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Original Article

Frequency of Common CT Brain Findings in Pediatric Patients Following Accidental Falls

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ABSTRACT

Background: Accidental falls are a common cause of pediatric head trauma and may produce skull fractures, cerebral contusions, and intracranial hemorrhage. Computed tomography is useful for rapidly identifying acute traumatic abnormalities in clinically selected children. Objective: To determine the frequency and pattern of CT brain findings among children undergoing imaging after accidental falls. Methods: This hospital-based cross-sectional observational study included 69 children aged 1–16 years who underwent non-contrast CT brain examination following accidental falls. Demographic characteristics, clinical features, acute traumatic CT abnormalities, and incidental findings were summarized using frequencies, percentages, means, and standard deviations. Results: The mean age was 8.42 ± 4.26 years; 37 participants (53.6%) were male and 32 (46.4%) were female. Scalp swelling was present in 36 patients (52.2%), vomiting in 26 (37.7%), loss of consciousness in 25 (36.2%), and ENT bleeding in 16 (23.2%). Hematoma was the most frequently recorded CT abnormality, occurring in 19 patients (27.5%), followed by cerebral contusion in 13 (18.8%), skull fracture in 11 (15.9%), extradural hematoma in 10 (14.5%), subdural hemorrhage in 10 (14.5%), and other intracranial hemorrhage in nine (13.0%). Calcification and remote infarction were each identified in two patients (2.9%) and were classified as incidental findings. Conclusion: Hematomas, cerebral contusions, and skull fractures were the most frequently recorded traumatic CT abnormalities among children selected for imaging after accidental falls. Clinically indicated CT can identify important traumatic injuries, but the findings do not support routine CT examination of all children following falls. Keywords: Accidental falls; brain computed tomography; cerebral contusion; pediatric head trauma; skull fracture; traumatic brain injury.

INTRODUCTION

Accidental falls are a major cause of pediatric head injury and commonly result from falls on level surfaces, stairs, furniture, playground equipment, or other elevated structures. Children are particularly vulnerable to head trauma because of their relatively large head-to-body ratio, developing motor coordination, limited protective reflexes, and age-specific patterns of physical activity. Although most fall-related head injuries are clinically minor, some children sustain skull fractures, cerebral contusions, intracranial hemorrhage, or other injuries that require urgent assessment and management (1,2).

Clinical evaluation remains the foundation of pediatric head-injury assessment. Presenting features may include scalp swelling, vomiting, loss of consciousness, seizures, headache, altered behavior, neurological deficits, or bleeding from the ear or nose. However, clinical manifestations do not always accurately indicate the presence or severity of intracranial injury, particularly in younger children who may be unable to describe their symptoms reliably. Clinical findings must therefore be interpreted alongside the mechanism of injury, age of the child, neurological status, and other risk indicators when determining the need for imaging (3).

Non-contrast computed tomography of the brain is the principal imaging modality used for the rapid evaluation of suspected acute traumatic brain injury in children. It provides timely visualization of skull fractures, extradural and subdural hematomas, intracerebral hemorrhage, cerebral contusions, edema, mass effect, and other clinically important abnormalities. Its rapid acquisition and widespread availability make CT particularly valuable in emergency settings where early identification of a significant intracranial injury may affect observation, hospital admission, neurosurgical referral, or other management decisions (3,4).

The use of CT in children must nevertheless be clinically justified because it involves exposure to ionizing radiation. Routine imaging of every child following a fall is neither necessary nor appropriate. Instead, CT referral should be guided by the overall clinical presentation and validated pediatric head-injury assessment principles. Features such as altered consciousness, suspected skull fracture, focal neurological signs, recurrent vomiting, significant scalp hematoma, seizure, or a concerning mechanism of injury may indicate an increased likelihood of clinically important traumatic findings (5–7).

The frequency and pattern of positive CT findings after pediatric falls vary according to age, mechanism and height of the fall, injury severity, clinical selection criteria, and healthcare setting. Previous studies have identified skull fractures, scalp or intracranial hematomas, cerebral contusions, and intracranial hemorrhage among the most frequently observed traumatic abnormalities in children selected for CT imaging after head injury (1,4,5). However, findings from CT-referred populations should not be interpreted as the prevalence of injury among all children who sustain accidental falls because children undergoing imaging generally represent a clinically selected group with greater concern for traumatic injury.

Evidence describing the pattern of CT abnormalities among children presenting after accidental falls remains limited in many low- and middle-income settings, including Pakistan. Locally generated data may help characterize the injuries encountered in emergency and radiology departments, support clinical interpretation of common presenting features, and inform more appropriate use of pediatric CT imaging. Such evidence is also important for distinguishing acute traumatic abnormalities from incidental or pre-existing findings detected during imaging.

Therefore, this study aimed to determine the frequency and pattern of acute traumatic CT brain findings among children aged 1–16 years who underwent CT examination following accidental falls. It also described their demographic characteristics and presenting clinical symptoms and assessed the relationship between selected clinical features and CT abnormalities where supported by the available data.

MATERIALS AND METHODS

A hospital-based cross-sectional observational study was conducted at Different private and government hospitals and diagnostic setups, Lahore, Pakistan, over a 90-day period following approval of the study protocol. The study population comprised pediatric patients referred from the emergency or relevant clinical departments for non-contrast CT examination of the brain after an accidental fall. The study was observational, and the decision to request CT imaging was made by the treating clinical team as part of routine patient care.

Children aged 1–16 years of either sex were eligible when they had a suspected fall-related head injury, had been referred for CT examination of the brain, and had sufficiently complete clinical information and interpretable CT images or radiology reports. Children younger than 1 year or older than 16 years, those with a known pre-existing neurological disorder that could substantially affect interpretation of the imaging findings, those with incomplete clinical records, and those with technically inadequate CT examinations were excluded. Patients whose head injury resulted from mechanisms other than an accidental fall were not included.

A sample size of 69 participants was estimated using the single-population proportion formula, based on a 95% confidence level, an expected proportion of 76%, and a 10% absolute margin of error. Eligible patients were recruited consecutively during the study period until the required sample size was achieved. Each participant was included once in the analysis.

Demographic and clinical information was obtained using a structured data-collection form. The recorded variables included age, sex, loss of consciousness, vomiting, scalp swelling, fever, ear, nose, or throat bleeding, and post-traumatic fits or seizures. Loss of consciousness was recorded when a temporary post-traumatic reduction or complete loss of awareness was documented in the clinical record. Scalp swelling referred to externally evident soft-tissue swelling at or near the site of impact. Ear, nose, or throat bleeding was recorded as ENT bleeding when documented following the injury. Clinical symptoms were treated as non-mutually exclusive because an individual patient could present with more than one feature.

All participants underwent axial non-contrast CT examination of the brain using a Toshiba 640-slice multidetector CT scanner. Images were acquired using the institution's pediatric head CT protocol, with multiplanar reconstruction performed when required for further evaluation of cranial or intracranial abnormalities. Both brain and bone-window images were assessed. The CT examinations and corresponding radiology reports were reviewed for acute traumatic findings, including skull fracture, cerebral contusion, extradural hematoma, subdural hemorrhage, other intracranial hemorrhage, and hematoma. Where present, calcification and remote infarction were classified as incidental or pre-existing findings rather than acute traumatic abnormalities.

The primary outcome was the frequency of individual acute traumatic abnormalities identified on CT brain imaging. Secondary variables included demographic characteristics, presenting clinical symptoms, and incidental CT findings. Because more than one symptom or CT abnormality could occur in the same participant, the sum of the individual frequencies was permitted to exceed the total sample size. CT findings were recorded as present or absent for each participant.

Data were entered, cleaned, and analysed using IBM SPSS Statistics version 27.0. Continuous variables were summarized using mean and standard deviation, whereas categorical variables were presented as frequencies and percentages. Percentages were calculated using the total sample of 69 participants unless otherwise specified. Associations between selected categorical clinical features and CT abnormalities were assessed using the chi-square test or Fisher's exact test when expected cell frequencies were small. Statistical significance was evaluated using a two-sided p-value of less than 0.05. No causal interpretation was made because of the cross-sectional observational design.

Data were checked for completeness and consistency before analysis. Records with inadequate clinical information or non-diagnostic CT images were excluded in accordance with the eligibility criteria. Participant confidentiality was protected by analysing clinical and imaging information without personal identifiers. The study did not alter the clinical decision to perform CT, the imaging protocol, or the management provided by the treating healthcare team.

RESULTS

A total of 69 pediatric patients aged 1–16 years underwent non-contrast CT examination of the brain following accidental falls. The mean age of the participants was 8.42 ± 4.26 years. Male children accounted for 37 cases (53.6%), while 32 participants (46.4%) were female.

Abbreviations: SD, standard deviation. Note: The total sample included 69 children aged 1–16 years. Table 1 presents the demographic characteristics of the study participants. The mean age was 8.42 ± 4.26 years. There was a slight predominance of male children, who represented 53.6% of the sample, compared with 46.4% female children.

Table 1. Demographic Characteristics of the Study Participants

Characteristic	Category	n (%) or Mean ± SD
Age, years	—	8.42 ± 4.26
Sex	Male	37 (53.6)
	Female	32 (46.4)

Table 2. Clinical Presentation of Pediatric Patients Following Accidental Falls

Clinical feature	n (%)	95% CI
Scalp swelling	36 (52.2)	40.6–63.5
Vomiting	26 (37.7)	27.2–49.5
Loss of consciousness	25 (36.2)	25.9–48.0
ENT bleeding	16 (23.2)	14.8–34.4
Fever	8 (11.6)	6.0–21.2
Fits or seizures	8 (11.6)	6.0–21.2

Abbreviations: CI, confidence interval; ENT, ear, nose, or throat.

As shown in Table 2, scalp swelling was the most frequently documented clinical feature, occurring in 36 patients (52.2%; 95% CI: 40.6–63.5). Vomiting was reported in 26 patients (37.7%; 95% CI: 27.2–49.5), while loss of consciousness occurred in 25 patients (36.2%; 95% CI: 25.9–48.0). ENT bleeding was observed in 16 patients (23.2%; 95% CI: 14.8–34.4). Fever and fits or seizures were the least frequently recorded clinical features, each affecting eight patients (11.6%; 95% CI: 6.0–21.2).

Table 3. Acute Traumatic CT Brain Findings

CT finding	n (%)	95% CI
Hematoma, as recorded	19 (27.5)	18.4–39.0
Cerebral contusion	13 (18.8)	11.4–29.6
Skull fracture	11 (15.9)	9.1–26.3
Extradural hematoma	10 (14.5)	8.1–24.7
Subdural hemorrhage	10 (14.5)	8.1–24.7
Other intracranial hemorrhage	9 (13.0)	7.0–23.0

Abbreviations: CI, confidence interval; CT, computed tomography.

Table 3 summarizes the acute traumatic abnormalities identified on CT brain imaging. Hematoma was the most frequently recorded abnormality, occurring in 19 patients (27.5%; 95% CI: 18.4–39.0). Cerebral contusions were identified in 13 patients (18.8%; 95% CI: 11.4–29.6), while skull fractures were detected in 11 patients (15.9%; 95% CI: 9.1–26.3). Extradural hematoma and subdural hemorrhage were each observed in 10 patients (14.5%; 95% CI: 8.1–24.7). Other intracranial hemorrhage was reported in nine patients (13.0%; 95% CI: 7.0–23.0).

Table 4. Incidental or Pre-Existing CT Brain Findings

CT finding	n (%)	95% CI
Calcification	2 (2.9)	0.8–10.0
Remote infarction	2 (2.9)	0.8–10.0

Abbreviations: CI, confidence interval; CT, computed tomography.

As presented in Table 4, calcification and remoteinfarction were each detected in two patients, corresponding to 2.9% of the study population. These abnormalities were interpreted as incidental or pre-existing findings rather than acute traumatic changes.

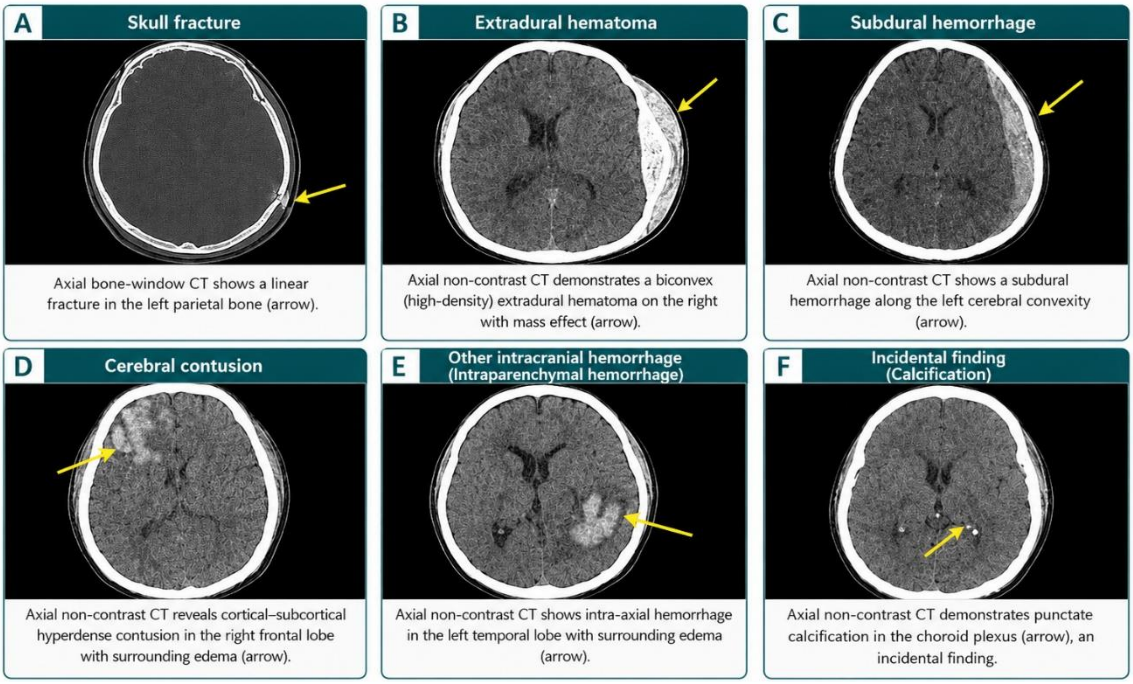

Figure 1. The multipanel figure presents representative axial non-contrast CT findings in pediatric patients following accidental falls, including a linear skull fracture, extradural hematoma, subdural hemorrhage, cerebral contusion, intraparenchymal hemorrhage, and incidental choroid plexus calcification, with arrows indicating the principal radiological abnormalities in each panel.

Overall, scalp swelling, vomiting, and loss of consciousness were the predominant clinical features, whereas hematoma, cerebral contusion, and skull fracture were the most frequently recorded acute CT abnormalities. Because participant-level cross-tabulations were not available, associations between individual clinical symptoms and specific CT findings could not be assessed. The number of patients with a normal CT examination and the overall number with at least one acute traumatic abnormality were also not reported in the available aggregate data.

DISCUSSION

This study described the clinical presentation and CT brain findings of 69 children who underwent imaging after accidental falls. Scalp swelling was the most frequently documented clinical feature, followed by vomiting and loss of consciousness. Among the recorded acute traumatic abnormalities, hematoma was the most frequent finding, followed by cerebral contusion, skull fracture, extradural hematoma, subdural hemorrhage, and other intracranial hemorrhage. Calcification and remote infarction were uncommon and were interpreted separately as incidental or pre-existing findings rather than acute consequences of trauma.

Male children represented 53.6% of the study population, indicating only a modest male predominance. Previous studies of pediatric head trauma have also reported a higher proportion of injuries among boys, although the magnitude of the difference varies according to age, activity patterns, injury mechanism, and study setting (1,2). The present sex distribution should therefore be interpreted descriptively and should not be taken to establish a sex-related difference in the risk of fall-related intracranial injury because the study included only children who had already been referred for CT examination.

Scalp swelling was recorded in slightly more than half of the participants and was the most common presenting feature. External signs of impact, including scalp swelling or hematoma, may accompany skull or intracranial injury, particularly in younger children, although their predictive value depends on age, location, size, mechanism of injury, and associated neurological findings (6). Vomiting and loss of consciousness were also common in the present study. These symptoms are frequently considered during pediatric head-injury assessment because they may reflect concussion or more clinically important traumatic injury; however, neither symptom should be interpreted in isolation when deciding whether CT imaging is required (3,5,7).

Hematoma, as recorded in the original dataset, was the most frequent CT abnormality, affecting 27.5% of participants. This category requires clear anatomical definition because it may represent scalp hematoma, intracerebral hematoma, or another collection and may overlap with the separately recorded extradural and subdural lesions. Such overlap is important when interpreting the frequency distribution because an individual patient may have had more than one radiological abnormality. Future analyses should classify hematomas according to anatomical compartment and should distinguish extracranial soft-tissue hematomas from intracranial traumatic hemorrhage.

Cerebral contusions were identified in 18.8% of participants. Contusions result from focal injury to the cerebral parenchyma and commonly occur near irregular bony surfaces or at sites of direct impact. Their CT appearance may include focal cortical or subcortical hyperdensity, surrounding edema, and mixed hemorrhagic components. Pediatric imaging studies have similarly identified cerebral contusions among the clinically relevant abnormalities encountered after traumatic head injury (4,8). Their clinical importance depends on lesion size, anatomical location, associated hemorrhage, mass effect, neurological status, and progression over time.

Skull fractures were present in 15.9% of the sample. CT, particularly when bone-window images and multiplanar or three-dimensional reconstructions are available, is sensitive for detecting linear, depressed, diastatic, and basilar fractures that may be difficult to identify clinically (4,9). A skull fracture does not necessarily indicate severe intracranial injury, but it may coexist with epidural, subdural, or parenchymal hemorrhage. Accordingly, fracture findings should be interpreted together with neurological examination and associated intracranial abnormalities rather than as an isolated marker of severity.

Extradural hematoma and subdural hemorrhage were each observed in 14.5% of participants, while other intracranial hemorrhage was recorded in 13.0%. These abnormalities are clinically important because lesion expansion, mass effect, or neurological deterioration may require urgent monitoring or neurosurgical assessment. CT remains the principal acute imaging modality for identifying such hemorrhagic injuries because it can be performed rapidly and is highly sensitive to acute blood and skull injury (3,10). Nevertheless, the present study did not evaluate lesion size, midline shift, neurosurgical intervention, admission status, or clinical outcomes; therefore, the severity and management implications of the individual findings cannot be determined from these data.

Calcification and remote infarction were each detected in 2.9% of participants. These findings were unlikely to represent acute traumatic abnormalities and were therefore separated from the principal traumatic outcomes. Their identification illustrates that CT examinations performed after trauma may reveal unrelated or pre-existing abnormalities. Such findings require clinical correlation and should not be included in calculations of acute traumatic CT positivity unless a plausible relationship with the injury is established.

The findings support the role of CT in characterizing acute traumatic abnormalities among clinically selected children following accidental falls, but they do not support routine CT examination for every child who falls. Pediatric CT involves ionizing radiation, and imaging decisions should be based on clinical assessment, neurological findings, age, injury mechanism, and validated pediatric head-injury decision principles (5,7,10). The observed frequencies apply only to children who were referred for CT and cannot be interpreted as the prevalence of traumatic abnormalities among all children presenting after accidental falls.

This study contributes descriptive information regarding fall-related CT findings in a pediatric hospital population. Its strengths include the inclusion of clearly defined pediatric age limits and the reporting of several relevant clinical and imaging findings. However, the findings must be interpreted in light of important limitations. The sample was relatively small and was collected during a 90-day period at a single hospital, limiting generalizability. Referral for CT introduced selection bias because children with greater clinical concern were more likely to undergo imaging. The available aggregate data did not report the mechanism or height of the fall, Glasgow Coma Scale score, neurological examination, normal CT frequency, number of patients with at least one acute abnormality, or the number with multiple abnormalities.

Additional limitations include the absence of participant-level cross-tabulations between symptoms and CT findings, which prevented valid association analysis. The broad "hematoma" category was not anatomically defined and may have overlapped with other hemorrhagic categories. Details regarding image interpretation, reader qualifications, interobserver agreement, radiation-dose parameters, treatment, and clinical follow-up were also unavailable. Because of the cross-sectional design, no conclusions can be drawn regarding prognosis, treatment effectiveness, or whether CT imaging improved patient outcomes. Larger multicenter studies using standardized injury definitions, validated clinical assessment variables, and clearly separated traumatic and incidental CT findings are warranted.

CONCLUSION

Among 69 children who underwent CT brain imaging following accidental falls, scalp swelling, vomiting, and loss of consciousness were the most frequently documented clinical features. Hematoma was the most commonly recorded acute CT abnormality, followed by cerebral contusion, skull fracture, extradural hematoma, subdural hemorrhage, and other intracranial hemorrhage, while calcification and remote infarction were uncommon incidental findings. These results describe the pattern of abnormalities among clinically selected children referred for CT and support the use of appropriately indicated CT imaging for identifying traumatic cranial and intracranial injuries; however, they should not be interpreted as supporting routine imaging of all children following accidental falls.

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