Nigerian Medical Journal
NIGERIA MEDICAL ASSOCIATION
Print ISSN 0300-1652, E-ISSN 2229-774X

Original Research

Neuroimaging Findings in Pediatric Chronic Headaches: Is Imaging Always Necessary?

***Ukamaka Dorothy Itanyi[1], Joshua Oluwafemi Aiyekomogbon[1]**

[1]Department of Radiology, University of Abuja Teaching Hospital, Gwagwalada, FCT, Nigeria

Abstract

Background: Considering the high cost of Magnetic Resonance Imaging and the high risk of radiation exposure to growing children from Computed tomography scans, we aim to evaluate the neuroimaging findings in children with chronic headaches, determine the frequency of significant remediable pathologies, and establish the need for neuroimaging.

Methodology: This is a cross-sectional study of clinical data and neuroimaging findings in 41 children who were imaged in a tertiary hospital and a private diagnostic center in Abuja on account of chronic headaches. Twenty-two children were referred for brain Computed Tomography scan while 19 had brain Magnetic resonance Imaging. Collected data was statistically analyzed using SAS software version 9.3 with the level of significance set at 0.05.

Results: The age range of patients was 4 -18years.Thirty-three patients (80.5%) had chronic primary headaches while eight (19.5%) patients had additional "red flag" indications. Normal findings and extracranial lesions accounted for 89.5% of MRI (17/19) and 72.7% (16/22) in CT. Intracranial lesions were seen in 75% of patients with "red flag" and 6.1% of patients with primary headache with significant differences (p=0.0001) between the subsets. The commonest abnormalities were chronic sinusitis (17.1%) and intracranial tumors (9.6%) with no significant difference in the overall neuroimaging findings across the age groups. Chronic sinusitis was found predominantly in adolescent females (85.7%).

Conclusions: Neuroimaging has a low yield of significant remediable intracranial lesions in children with chronic headaches without additional "red flag" symptoms thereby necessitating the call to reconsider the use of neuroimaging with a view to imaging gently.

Keywords: CT, MRI, Pediatric, Chronic Headaches

***Correspondence:** Ukamaka Dorothy Itanyi, Department of Radiology, University of Abuja Teaching Hospital, Gwagwalada, FCT, Nigeria
Email: amakaitanyi1995@gmail.com

How to Cite: Itanyi UD, Aiyekomogbon JO. Neuroimaging Findings in Pediatric Chronic Headaches: Is Imaging Always Necessary? Niger Med Journal; 2023 64(6):773 - 779

Quick Response Code:

Introduction

Headache is a common symptomology of childhood with increasing prevalence with age.[1,2]A Nigerian study showed the overall prevalence of headaches in Nigerian adolescents to be 19.5%.[3]Primary headaches, such as migraine or tension headaches that are typically chronic or recurrent, are the predominant type of headache in children.[4]Secondary or organic headaches require prompt diagnosis which includes detailed physical examination, neuroimaging, and possible intervention. Routine investigation of all cases of headache is however not recommended. It is recommended that certain "red flags" signs and symptoms should be used in determining which patients should undergo neuroimaging.[5]These include sudden onset of headache, increased frequency, severity, or significant change in the usual headache pattern, new onset with an underlying medical condition (such as cancer or immune depression), concomitant signs of systemic illness (such as fever, neck stiffness, vomiting rash), focal neurologic signs or symptoms, papilledema, and head trauma.[5]

It has been documented that neuroimaging has a limited role in children with primary headaches and that in the vast majority of patients with chronic headaches, CT may be normal since most of the children do not have any serious or treatable underlying medical cause of the headache.[6]Despite these findings and recommendations, the management of pediatric chronic headaches remains a challenge and major concern for the physician since potential etiologies of headache may be life-threatening while significant intracranial pathology can cause nothing more than a mild headache.[7]

In clinical practice, indications for brain scans include suspicion of a structural abnormality by the managing or referring physician and efforts to reassure a worried patient or relatives. The lack of proper clinical evaluation due to the dearth of Neurophysicians in our environment is a further reason for radiologic investigations. Neuroimaging ends up being used as a means of classifying headaches and assuring patients with chronic headaches of the absence of potentially life-threatening underlying pathologies.[8]

Computed tomography (CT) scan and Magnetic resonance imaging (MRI) are the most common imaging modalities used for the evaluation of chronic headaches. Because of its non-ionizing property, multiplanar capabilities, and good spatial resolution, MRI is often used as the imaging modality of choice in children. The exorbitant cost, non-availability, and long duration of image acquisition requiring sedation are disadvantages to its use.

CT on the other hand is faster, available, and relatively cheaper and may not usually require patient sedation. Although CT allows rapid acquisition of high-resolution three-dimensional images, providing cross-sectional images of the brain, it poses a risk of radiation exposure with effective doses of 2-4mSv for a typical head CT. [9] Children, especially those younger than 2 years of age, are considerably more sensitive to radiation than adults due to rapidly dividing cells associated with growth. Exposure in childhood increases the risk of expression of radiation damage during a lifetime with a single-head CT exposing children to 200 to 600 times as much radiation as typical posteroanterior and lateral chest radiographs.[10]

The cost of neuroimaging in Abuja, Nigeria ranges from $27 for two projections of a skull radiograph, to $118 for a cranial CT scan, and $210 for a cranial MRI making it unaffordable for most patients. It therefore becomes necessary to determine how useful neuroimaging is in the management of these children.

There is a paucity of data in our locality on the use of neuroimaging in identifying treatable lesions in children with chronic headaches. We therefore aim to evaluate the CT and MRI findings in children with

chronic headaches, determine the frequency of significant pathologies, and establish the need for neuroimaging.

Methodology

Out of 98 pediatric patients with chronic headaches, a cross-sectional evaluation of clinical records and imaging findings of 41eligible children was done over3 years (2016-2018) and approved by the Institution's human research ethical committee (UATH/HREC/PR/2020/013/008). Twenty-two patients had Brain CT scans at a tertiary health institution while 19 had brain MRIs in a private diagnostic center in Abuja. Clinically they were grouped into 2: patients with only chronic headaches and patients with additional "red flag" indications. Excluded from the study were patients with incomplete data, previous surgery, and known intracranial malignancies.

CT studies were performed with a Hispeed Toshiba 16-slice CT scanner. The study subjects were scanned supine from the skull base to the vertex with contiguous axial slices parallel to the inferior orbitomeatal line using 3- 5 mm slice thickness at intervals of 3 mm. A few of the younger patients were sedated with 2.5 of diazepam as necessary. Intravenous contrast material was administered to all patients.

MRI was done with a 0.3T Toshiba MRI machine (Toshiba Medical Systems, USA, Inc). Multiplanar brain images were obtained on various sequences which included- T1-weighted (T1W; TE- 20ms, TR- 240ms), Gadolinium diethylenetriaminepentacetate (Gd-DTPA) - enhanced T1W (TE- 20ms, TR- 240ms), T2-weighted (T2W; TE- 120ms, TR- 3800ms), Fluid-attenuated Inverse Recovery (FLAIR; TE- 100ms, TR- 6600ms) and Magnetic Resonance Angiography (MRA 5-7mm-thick slices with a field of view (FOV) of 240mm were utilized as requested by the Radiologist.

Records of the clinical notes, images stored in the Picture archiving system (PACS), and written reports were reviewed, and data was entered into Microsoft Excel and analyzed using SAS software version 9.3 with the level of significance set at 0.05.

Results:

The age range of patients that had cranial CT was 5 -18years, (mean 11.7years, SD 4.6), male to a female ratio of 1.2:1, while MRI ranged from 4 -18years, (mean of 13.32years, SD 4.1), male to female ratio was 1:3.8. Majority (80%) of the females were adolescents >10years while 50% of males were < 10years.

Eight (19.5%) of the patients had additional "red flag" indications which comprised: RTA in 2 patients and 6 patients with neurologic symptoms which included vomiting, unsteady gait, and concomitant fever, while the rest (80.5%) presented with only chronic headache.

Normal brain parenchyma and extracranial lesions accounted for 89.5% of MRI and 72.7% of CT. Intracranial lesions accounted for 10.5% and 27.3% of the MRI and CT findings respectively (Tables 1, 2).

Table 1: MRI findings of Paediatric chronic headaches

	GENDER		
Findings	**Males (%)**	**Females (%)**	**Total**
Normal	4(30.8)	9(60.2)	13(68.4)
Chronic sinusitis	0	4(13.3)	4(21.5)
Intracranial Tumor	0	1(6.7)	1(5.3)
V-P shunt obstruction	0	1(6.7)	1(5.3)
			19(100)

Table 2: CT findings of Paediatric chronic headaches

	GENDER		
Findings	**Male (%)**	**Females (%)**	**Total(%)**
Normal	6(50)	6(50)	13(59.1)
Intracranial tumors	3(8.3)	0(0)	3(13.6)
Chronic sinusitis	1(8.3)	2(0)	3(13.6)
Arachnoid cyst	1(8.3)	0(0)	1(4.5)
Cerebral atrophy	1(8.3)	0(0)	1(4.5)
Subdural abscess	0(0)	1(4.5)	1(4.5)
			22(100)

Of the 8 patients classified with “red flag” indications, 6(75%) had intracranial lesions while 2(25%) had extracranial lesions. Only 2(6.1%) of the 33patients who presented with primary headaches had intracranial lesions which included mild generalized cerebral atrophy and non-obstructive arachnoid cyst. There was a positive correlation (p=0.0001) between the additional red flags and neuroimaging findings.

The most common neuroimaging abnormalities were chronic sinusitis (17.1%) and intracranial tumors (9.6%).

Abnormal findings were significantly higher in males on CT but were found in only females on MR. There was no significant difference in the overall neuroimaging findings across the age groups, but chronic sinusitis was found predominantly in adolescent females (85.7%)

Discussion

The main reason for neuroimaging in patients with headaches is the diagnosis of curable lesions, which can increase the patient's longevity or improve the quality of life.[11]

Most (63.4%) of the neuroimaging findings in the index study were normal. This shows similarity with other studies conducted in different parts of the world. A Turkish study of 407 children imaged with MRI showed,68.6% were normal with only 5(16.9%) having a significant treatable abnormality.[12] This corresponds with our study which showed 13(36.6%) abnormal cases with only 6(14.6%) significant lesions that needed urgent treatment. These included4 intracranial tumors, 1 obstructed VP shunt, and 1 subdural abscess. They noted a significantly higher percentage of abnormal findings using CT and MRI in males. Our study on the contrary recorded significantly higher abnormalities in females on MRI and males on CT. The majority (85.7%) of the patients with findings of chronic sinusitis were adolescent females. This is consistent with epidemiological studies that reported that the rate of chronic rhinosinusitis among women is almost double that of men.[13]

An Iranian study done in a larger cohort of children with chronic headaches showed that 88.9% of MRI and 75.7% of CT scans were normal [14] while another had 98%of normal CT scans.[15] The difference in sample size could be the reason for the higher values obtained in these studies. The studies were all in agreement with the fact that most of the findings were essentially normal.

In a study of 100 children with chronic headaches in India, 96% were normal; the abnormal cases were all sinusitis.[16] Chronic sinusitis was the commonest imaging finding in our study making up 46.7% of the abnormalities. Although chronic sinusitis may be a cause of headaches, neuroimaging may not be justified based on clinical history and examination. It has been reported that pediatric secondary headaches are more frequently due to non-life-threatening diseases such as sinusitis, upper respiratory tract infections, and systemic infections with life-threatening aetiologies found in patients with "red flags" on clinical history and physical examination.[17]

A similar study which included 25 children with chronic headaches without neurologic symptoms, reported that 16.6% had abnormalities but their discovery did not influence the diagnosis, management, or outcome of the patients.[18] These studies show that chronic pediatric headaches are not usually due to serious intracranial disease.

The need for proper clinical evaluation is further highlighted in this study which shows that only 8(19.5%) had red flags that constitute recommended indications for neuroimaging, compared with 33(80.5%) with negative examinations. It is worthwhile to note that curable and potentially devastating abnormalities were seen in only the patients with red flags. This finding is congruent with the study by Fallah et al[19] which showed that all patients with focal seizure and 61% of developmental delays had abnormal findings lending credence to the evidence-based appropriateness criteria for imaging of children. A similar study by Talebian et al [15] showed that all the patients with abnormal neurological findings also had abnormal brain CT scans (sensitivity=100%) same as our study.

ACR appropriateness criteria, American Academy of Neurology/Child Neurology Society practice parameter supports that neuroimaging is not indicated in a child with recurrent headache and a normal neurologic examination. It is recommended that neuroimaging should be considered for children with recurrent headaches and abnormal neurologic examination (e.g., focal findings, signs of increased intracranial pressure, or significant alteration of consciousness), the coexistence of seizures, or both; recent onset of severe headache; change in the type of headache; or headaches with associated neurologic dysfunction.[9,10,]Accordingly, MRI is the recommended imaging modality of choice if there are signs of increased intracranial pressure and concern for a possible tumor. They recommended that non-contrast CT may be used in the screening evaluation of children with secondary headaches, especially in the case of non-availability of MRI. Despite these recommendations, it has been reported that approximately 11% of the estimated 69 million CT scans performed in the US as of data reported in 2000 and 2007 were performed on children, with 45% not contributory to treatment. [20] This is worrisome since our study showed that all (100%) of the patients who underwent CT imaging had pre and post-contrast evaluation of the brain further increasing the radiation dose burden.

American College of Radiology, Radiological Society of North America, American Society of Radiological Technologists, and American Association of Physicists in Medicine came up with a Programme, Image Gently (children), Image Wisely (adults).[21]

The Mission of Image Gently is to advocate for radiation safety in pediatric imaging to improve safe and effective imaging care of children worldwide, to raise awareness of opportunities to eliminate unnecessary imaging examinations, and to lower the amount of radiation used in necessary imaging examinations to only that needed to acquire appropriate medical images. Their advocacy is in simple terms: right patient, right exam, at the right time, done the right way.[21]

The small sample size of this study constitutes a limitation in the sense that more positive findings may be elicited in a larger study. The findings however are of utmost importance in the management of children with chronic headaches in our environment and should contribute to proper referral of patients, reevaluation of imaging protocols, and reduction in unnecessary application of neuroimaging in children.

Conclusions

There is a very low yield of significant remediable neuroimaging findings in children with chronic headaches without red-flag symptoms. The high percentage of normal cases lends credence to the inappropriate use of imaging. There is therefore an urgent need for proper clinical evaluation, reconsideration of the use of neuroimaging, and development of algorithms for different headache types with a view to imaging gently.

Competing interests: The authors declare that they have no competing interests.

Acknowledgment

We sincerely appreciate the input of the secretarial staff of the Department of Radiology for their input to the finished manuscript.

Funding: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

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