Incidental cranial CT findings in head injury patients in a Nigerian tertiary hospital

Godwin I. Ogbole¹,², Amos O. Adeleye³, Mayowa O. Owolabi³, Richard B. Olatunji⁴, Bolutife P. Yusuf⁴

¹Departments of Radiology, ²Surgery, Division of Neurological Surgery and ³Medicine, Neurology Unit, College of Medicine, University of Ibadan, Ibadan, ⁴Department of Radiology, University College Hospital, Ibadan, Nigeria

ABSTRACT

Background: Incidental findings on computed tomography (CT) scans are occasionally noted in patients presenting with head injury. Since it can be assumed that head injured patients are of normal health status before the accident, these findings may be a representation of their frequency in the general population. Our aim was to determine the prevalence of such incidental findings among head injured patients in Nigeria’s foremost center of clinical neurosciences. Materials and Methods: We conducted a retrospective review of CT scan images of 591 consecutive eligible patients over a 5-year period (2006-2010) to identify incidental findings. The images were evaluated by consensus agreement of two radiologists. Associations with gender and age were explored using appropriate statistical tests with an alpha level of 0.05. Results: The mean patient age was 34.6 ± 21.2 years, and male to female ratio was 3.2: 1. Incidental findings were noted in 503/591 (85.1 %) of the scans. Intracranial calcification was the commonest finding occurring in 61.8% of patients. Over 90% of the findings were benign. Compared with older ones, patients under the age of 60 were less likely, (P < 0.001), to have incidental findings. Conclusion: Although the majority of incidental findings in this African cohort of head injury patients are benign some clinically significant lesions were detectable. It is therefore recommended that such findings be adequately described in the radiological reports for proper counseling and follow-up.

Key Words: Computed tomography, incidental finding, head injury

INTRODUCTION

Computed tomography (CT) scanning is increasingly used both in research and in clinical medicine in Nigeria, and the quality of images obtained with newer helical scanners is continually being improved upon.¹⁻⁵ The accessibility of CT scanners to Nigerian head injury patients has increased over the years.³⁻⁵ With these increases, the detection of unexpected, apparently asymptomatic brain abnormalities such as brain tumors, calcifications, anatomical variants, cysts, aneurysms and some other subclinical vascular pathologic changes become possible. These findings are frequently included in the radiology report are usually unrelated to the principal complaint and may not be pertinent to the immediate care of the patient. Such unexpected abnormalities are classified as “incidental findings”.

Relatively few studies have reported incidental findings in head injury, most reports on incidental CT findings have focused on intracranial tumors and conditions requiring follow-up or intervention and to our knowledge there is none in an African setting.⁶⁻¹⁰ With the diagnostic sensitivity of CT and robust reporting by radiologists, more incidental lesions are likely to be seen. While most of these incidental findings are benign and require no follow-up, there are a few whose discovery may hold unexpected importance to the patient’s future well-being. The latter may therefore require serial imaging follow-up and close supervision of the patients by their primary care physicians.¹¹⁻¹⁰ Also, identification and reporting of these mostly innocuous findings creates the need for clinicians to properly interpret them and communicate the import to patients.
The assessment of the true prevalence of incidental cranial CT scan findings in the general population is logistically difficult in our low-resource practice area. We therefore assumed that head-injured patients whose only clinical indication for their neuroimaging was the index trauma would be somewhat representative of the general population.\[10\]

The purpose of this study was to assess the frequency of these incidental findings detected in head-injured patients after a cranial CT scan in our center.

**MATERIALS AND METHODS**

Cranial CT scans of 591 head trauma patients obtained from 2006-2010 were retrospectively evaluated by 2 radiologists (GIO and OAO) for recognized incidental findings. The CT scans were performed within one week of the event on a GE Brightspeed S (GE medical systems, USA) CT scanner. All cranial CT scans included 15-25 sections (each slice being 3 mm thick at the skull base and 7 mm thick from the base to the vertex). At our center the routine cranial axial CT scan for head trauma was usually performed at approximately 20° tilt relative to the orbitomeatal line. We excluded those CT scans/images that were not standard or were of poor image quality.\[11\]

**Classification of incidental findings**

All findings and classifications were derived by consensus agreement of the two radiologists. We replicated some of the methods used in previous studies.\[8-11\] With these, our own findings were classified into one of two categories:

1. Benign/(not clinically significant): No clinical follow up necessary, common normal findings in asymptomatic subjects (class 1: Minimal paranasal sinus disease, falx/pineal calcifications)
2. Clinically significant: Routine or urgent follow-up necessary (class 2: Acute sinusitis, non-acute intraparenchymal or extra-axial lesions other than small white matter foci and, acute intracranial lesions with significant mass effect).

**Statistical analysis**

We calculated the prevalence of each incidental brain finding in the study population. In reporting the prevalence, multiple similar findings within one patient (e.g., more than one sinus abnormality or multiple asymptomatic brain infarcts) were counted as a single incidental finding.

Next, we calculated the age-specific prevalence rates of the most frequent incidental findings. For intracranial calcifications, we calculated the age-specific median and interquartile range.

We used student t-test to achieve a comparison of the mean age of patients with and without incidental findings.

Other statistical evidence of associations on categorical variables were computed from Chi-square tests of contingency. A P-value of <0.05 was considered as significant.

**RESULTS**

Of the 636 scans evaluated, 591 (84.9%) scans had complete and eligible data for review. We detected incidental findings in 85.1% (503/591) patients but the majority of these, 462/503 (80.7%) were innocuous, findings requiring no clinical follow-up (class 1 findings as defined in ‘Methods’, above).

Findings classified to have required follow-up (class 2) were 41 in all (8.2% of the incidental findings, or, 6.5% of all CT images). These included, intracranial tumours/lesions, skull lesions and acute sinus or mastoid disease.

The ages of patients evaluated ranged from a few days of life to 95 years, mean 35.6 ± 21.2 years. The mean age of patients with incidental findings (39.0 years ± SD) was significantly higher than those without (16.2 years ± SD, P = 0.0001). Children below the age of 18 years constituted 19.4% of the cohort examined. Overall there were more males (72.1%) than females (27.9%) giving an approximate male to female ratio of 3.2:1. The head injury was caused by road traffic accidents (RTA) in 65.6% of the cases, fall from height in 20.0% assault in 13% and other causes accounted for 1.4%.

In all, we noted 11 kinds of structural incidental findings [Table 1]. The commonest was intracranial calcification (67.7%) followed by sinusitis/sinus abnormalities (52.8%). Leucomalacia was the least common incidental finding, seen in only seven patients (1.2%).

The other incidental findings were 4 intracranial tumours which included a suspected meningioma, giant cell astrocytoma associated with tuberous sclerosis [Figure 1], pituitary apoplexy, and suspected tuberculoma [Figure 2]. Other findings are listed in Table 1.

| CT Finding                  | Number* | Percentage (n = 591) |
|-----------------------------|---------|----------------------|
| Brain                       |         |                      |
| Brain neoplasm+             | 4       | 0.7                  |
| Dandy Walker variants       | 35      | 5.9                  |
| Ventriculomegaly (Hydrocephalus ex vacuo) | 23 | 3.9                  |
| Atrophy                     | 100     | 16.9                 |
| Calcifications              | 365     | 61.8                 |
| Falx                        | 234     | 39.6                 |
| Pineal                      | 306     | 51.8                 |
| Basal ganglia               | 35      | 5.3                  |
| Infarct                     | 32      | 5.6                  |
| Leucomalacia                | 07      | 1.2                  |
| Arachnoid cyst              | 28      | 4.7                  |
| Skull                       |         |                      |
| Mastoid opacity/sclerosis   | 190     | 32.1                 |
| Sinusitis                   | 312     | 52.8                 |
| Skull lesion/abnormality    | 16      | 2.7                  |

*Some patients had more than one finding, +The diagnoses were based on imaging only, without histologic confirmation.
Ventriculomegaly, cerebral atrophy, Dandy Walker variant, intracranial calcification, Sinusitits, infarction, skull lesion, collection and mastoid opacity/sclerosis were all significantly commoner in the adult population ($P < 0.05$). Suspected physiological calcification of the globus pallidus was visualized in 53 patients (10%). The frequency of these visualizations increased with increasing age.

**DISCUSSION**

Our findings demonstrate the prevalence of incidental findings on CT in head-injured patients in a major referral centre in Nigeria. The prevalence of incidental findings on neuroimaging of the head in the literature are as varied as the imaging modality used; technique of image acquisition; demographic and ethno-racial characteristics of subjects; as well as case definition of incidental findings reported. Cranial CT based studies reported prevalences which range from as low as 1% to as high as 19%. The prevalence in our series is 85.1% which is high when compared with the previous CT based studies, though majority of our findings was innocuous, non-critical and without need of further investigation or clinical follow up. An intermediate prevalence of 47% was however reported in one magnetic resonance imaging (MRI) based study.

The spectra and prevalence of reported incidental findings are diverse. In this series, calcification (61.8%) was the most frequent incidental finding followed by sinusitis (52.8%), mastoid opacity/sclerosis (32.1%), brain atrophy (16.9%) and arachnoid cysts (9.8%). Calcification was however, either an infrequent finding or not even considered in some previous studies.

The relatively young mean age of our cohort is similar to those of most other CT based studies and is unlikely to account for the observed disparity in frequency of calcification reported.

Although MRI based series had relatively older participants, calcification may be difficult to detect due to the low sensitivity of MRI for calcifications and this may explain the lower prevalence reported by Katzman et al. This observation suggests that intracranial calcification develops at an earlier age in black Africans than other races. Further studies will however be necessary to verify this.

The low frequency of incidental finding of intracranial calcifications in previous studies may also be because of the different classification methods used. For example, Bordignon and Arruda classified calcifications into three different groups of: one calcification (38.99%), several calcifications (17.6%) and basal ganglia calcification (5.62%). This form of grouping was very nonspecific and provides little information about location and the brain tissue involved. Brain atrophy was their most common incidental finding.

Eskandary et al., seem to only consider pineal calcification and basal ganglia calcification. We considered all forms of intracranial calcifications including falcine calcification which occurs in about 10% of elderly population. In view of the high percentage of calcifications we found, there might be a higher prevalence of intracranial calcification among black Africans, a hypothesis that may require further study. The calcifications we established occurred significantly in the older age-group, especially basal ganglia calcifications ($P = < 0.001$). They were mainly benign and do not require further clinical follow-up.

The calcifications which could be considered pathological were those found in a patient suspected to have sub-ependymal giant cell astrocytoma and the calcified cortical tubers which were seen in the patient were indicative of tuberous sclerosis. Although...
asymptomatic prior to his head injury, this patient will require follow up and possible intervention.

Sinusitis and mastoid disease formed the second and third most common incidental findings in our series. This probably reflects the higher incidence of infections in a developing country like Nigeria. Bordignon and Arruda[10] found a relatively low prevalence of sinus disease (4.49%) compared with the 52.8% we recorded in our series. The Nigerian climate found in our work. Eskandary et al.[11] did not report any case of sinus or mastoid disease.

Our series clearly demonstrated brain atrophy, hydrocephalus ex vacuo, leucomalacia, infarct, and mastoid opacity to be age-related [Table 2]. Table 3 clearly showed the gender related discrepancy with CT findings of atrophy, calcifications, sinusitis and cerebral infarctions in males.

Brain tumors are important incidental findings and autopsy reveals the frequency of between 1% and 2%.[14] We found 4 (0.7%) cases of suspected brain neoplasms. Most incidental findings of intracranial lesions have focused on pituitary adenoma.[18-20] We only found one case of pituitary adenoma presenting as pituitary apoplexy. The other tumors we found were suspected meningioma, tuberous sclerosis and tuberculosis. Meningioma is the most common of all incidental tumors accounting for up to 33% of the incidental tumors found at autopsy.[21]

Intracranial arachnoid cysts are often also discovered as incidental finding on imaging and make up 0.4-1% of the intracranial space occupying lesions.[22,23] The incidence of arachnoid cysts [Figure 3] found in our study is comparatively higher than previous studies.[10,11,22,23] This high proportion may be due to the difficulty in distinguishing between arachnoid cysts of the suprasellar region and other benign cysts resulting in an over call as the differential diagnosis may be wide and may include Rathke cyst, third ventricular dilatation, craniopharyngioma, or epidermoid tumors.[24] This imaging finding may require further investigation and validation from autopsy studies in our environment.

Some forms of intracranial calcifications, tuberous sclerosis or tuberculomas may predispose to seizures which could be

---

**Table 2: Association of age with the incidental findings on CT**

| CT finding                  | Mean Age ± SD present | Mean Age ± SD absent | t-value | P-value | OR for >45 years | 95% CI          |
|-----------------------------|-----------------------|----------------------|---------|---------|------------------|-----------------|
| Brain Neoplasm              | 32.7 (18.7)           | 36.7 (21.3)          | 0.557   | 0.578   | 0.766            | 0.079-7.414     |
| Dandy Walker variants       | 32.4 (22.1)           | 35.8 (21.2)          | -0.769  | 0.442   | 1.980            | 0.079-3.182     |
| Hydrocephalus ex vacuo      | 36.0 (21.1)           | 34.6 (20.6)          | -2.146  | 0.034a  | 1.910            | 3.233-24.324    |
| Atrophy                     | 60.7 (16.1)           | 30.5 (17.2)          | -3.147  | <0.001a | 1.996            | 9.899-29.526    |
| Calcifications              | 44.0 (19.5)           | 22.1 (16.5)          | -14.652 | <0.001a | 7.451            | 4.544-12.118    |
| Falx                        | 46.7 (19.2)           | 18.4 (19.4)          | -11.220 | <0.001a | 4.168            | 2.944-6.187     |
| Pineal                      | 45.3 (19.6)           | 25.3 (17.8)          | -12.996 | <0.001a | 6.349            | 4.176-9.653     |
| Basal ganglia               | 55.9 (18.2)           | 34.5 (20.8)          | -5.635  | <0.001a | 5.377            | 2.757-11.675    |
| Sinusitis                   | 39.9 (18.4)           | 30.8 (23.1)          | -5.319  | <0.001a | 1.084            | 0.762-1.541     |
| Infarct                     | 55.1 (24.2)           | 34.5 (20.5)          | -5.547  | <0.001a | 5.927            | 2.757-12.738    |
| Leucomalacia                | 52.7 (26.5)           | 35.4 (21.1)          | -2.146  | 0.032a  | 14.254           | 1.703-119.284   |
| Skull lesions               | 37.4 (23.1)           | 35.6 (22.2)          | 0.374   | 0.733   | 1.822            | 0.688-4.972     |
| Arachnoid cyst              | 36.4 (19.7)           | 35.5 (21.4)          | -0.318  | 0.751   | 1.238            | 0.079-7.414     |
| Mastoid opacity/sclerosis   | 41.9 (15.9)           | 32.6 (22.6)          | -5.666  | <0.001a | 1.509            | 1.044-2.180     |

*Significant at P < 0.05

**Table 3: Association of gender with incidental findings on CT**

| CT finding                  | % males with incidental finding | % males without incidental finding | χ²     | P-value | OR | 95% CI           |
|-----------------------------|---------------------------------|-----------------------------------|--------|---------|----|-----------------|
| Brain neoplasm              | 75                              | 76                                | 0.002  | 0.964   | 0.948 | 0.098-9.190     |
| Dandy Walker variants       | 80                              | 75                                | 0.331  | 0.565   | 1.283 | 0.054-3.003     |
| Hydrocephalus               | 78.2                            | 75.9                              | 0.069  | 0.793   | 1.344 | 0.417-3.40      |
| Atrophy                     | 62.0                            | 78.8                              | 12.87  | <0.001a | 0.438 | 0.277-0.693     |
| Calcifications              | 79.1                            | 70.7                              | 5.372  | <0.02a  | 1.169 | 0.70-2.230      |
| Falx                        | 75.2                            | 76.5                              | 0.122  | 0.727   | 0.934 | 0.636-1.372     |
| Pineal                      | 78.8                            | 73                                | 2.697  | 0.103   | 1.373 | 0.940-2.004     |
| Basal ganglia               | 58.1                            | 76.9                              | 5.716  | 0.037a  | 0.435 | 0.198-0.871     |
| Sinusitis                   | 80.8                            | 70.6                              | 8.329  | 0.004a  | 1.748 | 1.194-2.560     |
| Infarct                     | 57.6                            | 77.1                              | 6.481  | 0.011a  | 0.404 | 0.197-0.828     |
| Leucomalacia                | 71.4                            | 76                                | 0.080  | 0.777   | 0.788 | 0.151-4.08      |
| Skull lesion                | 87.5                            | 75.7                              | 1.197  | 0.374   | 2.253 | 0.506-10.034    |
| Arachnoid cyst              | 79.3                            | 75.6                              | 0.392  | 0.531   | 1.237 | 0.636-2.405     |
| Mastoid opacity/sclerosis   | 76.8                            | 75.6                              | 0.116  | 0.734   | 1.073 | 0.715-1.612     |
the cause of a road traffic accident or fall from height in the first place. Due to the retrospective nature of our study, the circumstances surrounding the cause of the head trauma could not be adequately established. However it is plausible that in those patients found with intracranial abnormalities, their injury may have resulted from a seizure event. Previous head trauma is also a possible etiological factor as head trauma victims are 12 times more likely than people who have not suffered from head injuries to have seizures.\cite{26} Head injuries occur all the time. People who have had acute intracranial hematomas can also have a high rate of epilepsy.

A limitation of this study is a referral bias that predominantly involved more young males, who apparently are more likely to present with head injury.\cite{27} However it is recognized that the Nigerian population is predominantly young with a life expectancy of 47 years and a greater proportion of males.\cite{28}

Also, we do not routinely perform contrast CT examinations for trauma cases especially when acute intracranial hemorrhage is found. This may also limit the detection and number of contrast enhancing lesions. We did not review the patients chart for documentation of counseling, referral or follow-up of incidental findings thus we could not comment on patient’s outcome.

**CONCLUSION**

Most incidental findings are benign and non-critical. However, we recommend that such findings be included in the radiological reports for proper counseling and follow-up when required.

**REFERENCES**

1. Arogundade RA. Brain tumour as a predisposing factor to head trauma: A review of two cases diagnosed by computed tomography. Niger Postgrad Med J 2010;17:168-71.
2. Adeleye AO, Olowookere KG, Olayemi OO. Clinicoepidemiological profiles and outcomes during first hospital admission of head injury patients in Ikeja, Nigeria. A prospective cohort study. Neuroepidemiology 2009;32:136-41.
3. Obajimoi MO, Shokunbi MT, Malomo AA, Agunloye AM. Computed tomography (CT) in civilian gunshot head injuries in Ibadan. West Afr J Med 2004;23:58-61.
4. Agunloye AM, Adeyinka AO, Obajimoi MO, Malomo A, Shokunbi MT. Computerised tomography of intracranial subdural haematoma in Ibadan. Afr J Med Sci 2003;32:235-8.
5. Ogunseyinde AO, Obajimoi MO, Ogunlade SM. Radiological evaluation of head trauma by computer tomography in Ibadan, Nigeria. West Afr J Med 1999;18:33-8.
6. Illes J, Rosen AC, Hwang I, Goldstein RA, Raffin TA, Swan G, et al. Ethical consideration of incidental findings on adult brain MRI in research. Neurology 2004;62:888-90.
7. Aron DC, Howlett TA. Pituitary incidentalomas. Endocrinol Metab Clin North Am 2000;29:205-21.
8. Nakamura M, Roser F, Michel J, Jacobs C, Samii M. The natural history of incidental meningiomas. Neurosurgery 2003;53:62-71.
9. Weisberg LA. Incidental focal intracranial computed tomographic findings. J Neurol Neurosurg Psychiatry 1982;45:715-8.
10. Bondignon KC, Arruda WO. CT scan findings in mild head trauma: A series of 2,000 patients. Arq Neuropsiquiatr 2002;60:204-10.
11. Eskandary H, Saba M, Khajehpour F, Eskandari M. Incidental findings in brain computed tomography scans of 3000 adult head trauma patients. Surg Neurol 2005;63:350-3.
12. Sanei TM, Hernandi H, Sadali NM, Jalali AH, Eftekharpour F, Evaluation of incidental findings in brain CT scans of mild head trauma patients (GCS: Thirteen to Fifteen). Iran J Cancer Prev 2010;3:32-5.
13. Ryan JT, Susan MW, William DG, Paul YK. Incidental findings on CT scans in the emergency department. Emerg Med Int 2011;2011:1-4.DOI 10.1155/2011/642847.
14. Paluska TR, Sise MJ, Sack DL, Sise CB, Egan MC, Biondi M. Incidental CT findings in trauma patients: Incidence and implications for care of the injured. J Trauma 2007;62:157-61.
15. Vernooij MW, Ikrar MA, Tanghe HL, Vincent AJ, Hofman A, Krestit GP, et al. Incidental findings in brain MRI in the general population. N Engl J Med 2007;35:1821-8.
16. Katzman GL, Dagher AP, Patronas NJ. Incidental findings of brain magnetic resonance imaging from 1000 asymptomatic volunteers. JAMA 1999;282:36-9.
17. Kiroglu Y, Carli C, Karabulut N, Oncel C. Intracranial calcifications on CT. Diagn Interv Radiol 2010;16:263-9.
18. Green JR, Waggener JD, Kriegsfeld BA. Classification and incidence of neoplasms of the central nervous system. Adv Neurol 1976;15:51-5.
19. Feldkamp J, Saiten R, Harms E, Aulich A, Moddert U, Scherbaum WA. Incidentally discovered pituitary lesions: High frequency of macroadenomas and hormone-secreting adenomas — results of prospective study. Clin Endocrinol (Oxf) 1999;51:109-13.
20. Molitch ME. Evaluation and treatment of the patient with a pituitary incidentaloma. J Clin Endocrinol Metab 1995;80:3-6.
21. Wood MW, White RJ, Kormohan JW. One hundred intracranial meningiomas found incidentally at necropsy. J Neuropathol Exp Neurol 1957;16:337-40.
22. Robinson RG. Congenital cysts of the brain: Arachnoid malformation. Prog Neurol Surg 1971;4:133-74.
23. Shuangshoti S. Calcified congenital arachnoid cyst with heterotopic neuroglia in wall. J Neurol Neurosurg Psychiatry 1978;41:88-94.
24. Tsuruda JS, Chew WM, Moseley ME, Norman D. Diffusion-weighted MR imaging of the brain: Value of differentiating between extraxial cysts and epidermoid tumors. AJR 1990;155:1039-63.
25. Available from: http://www.legalinfo.com/content/brain-injury/seizures-and-head-injury.html [Last accessed on 2014 Jul 11].
26. Jude-Kennedy EC, Ofodile EC, Timothy N. The burden of motorcycle-related neurotrauma in South-East Nigeria. J Clin Med Res 2009;1:13-7.
27. Available from: https://en.wikipedia.org/wiki/Nigeria [Last accessed on 2013 Apr 25].