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Pattern of Computed Tomography (CT) Findings in Traumatic Head Injury at a Tertiary Health Care Center, Birgunj

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ABSTRACT

Introduction: Head injuries, especially traumatic brain injury (TBI), represent a global health concern due to their significant physical, cognitive, and societal impacts. This study assesses the prevalence, imaging patterns, and diagnostic role of computed tomography (CT) in craniocerebral trauma.

Methods: A cross-sectional study was conducted from April 2022 to March 2023 at the Department of Radio-diagnosis, NMCTH, Birgunj, Nepal. A total of 85 patients with craniocerebral trauma were included after ethical approval. Patients of all ages and genders were studied, excluding those with hypertension, diabetes, cerebrovascular accidents, bleeding disorders, or anticoagulant therapy. CT imaging was performed using the AQUILION PRIME SP 160-Slice CT machine, and data on demographics, injury mechanisms, Glasgow Coma Scale (GCS) scores, and imaging findings were analyzed statistically.

Results: A total of 85 patients with head injuries, 72.9% were male, and 27.1% were female, with the highest incidence in the 31-50 age group (40%). Road traffic accidents (RTAs) were the leading cause (64.5%), followed by falls (20%) and physical assaults (16.5%). Common clinical manifestations included loss of consciousness (58.8%) and vomiting (45.9%). CT revealed abnormalities in 69.4% of cases, with skull fractures (49.4%) and epidural hematomas (41.2%) being the most common findings. Severe injuries had a mortality rate of 57.1%, predominantly due to RTAs.

Conclusions: CT is a vital diagnostic and prognostic tool for assessing head injuries, guiding treatment, and improving outcomes, particularly in severe cases with poor prognostic indicators.

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INTRODUCTION

Head injuries involve trauma to the scalp, skull, or brain and are often termed craniocerebral trauma or traumatic brain injury (TBI). Globally, TBI is a major cause of hospitalizations and deaths, with an annual incidence ranging from 27 to 69 million.[1,2,3] In Nepal, the burden is higher, with an estimated 382 cases per 100,000 people, exceeding the global average of 369.[4] TBI severity ranges from mild concussions to severe brain damage, with long-term disability or death.[5,6] Causes include accidents, falls, sports, and combat. It also affects cognitive and emotional health, earning the label "silent epidemic."[7,8]

CT is vital in acute trauma settings for evaluating skull fractures and intracranial hemorrhages, especially in patients with neurological deficits or bleeding risks.[9] Multidetector CT offers enhanced imaging and 3D reconstructions.[10]

This study assesses CT's diagnostic utility in head injuries, examining age-gender patterns, common causes, and injury types in a tertiary care center in Nepal.

METHODS

Study Design:

This cross-sectional study was conducted in the Department of Radio-diagnosis at the National Medical College and Teaching Hospital (NMCTH), Birgunj, Nepal. The study included 85 patients presenting with craniocerebral trauma at the emergency department of NMCTH, including referred cases from other hospitals. The study spanned 12 months, from April 2022 to March 2023, after obtaining approval from the Institutional Review Committee (Ref: PG-NMC/553/078-079).

Study Population (Inclusion/Exclusion Criteria):

Patients presenting with head injuries in the emergency department or referred to NMCTH for CT imaging were included in the study. Inclusion criteria required all cases with head injury, regardless of age or gender. Exclusion criteria included patients with known hypertension, diabetes, cerebrovascular accident history, known bleeding disorders, or those receiving anticoagulant therapy. This ensured a focused analysis of trauma-related findings without confounding factors from pre-existing medical conditions.

Sample Size Calculation:

The sample size was calculated using the formula:

$n = Z^2 \times p \times q / e^2$

Where, Z=1.96 (at 95% confidence interval), p=33%,[11] q=1−p, and e=10% (margin of error). This yielded n = 84.93, which was rounded to 85 participants. Ethical considerations, including patient anonymity and non-invasive procedures, were strictly adhered to.

Study Setting and Equipment:

The study was performed using an AQUILION PRIME SP (Canon) 160-slice CT scanner. Sequential (non-helical) axial scans were used to reduce radiation dose and minimize motion artifacts, especially in trauma patients. Although helical mode allows better reconstructions, sequential mode was adequate for initial evaluation in emergency settings.

The gantry was angled 15–20 degrees parallel to the orbitomeatal line to avoid direct eye exposure. Axial slices of 5 mm were taken through the posterior fossa and 10 mm slices for the rest of the brain. Thinner cuts (1–2 mm) were obtained when small bleeds, skull base fractures, or other subtle lesions were suspected based on the initial images.

Data Collection Procedures:

Data were collected from clinical history, physical examinations, and CT imaging findings. Study variables included demographic details (age, gender), type and mechanism of injury (e.g., road traffic accidents, falls, assaults), presenting complaints (loss of consciousness, vomiting, seizures, ENT bleeding, black eyes, headache), and severity of trauma graded using the Glasgow Coma Scale (GCS). CT findings were categorized into skull fractures (linear, depressed, basilar, comminuted, diastasis), extra-axial lesions (epidural hematoma, subdural hematoma, subarachnoid hemorrhage, intraventricular hemorrhage), intra-axial lesions (contusions, intracerebral hemorrhage, diffuse axonal injury), and secondary lesions (cerebral edema, herniation, pneumocephalus).

Image Analysis/Interpretation:

All CT images were reviewed independently by experienced radiologists, with over five years of experience in neuroimaging. Radiologists were blinded to the patients' clinical information to minimize interpretation bias. Findings were systematically assessed for skull fractures (type and extent), extra-axial lesions (location and severity), and intra-axial or secondary injuries affecting brain structure. In cases of disagreement, final decisions were reached by consensus. High-resolution imaging protocols supported accurate detection and classification of traumatic findings.

Statistical Analysis:

All statistical analyses were performed using Microsoft Excel (Office 2019) and SPSS version 20.0.0. Descriptive statistics summarized patient demographics, clinical presentations, and CT findings.

RESULT

A total of 85 patients were enrolled in this prospective study, with a demographic breakdown of 62 males (72.9%) and 23 females (27.1%), (Figure 1) reflecting a male-to-female ratio of 2.7:1.

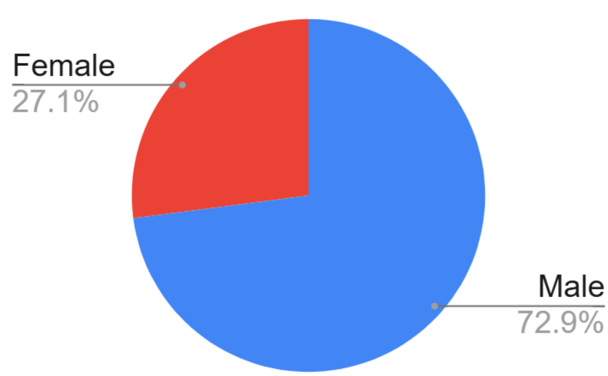

Figure 1: *Gender wise distribution cases*

The age of patients ranged from 2 to 66 years, with a mean age of 30.7±16.0 years. The highest incidence of head injuries was observed in the 31-50 years age group, comprising 34 patients (40.0%), followed by the 16-30 age group with 27 patients (31.8%). The 0-15 years age group accounted for 16 patients (18.8%), while the 50+ age group had 8 patients (9.4%). Males were predominant across all age groups. **(Table 1) (Figure 2)**

Table 1: Age group and gender wise distribution of cases

Age group (years)	Sex		Total No.	Percentage
	Male	Female		
0-15	13	3	16	18.8
16-30	24	3	27	31.8
31-50	19	15	34	40.0
50+	6	2	8	9.4
Total	62	23	85	100.0

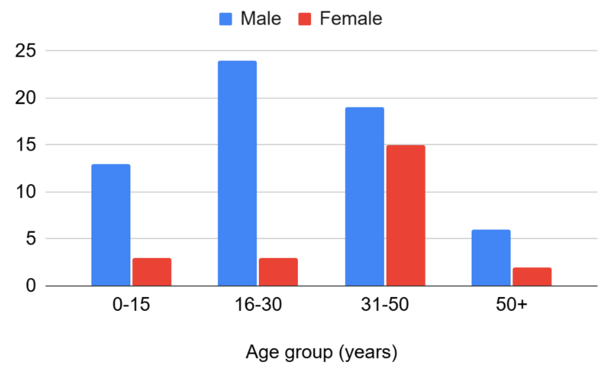

***Figure 2:** Frequency of patients in the Age group and Gender*

The most common cause of cranio-cerebral trauma was road traffic accidents (RTA), accounting for 54 patients (64.5%). Falls were the second most frequent cause, involved in 17 cases (20%), while physical assault was responsible for 14 injuries (16.5%). In all categories, males outnumbered females. The distribution of trauma by age group revealed that falls were more common in the 0-15 age group, while RTA was the leading cause of injury in the 16-30, 31-50, and 50+ age groups. This difference in injury patterns across age groups was statistically significant (p=0.007).

Figure 1: Distribution of cases based on mode of injury

Clinical manifestations varied, with loss of consciousness (LOC) being the most prevalent symptom, observed in 50 cases (58.8%), followed by vomiting in 39 cases (45.9%). Seizures were reported in 17 cases (20.0%), black eyes in 14 cases (16.5%), headache in 13 cases (15.3%), and ENT bleeding in 8 cases (9.4%).

The severity of the head injuries, as assessed by the Glasgow Coma Scale (GCS), showed that 58 cases (68.2%) were classified as mild head injuries, 13 cases (15.3%) as moderate, and 14 cases (16.5%) as severe. A significant association was found between the severity of head injury and abnormal CT findings. Of the 80 patients with recorded GCS scores, 32 of 58 patients (55.2%) with mild head injury, all 13 patients (100%) with moderate head injury, and 14 of 14 patients (100%) with severe head injury had abnormal CT findings. This correlation was statistically significant (p<0.05).

Figure 2: Severity of head injury based on GCS

Of the 85 patients, 26 (30.6%) had normal CT findings, while 59 patients (69.4%) had abnormal findings. The prevalence of different CT findings was as follows: skull fractures were identified in 42 cases (49.4%), with linear fractures being the most common (27 cases, 31.8%), followed by basilar fractures in 15 cases (17.6%). Comminuted fractures were seen in 7 cases (8.2%), depressed fractures in 5 cases (5.9%), and diastatic fractures in 2 cases (2.4%). Epidural hematoma (EDH) was observed in 35 cases (41.2%), contusions in 22 cases (25.9%), subdural hematoma (SDH) in 21 cases (24.7%), and subarachnoid hemorrhage (SAH) in 16 cases (18.8%). Pneumocephalus was noted in 14 cases (16.5%), while cerebral edema was seen in 8 cases (9.4%). Diffuse axonal injury (DAI) was present in 5 cases (5.9%), intracerebral hemorrhage (ICH) in 4 cases (4.7%), cerebral herniation in 3 cases (3.5%), and intraventricular hemorrhage (IVH) in 2 cases (2.4%). (Table 2)

Table 2: CT findings among patient and gender

Lesions	Sex		Total Cases	Percentage
	Male	Female		
Skull fracture	**31**	**11**	**42**	**49.4**
EDH	27	8	35	41.2
Contusions	10	12	22	25.9
SDH	18	3	21	24.7
SAH	7	9	16	18.8
Pneumocephalus	12	2	14	16.5
Cerebral edema	5	3	8	9.4
DAI	5	0	5	5.9
ICH	1	3	4	4.7
Cerebral Herniation	2	1	3	3.5
IVH	2	0	2	2.4

In terms of injury patterns by mode, RTA was the most common cause for both abnormal CT findings and mortality. Of the 54 patients with RTA, 38 (44.7%) had abnormal CT findings, while falls and physical assault contributed 13 (16.5%) and 7 (8.2%) cases, respectively. However, the difference between modes of injury and abnormal CT findings was not statistically significant (p=0.146).

The association between injury severity and CT findings revealed that the incidence of abnormal CT findings was significantly higher in patients with severe head injuries. Mortality was observed only in the severe head injury group (GCS 3-8), where 8 of 14 patients (57.1%) died. The mortality rate was highest in patients who sustained RTA (6 out of 54 cases, 11.1%), followed by falls (1 out of 17 cases, 5.9%) and physical assault (1 out of 14 cases, 7.1%). However, the difference in mortality between the various modes of injury was not statistically significant (p=0.773).

Figure 3: Mode of head injury and severity

Among patients who died, the most common CT findings included skull fractures (7 cases, 87.5%), subdural hematoma (6 cases, 75%), and cerebral edema (6 cases, 75%). These findings suggest that severe structural damage was a significant factor contributing to mortality.

In summary, our study highlights the high prevalence of craniocerebral trauma in males, with RTA being the predominant cause. CT imaging plays a crucial role in diagnosing and assessing the severity of head injuries, with a strong correlation between GCS score and abnormal CT findings. The findings also underscore the high mortality rate associated with severe head injuries and the critical role of CT in guiding clinical management.

DISCUSSION

Head injuries are a growing global health concern. According to the World Health Organization (WHO), traumatic brain injury (TBI) accounts for a significant proportion of injury-related deaths and disabilities worldwide, especially in low- and middle-income countries.[12] Recent global estimates indicate that approximately 69 million people suffer TBIs annually,[13] with road traffic accidents (RTAs) being the leading cause among young adults. Our study contributes to this body of evidence by evaluating head injury patterns at a tertiary care center in Nepal and underscores the need for improved trauma care and preventive strategies.

The incidence and demographic profile observed in our setting largely mirror regional and global trends.[14] A clear male predominance (72.9%) was observed, which is consistent with numerous studies.[2, 15, 16] This trend is likely influenced by sociocultural and behavioral factors, such as higher exposure to risk-prone environments, occupations involving outdoor or manual labor, and greater involvement in road traffic as drivers or motorcyclists, which is more common among males in South Asian settings.[17] Risk-taking behavior and limited adherence to safety measures (e.g., helmet use) may further explain the increased vulnerability among men.[18] Additionally, some literature suggests gender-based differences in injury severity and outcomes, though our sample size limits a detailed stratified analysis.

The mean age was 30.7 years, indicating that head injuries predominantly affect individuals in their most economically productive years. However, a more detailed analysis revealed a right-skewed age distribution, with a higher concentration of cases among young adults aged 20–40 years. Children and older adults comprised a smaller portion of the sample but remain important vulnerable groups.[19] Pediatric head injuries in our study were often due to falls and typically resulted in mild TBI, while older adults showed a higher proportion of subdural hematomas and contusions, often with worse outcomes.[20] These findings emphasize the need for age-specific injury prevention strategies and care protocols.

RTAs were the most frequent cause of injury (63.5%), with motorcycle crashes being the predominant subtype, followed by pedestrian accidents. Most incidents occurred in urban settings, possibly due to dense traffic, poor enforcement of road safety laws, and insufficient infrastructure. Skull fractures and epidural hematomas were particularly common in high-velocity impacts such as motorcycle collisions, while falls were more associated with cerebral contusions and subdural hematomas. These associations underscore the role of injury mechanism in determining lesion type.

Mild TBI accounted for 68.2% of cases. Most were managed conservatively, though ensuring appropriate follow-up remains a challenge, especially in patients discharged early.[21] Mortality was reported in 9.4% of cases, primarily linked to severe TBI with low Glasgow Coma Scale (GCS) scores and findings such as diffuse axonal injury or large-volume hemorrhages.[22] This highlights the importance of early identification and aggressive management of severe TBI cases.

Abnormal CT findings were present in 69.4% of patients, with skull fractures (49.4%) and epidural hematomas (41.2%) being most common. Patients with epidural hematomas often required neurosurgical intervention and had variable outcomes depending on timing of diagnosis and initial neurological status.[23] In contrast, isolated skull fractures without associated brain injury typically had favorable prognoses. These findings reinforce the prognostic value of CT in head trauma and guide management strategies.

The mortality rate of 9.4% in this study aligns with previous research by Khadka et al.[24] and Yattoo et al.[25] Severe head injuries, primarily due to RTAs, were the main contributors to mortality, with subdural hematomas (SDH) being particularly lethal. These findings underscore the critical role of timely CT imaging and intervention in improving outcomes for severe head injuries.

CONCULSION

This study underscores the significant burden of head injuries in a tertiary care setting, with young adult males and road traffic accidents emerging as the most affected demographic and primary cause, respectively. Computed tomography (CT) imaging proved essential in the rapid evaluation and classification of traumatic brain injuries, offering critical insights into lesion types such as cerebral edema, hematomas, contusions, and skull fractures. These imaging findings directly influenced clinical decision-making, enabling timely interventions and improving patient outcomes. The integration of radiological data with clinical and epidemiological profiles not only facilitates individualized care but also informs broader public health strategies. Our findings, which align with global and regional patterns, highlight the urgent need for targeted preventive measures, improved road safety enforcement, and better trauma care infrastructure, especially in resource-limited settings. Strengthening these areas may significantly reduce the incidence, severity, and mortality associated with head injuries.

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None

CONFLICT OF INTEREST

None

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