmic causes
2. Headache with immediate history of trauma
3. Known cases of brain tumors or space-occupying lesions (SOL)
4. Pregnant women with headache

#### Procedure:

- Patients were positioned supine for CT scans of the brain and limited PNS.
- The scan plane was parallel to the orbito-meatal plane, angled 10–25° to Reid's line.
- For restricted PNS imaging, the plane of the segment was oriented along Reid's line.
- Serial sections were obtained:
  - 4 mm cuts for supratentorial brain
  - 2.5 mm cuts for the posterior fossa
  - 5 mm cuts for paranasal sinuses (PNS)
- Intravenous iodinated contrast (mean volume: 25 mL) was administered for contrast-enhanced brain imaging when indicated.

#### Data Collection:

- A detailed clinical history was taken, including:

- Frequency, severity, onset, and progression of headache
- Associated symptoms: nausea, vomiting, photophobia, visual disturbances, red eyes, neurological deficits, rhinorrhea, and fever
- Known systemic diseases, including hypertension and extra-CNS malignancies
- Findings from CT brain and limited PNS imaging were documented in a tabular format.

#### Statistical Analysis:

- Imaging findings were analyzed for patients with:
  - Isolated headaches
  - Headaches with associated symptoms (e.g., nausea, vomiting, vision problems)
  - Headaches without associated symptoms
- Diagnostic accuracy of imaging was evaluated in patients with migraine, tension-type headache, persistent daily headache, and those with established systemic diseases.

## RESULTS

There was no notable difference between sexes in the detection of pathologies. Headache alone was the most common reason for referral to neuroimaging, even when other symptoms were present. The diagnostic yield of imaging was low in patients presenting with isolated headache.

A substantial proportion of headaches were attributable to both paranasal sinus (PNS) and intracranial causes, highlighting that the additional acquisition of limited PNS imaging alongside brain CT increases diagnostic yield, reduces costs, and supports better patient management. Patients presenting with sudden, severe headaches accompanied by symptoms such as nausea, blurred vision, fever, or rhinorrhea were more likely to have detectable pathology on imaging. Similarly, the presence of systemic illness, such as known malignancy with abrupt-onset headache, increased the likelihood of positive findings.

Conversely, patients with isolated headache, headache with mild nausea, or primary headache types such as tension-type or chronic daily headaches had a low probability of abnormal imaging. In patients with migraine, sudden changes in headache character or severity, especially when coupled with neurological symptoms, warranted imaging due to a higher likelihood of underlying pathology.

Overall, CT imaging serves not only to detect structural abnormalities but also to exclude serious causes of headache, providing reassurance to patients and reducing anxiety.

**Table 1: Dispersion of ages between those with and those without an imaging pathology.**

| Pathology on CT | 12 years<br>n (%) | 13 years<br>n (%) | 14 years<br>n (%) | 15 years<br>n (%) | 16 years<br>n (%) | 17 years<br>n (%) | 18 years<br>n (%) | Total<br>n (%) |
|-----------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|----------------|
| Present         | 5(6.66)           | 12(16)            | 7(9.33)           | 5(6.66)           | 4(5.33)           | 4(5.33)           | 1(1.33)           | 38(50.65)      |
| Absent          | 6(8)              | 10(13.3)          | 12(16)            | 3(4)              | 3(4)              | 2(2.67)           | 1(1.33)           | 37(49.35)      |
| Total           | 11(75)            | 22(75)            | 19(75)            | 8(75)             | 7(75)             | 6(75)             | 2(75)             | 75(100)        |

**Table 2: Statistical analysis of the prevalence of imaging pathologies by gender.**

| Pathology on CT | Males     | Females   | Total     |
|-----------------|-----------|-----------|-----------|
|                 | n (%)     | n (%)     | n (%)     |
| Present         | 18(24)    | 20(26.6)  | 38(50.65) |
| Absent          | 19 (25.3) | 18(24)    | 37(49.35) |
| Total           | 37(49.35) | 38(50.65) | 75(100.0) |

**Table 3: Distribution of the length of time a head-ache lasts, depending on whether imaging was abnormal or not.**

| Pathology on CT | <1months n(%) | 1-3months n(%) | Months n(%) | >6months n(%) | Total n(%) |
|-----------------|---------------|----------------|-------------|---------------|------------|
| Present         | 12(16)        | 7(9.3)         | 9(12)       | 10(13.3)      | 38(50.65)  |
| Absent          | 11(14.6)      | 7(9.3)         | 8(10.6)     | 11(14.6)      | 37(49.35)  |
| Total           | 23(75)        | 14(75)         | 17(75)      | 21(75)        | 75(75)     |

**Table 4: The prevalence of different types of head-aches, both with & without pathologies on imaging.**

| Pathology on imaging | Diffuse | Focal   | Total     |
|----------------------|---------|---------|-----------|
|                      | n (%)   | n (%)   | n (%)     |
| Present              | 30(40)  | 8(10.6) | 38(50.65) |
| Absent               | 30(40)  | 7(9.3)  | 37(49.35) |
| Total                | 60(80)  | 12(20)  | 75(100)   |

**Table 5: Visual impairment & its distribution in relation to imaging pathologies.**

| CT pathology | Yes       | No        | Total     |
|--------------|-----------|-----------|-----------|
|              | n(%)      | n(%)      | n(%)      |
| Present      | 4(5.3)    | 10(13.3)  | 14(18.66) |
| Absent       | 10(13.3)  | 51(67.99) | 61(81.33) |
| Total        | 14(18.66) | 61(81.33) | 75(100)   |

**Table 6: The prevalence of nausea & vomiting in relation imaging with or without pathologies.**

| CT pathology | Nausea   | Vomiting | Nausea/ vomiting | Total     |
|--------------|----------|----------|------------------|-----------|
|              | n(%)     | n(%)     | n(%)             | n(%)      |
| Present      | 2(2.66)  | 10(13.3) | 2(2.66)          | 14(18.66) |
| Absent       | 15(20)   | 12(16)   | 34(45.33)        | 61(81.33) |
| Total        | 17(22.6) | 22(29.3) | 36(48)           | 75(100)   |

**Table 7: Dispersion of Fever with or without Imaging pathologies.**

| CT pathology | Fever  | No fever | Total    |
|--------------|--------|----------|----------|
|              | n(%)   | n(%)     | n(%)     |
| Present      | 3(4)   | 9 (12)   | 12(11)   |
| Absent       | 6(8)   | 57(75.8) | 63(89)   |
| Total        | 9 (12) | 66(87.8) | 75 (100) |

**Table 8: Distribution of imaging anomalies in terms of frequency of occurrence.**

| Pathology detected on CT | Frequency(75) | Percent(%) |
|--------------------------|---------------|------------|
| Infarct                  | 2(75)         | 2.66       |
| Cortical vein thrombosis | 4(75)         | 5.32       |
| SAH                      | 1(75)         | 1.33       |
| SOL                      | 6(75)         | 8          |
| Sinusitis                | 4(75)         | 5.32       |
| Total pathology          | 17(75)        | 22.66      |
| Normal CT study          | 58(75)        | 77.3       |
| Total                    | 75(75)        | 100        |

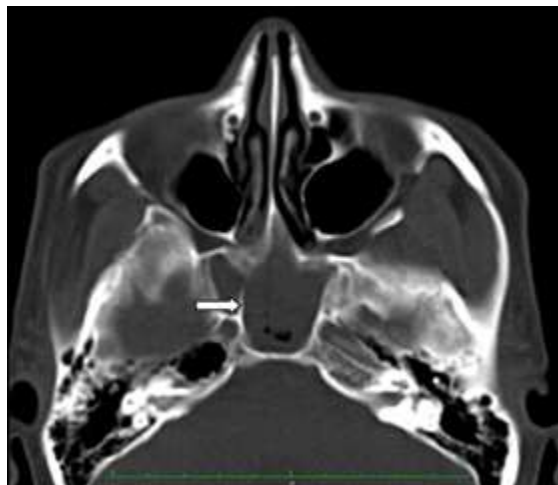
**Table 9: Prevalence of Head-ache Diagnosis in Clinical Practice.**

| Clinical diagnosis      | Frequency | Percent |
|-------------------------|-----------|---------|
| Tension Head-ache       | 6         | 8       |
| Chronic daily Head-ache | 16        | 21.33   |
| Migraine                | 6         | 8       |
| Sinusitis               | 8         | 10.66   |
| Meningitis              | 2         | 2.66    |
| others                  | 37        | 49.33   |
| Total                   | 75        | 100.0   |

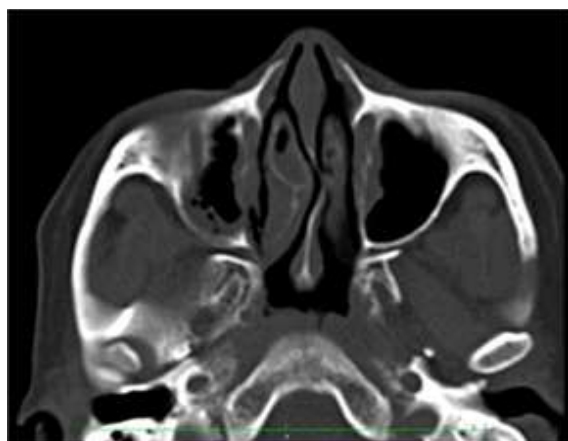
**Table 10: Imaging pathology detection likelihood ratio.**

| Symptom                 | Likelihood ratio+ | Likelihood ratio- |
|-------------------------|-------------------|-------------------|
| Only head-ache          | 0.19              | 1.22              |
| Head-ache with nausea   | 0.714             | 1.02              |
| Head-ache with vomiting | 5.17              | 0.74              |
| Head-ache with fever    | 3.3               | 0.75              |

|                                   |      |      |
|-----------------------------------|------|------|
| Head-ache with blurring of vision | 2.3  | 0.85 |
| Head-ache with running nose       | 5.37 | 0.55 |
| Severe head-ache                  | 6.2  | 0.54 |
| Abrupt onset                      | 4.4  | 0.68 |
| Systemic illness                  | 2.5  | 0.84 |
| Migraine                          | 0.81 | 1.02 |
| TTH                               | 0    | 1.12 |
| CDH                               | 0.2  | 1.1  |



**Figure 1:** 12 years male patient who suffers from recurrent head- aches and has been diagnosed with bilateral sphenoid sinusitis.



**Figure 2:** 17 years Male patient presenting with persistent, widespread head- ache and a nasal septum that is deviated to the left.

## DISCUSSION

Before including patients in the study, a comprehensive clinical history was obtained, including details on headache characteristics (onset, duration, and nature) and associated symptoms such as nausea, vomiting, blurred vision, photophobia, fever, rhinorrhea, neurological deficits, or systemic illnesses. Patients with pre-existing ophthalmic causes of headache were excluded.

After contrast-enhanced CT (CECT) scans, several significant diagnoses were identified: one patient had meningitis, two patients had metastases, and others were diagnosed with cerebral vein thrombosis (CVT). Patients' ages ranged from 12 to 18 years. Imaging findings were lowest among the youngest

patients, consistent with prior studies indicating that advancing age correlates with more severe anomalies.

Females slightly outnumbered males in the study population. Among the total cohort, 22 patients (11%) demonstrated abnormalities on imaging potentially related to their symptoms. Ancillary findings not directly attributable to the presenting complaint were observed in six patients, including diffuse cerebral atrophy (n=2), calcific granulomas (n=2), and chronic lacunar infarcts (n=2). Significant pathologies were found in approximately 10 female patients (9.3%) and 12 male patients (12.9%), with no sex-based difference in the ability of imaging to identify the cause of headache.

Headache duration ranged from 9 days to 98 months, with 35.5% of patients experiencing headaches lasting more than six months. Patients with headaches lasting less than one month had the highest proportion of pathologies on imaging (15/51), while those with headaches of less than six months had the fewest. These findings align with previous research suggesting that recent-onset headaches may be associated with severe anomalies.

Among the 22 patients with imaging abnormalities:

- Six patients (3%) had space-occupying lesions (SOLs)
- Two (1%) had acute ischemic strokes (AISs)
- One (0.5%) had subarachnoid hemorrhage (SAH)
- Four (2%) had cortical vein thrombosis (CVT)
- Nine (4.5%) had sinusitis (including pansinusitis)

Neuroimaging was performed in 60.5% of patients with headache but no associated neurological symptoms, followed by 22% with headache and vomiting, consistent with previous studies on CT indications and outcomes in primary care. Among patients with headache and nausea, pathologies were detected in only two cases (both sinusitis), reflecting a low positive likelihood ratio (0.71), similar to prior research.

Among 44 patients with headache and vomiting, imaging revealed pathologies in 13, including six SOLs, two acute-onset AISs, one SAH, and four CVTs. The positive predictive ratio (PPR) for vomiting was 5.17, indicating a higher likelihood of detecting pathology. Severe headaches, reported in 14 patients, were associated with an odds ratio of 6.2 for significant findings on imaging.

All four CVT cases presented with sudden severe headaches, three with vomiting, and one with visual disturbances. Diagnoses included transverse sinus thrombosis and combined transverse & straight sinus thrombosis. No parenchymal abnormalities were observed.

Among the 22 patients with imaging abnormalities, 13 had intracranial pathologies causing headache, while nine had sinusitis. Sinusitis cases included bilateral maxillary sinusitis, bilateral maxillary and ethmoid sinusitis, bilateral sphenoid sinusitis, fronto-ethmoid sinusitis, right frontal sinusitis, and pansinusitis. Sphenoid sinusitis often presents with recurrent headaches but lacks classical sinus symptoms, making imaging critical for diagnosis.

The study demonstrated that adding limited PNS imaging to CT brain increases diagnostic yield by 11 percentage points (from 13% to 22%). Incidental findings such as polyps and retention cysts were detected, most commonly in the maxillary sinus.

Anxiety regarding potential brain pathology was a common concern among patients. CT imaging provided reassurance by excluding organic causes of headache. Compared to MRI, CT remains the preferred initial screening modality due to wider availability, lower cost, and faster acquisition. Limitations of CT include reduced sensitivity for sellar/parasellar and posterior fossa pathologies, as well as radiation exposure.

In summary, CT brain combined with limited PNS imaging enhances the detection of headache-related pathologies, distinguishes intracranial from sinus causes, and provides diagnostic and psychological benefits while remaining a practical first-line investigation.

## CONCLUSION

CT brain imaging is an effective screening tool for evaluating patients with headaches, allowing for the identification or exclusion of structural pathologies.

The addition of limited paranasal sinus (PNS) imaging increases diagnostic yield, reduces the need for separate PNS scans, and helps differentiate headaches of intracranial origin from those arising in the PNS. Patients presenting with severe or sudden-onset headaches, or those accompanied by symptoms such as vomiting, fever, rhinorrhea, or neurological deficits, are more likely to benefit from CT imaging.

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