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# Prevalence and Clinical Significance of Incidental Findings in Cranial Computed Tomography in Patients with Head Trauma

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## Abstract

**Objective:** This study evaluated the prevalence and clinical significance of incidental findings detected on cranial computed tomography in patients admitted to the emergency department (ED) with head trauma.

**Materials and Methods:** This single-center, retrospective study included 12.605 consecutive patients who presented to the ED due to head trauma from January 2017 to December 2019. Patients were divided into those with and without incidental findings. Patients with incidental findings were further categorized according to clinical significance. Demographic and clinical characteristics were compared among the patient groups.

**Results:** The study included 12.605 patients, including 8.771 males (66.2%) and 3.834 females (33.8%), with a mean age of 34.3±22.6 years. Incidental findings were not detected in 86.2% (n=10.864) of the patient population. The frequency of incidental and clinically significant findings increased with advanced age ($p<0.001$ for both). In addition, incidental findings were more common in males ($p<0.001$). Moreover, a statistically significant increase in the frequency of brain atrophy, infarction, ischemia, and intracerebral space-occupying lesions (such as mass, lipoma, and meningioma) was observed, especially in patients of advanced age. Conversely, the frequency of arachnoid cysts, hydrocephalus, megacisterna magna, and sinusitis was more common in the younger age group ($p<0.05$ for all).

**Conclusion:** Overall, 86.2% of patients with head trauma had no incidental findings. Additionally, most incidental findings were benign and non-critical. The frequency of incidental and clinically significant findings increased with advanced age. Furthermore, incidental findings were more common in males.

**Keywords:** Clinical significance, cranial computed tomography, head trauma, incidental findings

## Introduction

Incidental findings are unexpected abnormalities discovered unintentionally during medical evaluation for an unrelated issue [1]. These findings are typically asymptomatic and are not related to current symptoms or the primary reason for the medical assessment [1,2]. Despite being incidental, these findings can indicate serious conditions that require further investigation, testing, imaging, or procedures [3]. In recent years, the use of cranial computed tomography (CT) in emergency departments (EDs) has significantly increased [3,4]. This trend has led to the detection of unexpected and asymptomatic brain anomalies, including brain tumors, calcifications, anatomical variations (such as mega cisterna magna and Dandy-Walker malformation), cysts (such as arachnoid cysts), aneurysms, and other subclinical vascular pathological changes [2,5]. However, the

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actual prevalence of incidental findings in certain populations is unknown. Additionally, these findings frequently require further examination and treatment to determine their clinical significance and appropriate management [5,6]. Importantly, the prevalence of specific incidental findings varies by country, based on genetic and environmental factors [2,5]. For instance, a retrospective investigation conducted in Iran between 1998 and 2001 on 3.000 patients with head trauma revealed that the most common incidental finding was megacisterna magna, followed by brain tumors and arachnoid cysts [5]. Conversely, a retrospective study in Nigeria over 5 years examining 591 patients with head trauma reported that intracranial calcifications were the most frequently detected incidental findings, with a prevalence rate of 61.8% [2]. These regional variations highlight the need for population-based research to inform clinical practice. Currently, there is insufficient information about the prevalence and characterization of incidental findings on cranial CT scan in Türkiye. Moreover, no previous study has attempted to classify these incidental findings into subtypes, which is crucial for understanding their clinical significance and guiding management. This study aimed to determine the prevalence and clinical significance of incidental findings detected on cranial CT scan in patients admitted to the ED due to head trauma.

## Materials and Methods

### Ethics Committee Approval and Patient Consent

This study was conducted in accordance with the 1989 Declaration of Helsinki and was approved by the institutional review board (IRB) of Haseki Training and Research Hospital Clinical Research Ethics Committee (decision number: 2020-09, date: 29.02.2020). The IRB did not request patient consent to access the medical records because there were no potentially identifiable markers or patient identifiers

### Study Design and Setting

This single-center, retrospective, and observational study enrolled 21.186 consecutive patients who presented to the ED due to head trauma from January 2017 to December 2019. Data were collected by searching for S00-S10 International classification of disease (ICD) codes in the hospital's automation systems and archives. The patients' demographics (age and sex), initial complaints and diagnoses, comorbidities, vital signs, cranial CT findings, and clinical outcomes were assessed. Patients were divided into two groups: those with incidental findings detected on cranial CT scan and those without. Patients with incidental findings were also divided into two groups: Those with clinical significance and those without. Patients with clinically significant incidental findings include those requiring routine or urgent follow-up for conditions such as intracranial mass, cerebral ischemia or infarction, arachnoid cyst, and hydrocephalus. In contrast, patients whose incidental findings were not clinically significant included benign patients who did not require clinical follow-up if asymptomatic (e.g., sinusitis, intracranial calcification, cerebral atrophy, mega cisterna magna, etc.). Demographic and clinical characteristics were compared among patient groups to identify prevalence and evaluate the clinical significance of incidental findings.

### Study Population and Sampling

To reduce selection bias, all patients who satisfied the eligibility criteria during the study period were included. A total of 21.186 consecutive patients who visited the ED because of head trauma were enrolled in this study. Of these, 3.186 patients who did not undergo cranial CT were excluded. Additionally, 1,805 foreign and refugee individuals were excluded because they did not represent the patient population. A further 2.376 patients were excluded due to incorrect usage of the ICD code. A total of 625 patients underwent CT scan with substandard or poor image quality, and 589 patients were excluded due to the unavailability of their data. Ultimately, 12.605 patients were included in the analysis.

### Cranial CT İmaging Protocol

Cranial CT imaging was conducted using a 128-slice CT scanner (PHILIPS Ingenuity, Netherlands). The scanning protocol comprised non-contrast cranial CT scan in all cases, following standard CT procedures. Patients were positioned in the supine posture with meticulous alignment: The head was centered and positioned perpendicular to the CT table along the canthomeatal line. Additionally, the head was angled approximately 20° downward relative to the orbitomeatal line to optimize visualization. Subsequently, the images underwent post-processing, including axial, sagittal, and coronal reconstructions, in addition to maximum-and minimum-intensity projections. The reconstructed images maintained a slice thickness of 1 mm.

### Statistical Analysis

Data analysis was conducted using SPSS software (version 16.0 for Windows; SPSS Inc., Chicago, IL). Categorical variables (sex and age) are expressed as numbers (n) and percentages (%). Numerical data are expressed as means with standard deviations, minimums, maximums, and medians. Intergroup comparisons were conducted using Student's independent t-test for normally distributed variables and the Mann-Whitney U test for non-normally distributed variables. Dependent group comparisons among patients with incidental findings were performed using the Wilcoxon test for normally distributed variables and Chi-squared test for non-normally distributed variables. The significance level of alpha was set at $p<0.05$.

## Results

Table 1 presents the demographic and clinical characteristics of patients who underwent cranial CT scan due to head

| Table 1. Patient demographic and clinical characteristics | | |
|---|---|---|
| **Age in years, mean±SD (min.-max.)** | 34.3±22.6 | (0-104) |
| **Sex, n (%)** | | |
| Female | 3.834 | (33.8) |
| Male | 8.771 | (66.2) |
| **Incidental findings, n (%)** | | |
| No | 10.864 | (86.2) |
| 1 finding | 965 | (7.6) |
| 2 findings | 678 | (5.4) |
| 3 findings | 98 | (0.8) |
| Cerebral atrophy | 1.028 | (59.1) |
| Cerebral ischemia | 745 | (42.8) |
| Intracranial calcification | 334 | (19.2) |
| Arachnoid cyst | 246 | (14.1) |
| Sinusitis | 102 | (5.9) |
| Cerebral infarct | 87 | (5.0) |
| Megacisterna magna | 82 | (4.7) |
| Intracranial mass | 26 | (1.5) |
| Meningioma | 26 | (1.5) |
| Hydrocephalus | 24 | (1.4) |
| Lipoma | 14 | (0.8) |

Data are expressed as numbers (n), percentages (%), SD: Standard deviations, min.-max.: Minimum-maximum

trauma. This study included 12.605 patients with head trauma, including 8.771 males (66.2%) and 3.834 females (33.8%), with a mean age of 34.3±22.6 years. Incidental findings were not detected in 86.2% (n=10,864) of the patient population. The remaining 1,741 (13.8%) patients had at least one incidental finding. The most common incidental findings were cerebral atrophy (n=1,028; 59.1%), cerebral ischemia (n=745; 42.8%), and intracranial calcification (n=334; 19.2%), respectively. Patients with incidental findings had a significantly higher mean age than those without (60.3±24.3 vs. 30.2±19.3; p<0.001). In addition, 35.4% of patients with incidental findings were female, compared to 29.6% of those without incidental findings. A statistically significant difference in terms of sex was observed between the patient groups (p<0.001). Moreover, patients with clinically significant incidental findings were older than those with non-clinically significant findings (64.5±23.4 vs 54.5±24.3; p<0.001). Furthermore, 37.8% of patients with clinically significant findings were female, compared with 32.2% of those with non-clinically significant findings. There was a significant difference in sex between the patient groups (p=0.017). Non-clinically significant incidental findings were detected in 41.6% (n=724) of the patient population. The remaining 1.017 (58.4%) patients had clinically significant findings. The most common clinically significant incidental findings were cerebral ischemia and arachnoid cysts. Patients with cerebral ischemia were older than those without (p<0.001). Additionally, there were significantly more females in the cerebral ischemia group than in the non-ischemia group (p<0.001). Conversely, the mean age of patients with arachnoid cysts was significantly lower than those without (p<0.001). Moreover, the number of males was significantly higher in patients with arachnoid cysts than in those without (p<0.001). The most common non-clinically significant findings were cerebral atrophy and intracranial calcification. Patients with cerebral atrophy were significantly older than those without (p<0.001). Additionally, there were significantly more women in the cerebral atrophy group (p<0.001). Conversely, patients with intracranial calcification were significantly younger than those without (p=0.046). However, sex did not differ between patients with and without intracranial calcification (p=0.309) (Table 2).

## Discussion

In this study, we investigated the prevalence of incidental findings, with or without clinical significance, in patients admitted to the ED due to head trauma who underwent CT scan. Given that our tertiary hospital is a major trauma center in Istanbul, we posit that our study cohort is representative of the general healthy population for the detection of incidental skull and brain pathologies.

The prevalence of incidental findings varies among different populations [2-5]. Literature on CT-based studies from various countries has documented that the prevalence of these findings ranges from 1% to 85% [2,5,7-8]. In a study conducted in Türkiye by Köksal et al. [7] the frequency of incidental findings in patients who underwent cranial CT for head trauma was reported to be 3.2%. Another study conducted in Türkiye by Yigit et al. [8] found that the frequency of incidental findings in brain-thorax-abdominal CTs performed on patients admitted to the ED following a traffic accident was 27.3%, with approximately 87.9% of these findings identified as skull and brain pathologies. In the present study, the prevalence of incidental findings was 13.8%. The variability among population-based results can be attributed to several factors, including the demographic characteristics of the population, differences in screening protocols and methods, imaging quality, patients' medical histories and reasons for undergoing scans, and environmental and genetic factors [2-5]. The significant variation in the prevalence of incidental findings in CT-based studies worldwide underscores the importance of considering these factors when interpreting results.

In a study conducted in Nigeria, Ogbole et al. [2] examined the cranial CT findings of 591 patients and reported that 80.7% of the incidental findings were benign and did not require clinical follow-up. Another study, which analyzed the cranial CT images of 3000 trauma patients, also noted that the majority of incidental findings were benign [5]. Similarly, studies

**Table 2. Comparison of demographics (age and sex) between patients with and without incidental findings**

| Incidental findings | | Presence | Absence | p* |
|---|---|---|---|---|
| **Non-clinically significant findings** | | | | |
| **Cerebral atrophy** | Age in years, mean±SD | 73.4±13.5 | 42.0±24.2 | <0.001 |
| | Female, n (%) | 427 (42.0) | 190 (26.2) | <0.001 |
| | Male, n (%) | 589 (58.0) | 535 (73.8) | |
| **Intracranial calcification** | Age in years, mean±SD | 59.5±20.9 | 60.5 ± 25.0 | 0.046 |
| | Female, n (%) | 122 (37.9) | 495 (34.9) | 0.309 |
| | Male, n (%) | 200 (62.1) | 924 (65.1) | |
| **Sinusitis** | Age in years, mean±SD | 31.0±21.0 | 62.1±23.3 | <0.001 |
| | Female, n (%) | 21 (20.8) | 586 (36.3) | 0.002 |
| | Male, n (%) | 80 (79.2) | 1044 (63.7) | |
| **Megacisterna magna** | Age in years, mean±SD | 29.6±23.7 | 61.8±23.3 | <0.001 |
| | Female, n (%) | 13 (15.9) | 604 (36.4) | <0.001 |
| | Male, n (%) | 69 (84.1) | 1055 (63.6) | |
| **Lipoma** | Age in years, mean±SD | 64.2±20.5 | 60.2±24.4 | 0.314 |
| | Female, n (%) | 6 (42.9) | 591 (25.2) | 0.193 |
| | Male, n (%) | 8 (57.1) | 1090 (64.8) | |
| **Clinically significant findings** | | | | |
| **Cerebral ischemia/infarct** | Age in years, mean±SD | 73.9±13.1 | 49.3±25.7 | <0.001 |
| | Female, n (%) | 322 (42.7) | 285 (29.6) | <0.001 |
| | Male, n (%) | 445 (57.3) | 679 (70.4) | |
| **Arachnoid cyst** | Age in years, mean±SD | 32.1±22.7 | 64.3±21.8 | <0.001 |
| | Female, n (%) | 33 (15.4) | 584 (38.2) | <0.001 |
| | Male, n (%) | 181 (84.6) | 943 (61.8) | |
| **Intracranial mass/meningioma** | Age in years, mean ± SD | 64.3±20.2 | 60.1±23.4 | 0.314 |
| | Female, n (%) | 20 (43.5) | 591 (25.2) | 0.193 |
| | Male, n (%) | 26 (56.5) | 1090 (64.8) | |
| **Hydrocephalus** | Age in years, mean±SD | 44.8±26.2 | 60.6±24.2 | 0.003 |
| | Female, n (%) | 6 (35.4) | 611 (35.6) | 0.282 |
| | Male, n (%) | 18 (64.6) | 1106 (64.4) | |

Data are expressed as numbers (n), percentages (%),
*Intergroup comparisons were conducted using Student's independent t-test for normally distributed variables and Mann-Whitney U test for non-normally distributed variables
SD: Standard deviations

conducted in Türkiye have reported that most incidental findings were benign [7, 8]. Consistent with the literature, most incidental findings detected in our study were benign and did not require clinical follow-up.

The results of our study indicated that the frequency of incidental and clinically significant findings increased with advanced age. Furthermore, incidental findings were more common among males. Similarly, Ogbole et al. [2] observed that the mean age of patients with incidental findings was significantly higher than those without, with a higher prevalence in males. Another study, which analyzed 5,193 cranial CT images, also noted a greater incidence of incidental findings in males and individuals of advanced age [9].

The most common clinically significant incidental findings in our study were cerebral ischemia and arachnoid cysts, whereas the most common non-clinically significant findings were cerebral atrophy and intracranial calcification. In their study, Ogbole et al. [2] identified calcification as the most prevalent incidental finding in their study, with cerebral atrophy being less common than in our findings. However, their study cohort had a younger mean age than ours. In Razavi-Ratki et al. [9] study, the predominant clinically and non-clinically significant incidental findings were cerebral ischemia/infarction and megacisterna magna, respectively. The prevalence and specific types of incidental findings vary among countries based on population characteristics [2,5,8,9]. These differences may also

be associated with imaging methods and imaging quality. For instance, magnetic resonance imaging (MRI)-based studies often report a lower prevalence of calcifications due to MRI's lower sensitivity for detecting them [10].

### Study Limitations

The prevalence and types of incidental findings vary significantly across studies and populations. Therefore, population-based studies are necessary to identify incidental findings specific to specific societies. Our study is the first to investigate incidental findings detected on cranial CT scans in the Turkish population, categorizing these findings by subtype and evaluating them based on age and sex. However, our study also has several limitations. The most significant is the retrospective design, which was conducted at a single center, which may restrict the generalizability of the findings to other settings or populations. Additionally, we do not routinely perform contrast-enhanced cranial CT examinations for trauma cases, potentially limiting the detection and number of contrast-enhancing lesions. Moreover, alternative imaging modalities, such as MRI, could identify various incidental findings with different prevalences, affecting the overall interpretation of our results. A total of 3.186 patients who did not undergo cranial CT, 625 patients with substandard or poor-quality CT scans, and 589 patients with unavailable data were excluded from the study, potentially introducing bias. Finally, the absence of follow-up data limits our ability to assess outcomes over time.

## Conclusion

The results of our study demonstrated that most incidental CT findings were benign and non-critical. However, 13.8% of patients who underwent cranial CT scan were considered to have serious conditions that require further evaluation and intervention. Our findings highlight the necessity for increased attention, particularly in older patients, to clinically significant findings, such as intracranial mass, cerebral ischemia or infarction, and hydrocephalus.

### Ethics

**Ethics Committee Approval:** This study was conducted in accordance with the 1989 Declaration of Helsinki and was approved by the IRB of Haseki Training and Research Hospital Clinical Research Ethics Committee (decision number: 2020-09, date: 29.02.2020).

**Informed Consent:** A retrospective study.

### Footnotes

### Authorship Contributions

Concept: O.D., Design: H.A., A.A., Ö.S., Data Collection or Processing: H.A., Analysis or Interpretation: A.A., Ö.S., Literature Search: H.A., A.A., Ö.S., Writing: H.A., A.A., Ö.S.

**Conflict of Interest:** No conflict of interest was declared by the authors.

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