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Correlation of clinical parameters with computed tomography findings in patients with traumatic head injury in emergency services of Tribhuvan University Teaching Hospital

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Abstract

Introduction: Traumatic head injury (TBI) is a common presentation in the emergency services. Non-contrast computed tomography (NCCT) scan is the most commonly used tool for evaluation of these cases. However, its use is not justifiable when done without proper indication. There are certain Red flag signs (clinical predictors) of traumatic brain injury. A proper history and physical examination is needed to distinguish the presence of red flag signs and order a head CT if needed. The objective of this study is to find out the most predictable clinical parameters in patients with traumatic head injury where CT scan of head can play a deciding role in management.

Method: An observational cross-sectional study done in 106 individuals presented to emergency with TBI and underwent head NCCT for diagnosis at Tribhuvan university teaching hospital. The duration of study was 6 months. Presence or absence of red flag signs were determined after detailed history taking and physical examination. The association of head CT positivity with presence of red flag signs was studied by bivariate analysis using the chi-square test.

Result: Male were 79 (74.5%) and female were 27 (25.5%) in number with male to female ratio of 3:1. Most of the patients triaged to green area (50.9%). 66% had sustained injury to head as a result of fall injury while 26.4% has RTA. 95 (89.6%) had mild head injury and 11 (10.4%) had moderate head injury following the accident. 49 (46.2%) had red flag sign for ordering a CT scan. 25(23.58%) were positive for intracranial findings. Fracture of skull bone was found as most common CT finding in 16(15.10%) followed by sub arachnoid hemorrhage (SAH) 5(4.71%) and extra dural hematoma (EDH) 4(3.78).

Conclusion: Patients with any of the red flag signs needs immediate NCCT scan of head in case of traumatic head injury.

Keywords: Non-contrast computed tomography, Red flag signs, Traumatic brain injury

INTRODUCTION

Computed Tomography (CT) scan is one of the most commonly used tools in the Emergency Department (ED) for diagnostic and therapeutic purposes. The most common CT scan done in an ED is NCCT head, which falls under two categories i.e. post traumatic and non-traumatic CT head. Mandatory CT scans in Mild Traumatic Brain Injury (MTBI) unnecessarily waste money and time due to low yield. Moreover, it may increase brain cancer incidence by 1 in 5000–1 in 10,000 for a single head CT scan in young adults.¹ There are certain pre-requisites for ordering a CT scan of head. It includes comprehensive history taking & physical examination and documentation concerning relevant symptoms related to ordering a specific CT examination with reference to the standardized guidelines for CT imaging in an emergency setting.²

Trauma is a major health problem and is a leading cause of death in the age group 1 to 45 years.³ Head injuries contribute to death in most trauma fatalities. Motor vehicle accidents (MVAs) are the leading cause of head injury followed by falls, assaults, firearm wounds and others. TBI constitutes one of the main health problems worldwide, currently with a high and increasing incidences, representing an important cause of mortality among adolescents and young adults.³ Management of head injury has improved in recent times especially with the advent of better assessment scales, improved diagnostic modalities and better treatment. Even with all these developments, there are a lot of dissimilarities and confusion in the classification and management of head injuries mainly because of the diverse classification systems and guidelines for the management. Most of the cases presenting to the hospital are usually minor head injuries but the optimal evaluation and treatment protocols of these group remains controversial. Recommendations of use of CT scan vary from routine in all patients to more selective use based on findings on the history and physical examination. Unnecessary hospital admission or prolonged supervised observation remains the standard practice for many patients with minor head injuries. Whether to scan a minor head injury with GCS of 15 who appears well and has a normal physical and neurological examination or not is an issue commonly faced in all emergency departments especially with regards to medico-legal aspects.⁴ Several clinical decision rules exists that aim to identify those patients with minor head injuries who are at high risk

for intracranial complications and need CT of the head. Examples of frequently used decision rules are: the New Orleans criteria (NOC), Canadian CT head rule (CCHR), and the National Institute for Health and Care Excellence (NICE) guideline for head injury (Figure 1). The purpose of these rules is to detect all relevant intracranial traumatic lesions while minimizing the number of unnecessary CT scans.⁵

Overuse of CT head is common especially in an emergency setting. Though its use can't be denied in ED, most of the time it is unnecessary as it increases the cost of management, especially in country like ours, radiation hazards, and burden to the tertiary health care centers. The result of this study will help the department to develop its own protocol for ordering CT head in trauma patients. This study will also sensitize the general and emergency

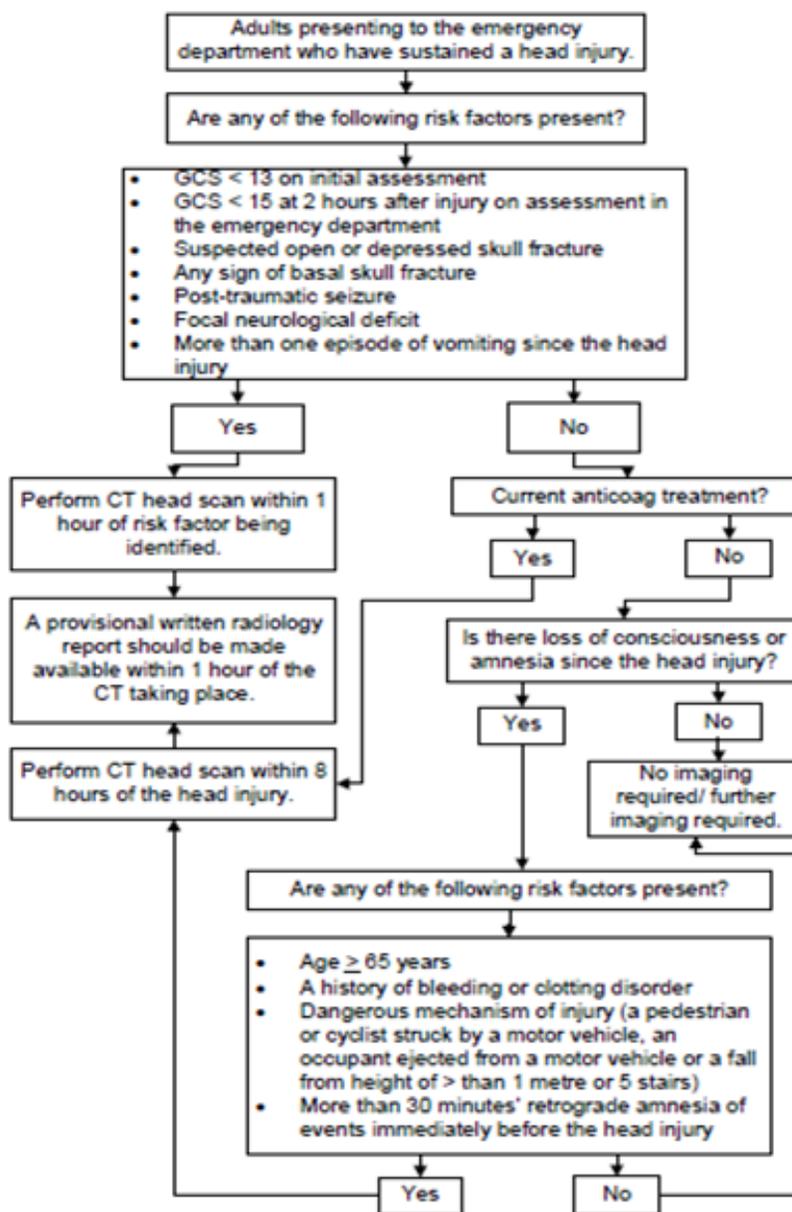


Figure 1. Algorithm for section of adults for CT head scan.⁶

physicians like us who mostly deal with the traumatic patients in resource limited settings. In this study we try to find out the most predictable clinical parameters in patients with traumatic head injury where CT scan of head can play a deciding role in management.

METHOD

This is an observational cross-sectional study done on different age groups including pediatric populations who presented to the emergency with traumatic head injury and underwent head NCCT for diagnosis. The decision for ordering head CT in the patients was taken by the treating doctor responsible for the patient care in the emergency and the researcher was not involved in this decision making. Individuals meeting the inclusion criteria were interviewed and examined separately and data was recorded in pre-structured pro-forma. The study was conducted in the Emergency services of Tribhuvan University Teaching Hospital, Maharajgunj Kathmandu, Nepal. As a tertiary care center and referral hub of the country, the patient load is high. The duration of study was Six month, from April 2021 to September 2021. An approval of ethical clearance was obtained from the Institutional Review Committee, Institute of Medicine reference no. 3201(6-11) E2/077/078. The individuals were explained about the study and were included in the study after receiving written informed consent from patient and patient relatives in case of pediatric population and unconscious patients.

Non-probability convenience sampling method is used to calculate sample size.

The sample size was calculated as follows: Confidence interval (CI) = 95% Level of significance = 5% For 95% CI, Z-score (Z) = 1.96 Sampling error (d) = 10% Prevalence (P) = 50% (in absence of known prevalence, it is taken as 50%).⁷

Sample size (n) = $\frac{Z^2 * P * (1-P)}{d^2} = \frac{1.96^2 * 0.5 * (1-0.5)}{0.1^2} = 96.04$

Assuming 10% non-response rate, 106 samples were approached and included for study.

Inclusion criteria

All patients having NCCT scan of head ordered by emergency on duty doctor for traumatic head injury.

Exclusion criteria

Any of the study variables listed below which is not explained by traumatic head injury or is amenable to some other explainable cause will be excluded from the study, like

- History of previous head injury
- Previous intracranial surgery
- Past history of stroke/seizure
- Known neurological deficits with intracranial lesions

Study variables

Demographic variables (Age, gender, work, address), Glasgow Coma Scale (GCS) at presentation, Mechanism of injury, Headache, Suspected open or depressed skull fracture, Any sign of basal skull fracture (racoon eye, battle sign, hemotympanum, CSF otorrhea, CSF rhinorrhea, palpable discontinuity, bleeding from ear/nose), Post traumatic seizure, Focal neurological deficit, Vomiting (episodes, timing of onset), Loss of consciousness (LOC) or amnesia after head injury, Patients on anticoagulation therapy. Among the study variables GCS<13 on initial assessment, GCS<15 at 2 hours after injury on assessment in ED, headache, suspected open or depressed skull fracture, any signs of basal skull fracture, post traumatic seizure, focal neurological deficit, >1 episodes of vomiting since the head injury are the red flag signs of head injury as mentioned in figure 1.

A validated questionnaire (the Performa prepared was administered to 15 patients in ER with head injury before collection of original data and was discussed among ER physician and neurosurgeons for generation of required data for the study) after patient consent is used. Patient record file is used as a primary source of data collection. Researcher himself is involved in examining the patient and data collection. The researcher took informed consent from each patient enrolled in the Nepali Language.

The study has no influence on the standard management of patient. Patient was managed as per the regular protocol of the hospital. Primarily the CT scans were read by neurosurgery and emergency medicine residents and second opinion was asked from radiologists when required.

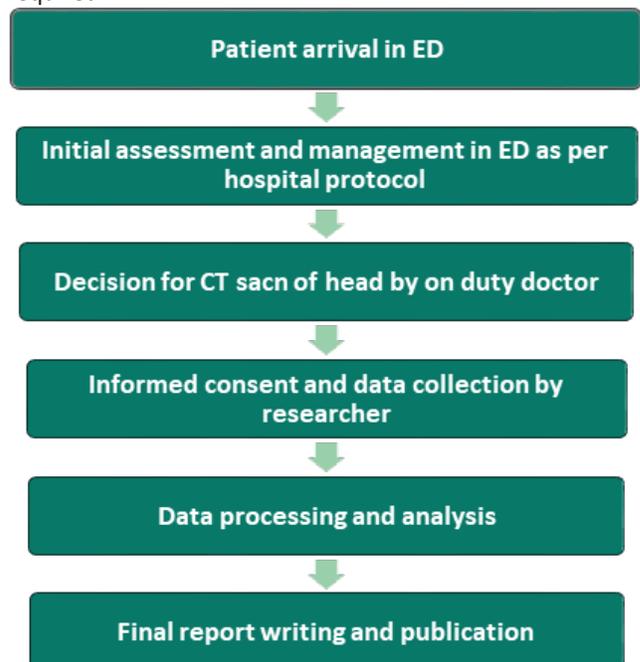


Figure 2. Flow chart showing research management

Data obtained was compiled and analyzed using standard statistical analysis. Patient’s primary data was kept confidential. Secondary data was obtained with IBM SPSS statistics software version 28 was used for data analysis and presentation. Various graphs for the study were also derived using this software. Bivariate analysis was done to test the association of individual clinical presentations with presence of significant intracranial abnormalities using the chi-square test or fisher exact test. P value of less than 0.05 was considered statistically significant. There was no observer bias while collecting or interpreting the data. Management of the study is shown below (Figure 2).

RESULT

Demographic Variables

The analysis was done on 106 patients who underwent NCCT for traumatic injury to brain. Male were 79 (74.5%) and female were 27 (25.5%) in number with male to female ratio was of 3:1 as shown in the figure 3. The highest number of patient being pediatric population of age group <10 years. The age ranges from 1 to 96 years. Age group distribution of study population is shown in figure 4. Most of the victims belong to Kathmandu valley 51(48.1%). Most of the patients triaged to green area 54(50.9%) followed by red area 45(42.5%).

Intracranial findings on NCCT head

Majority of the ordered CT head had normal finding 81(76.41%) while fracture of skull bone was found as most common CT finding in 16(15.10%) followed by SAH 5(4.71%) and EDH 4(3.78). (Table 1).

Mechanism of injury and CT positivity

Eighteen (17%) of patients presented to ER within 2 hours while 26(24.5%) presented within 24 hours. Rest

62(58.5%) was presented after 24 hours of injury. 70(66%) had sustained injury to head as a result of fall injury while 28(26.4%) had RTA. Rest had other mechanism for injury. Mostly younger children’s and older population had sustained fall injury while adult populations have RTA as

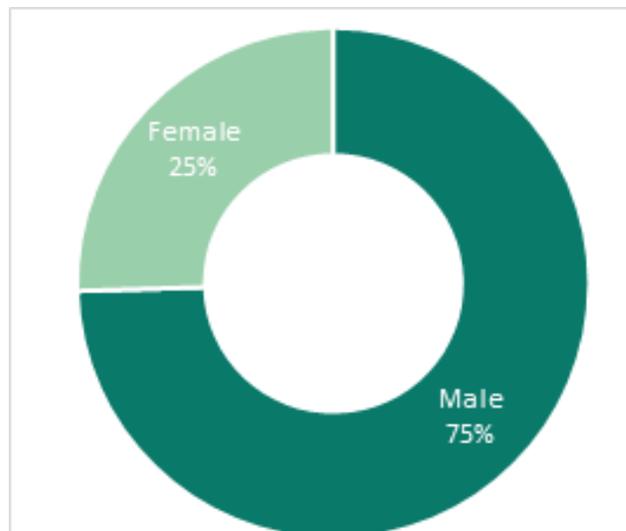


Figure 3. Gender wise distribution of study population

Table 1. CT scan head findings

Findings	Number (%)
Normal	81(76.41%)
Skull bone # with EDH	4(3.78%)
SAH	5(4.71%)
Skull bone # only	16(15.10%)
Total	106(100%)

main cause of head injury. 6(5.66%) individuals had sustained injury under influence of alcohol and one has

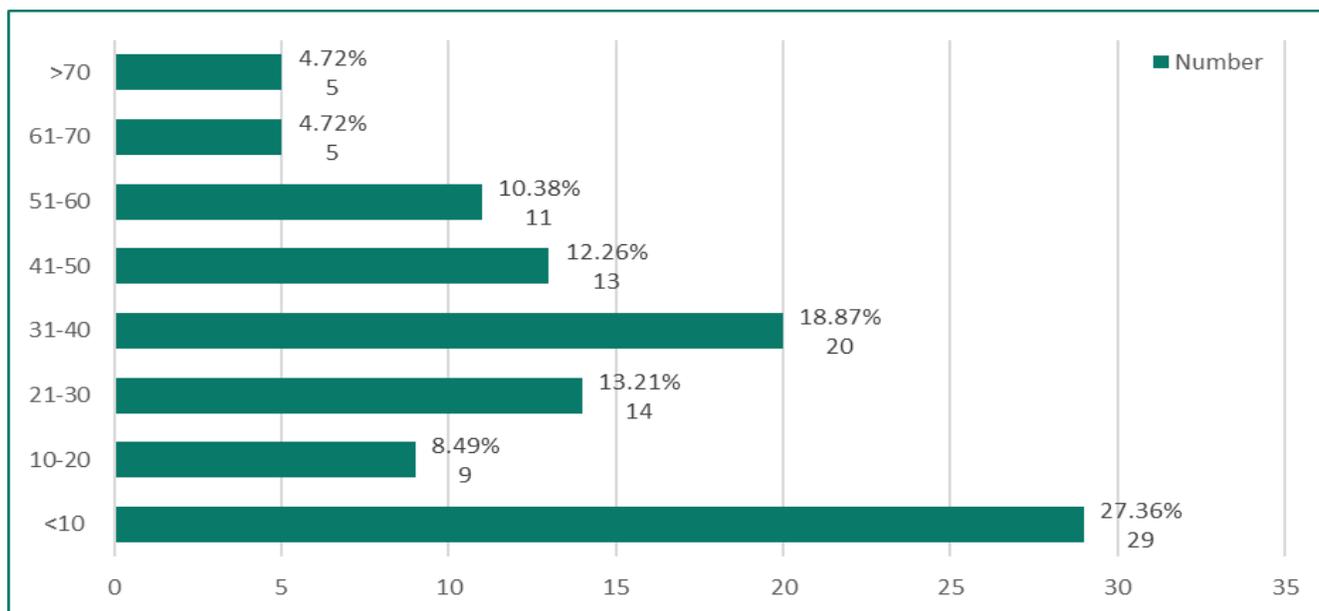


Figure 4. Age wise distribution of study population

Table 2. Association of different clinical findings with head CT positivity (n=106)

Variables	CT positivity		p-value
	Normal Frequency (%)	Positive Frequency (%)	
Red flag sign for CT head			
Yes	29(49.1%)	20(18.9%)	<0.001*
No	52(27.4%)	5(8.8%)	
Suspected open/depressed skull #			
Yes	3(2.8%)	4(3.8%)	0.014*
No	78(73.6%)	21(19.8%)	
Any sign of base of skull #			
Yes	7(6.6%)	4(3.7%)	0.011*
No	74(69.8%)	21(19.8%)	
Post traumatic seizure			
Yes	1(0.9%)	2(1.9%)	0.050*
No	80(75.5%)	23(21.7%)	
Focal neurological deficit			
Yes	3(2.8%)	1(0.9%)	0.931
No	78(73.6%)	24(22.6%)	
> 1 episode of vomiting			
Yes	18(17%)	6(5.7%)	0.814
No	63(59.4%)	19(17.9%)	
LOC/amnesia after head injury			
Yes	7(6.6%)	9(8.5%)	<0.001*
No	74(69.8%)	16(15.1%)	

*denotes Pearson Chi-Square for statically significant at $p < 0.05$

seizure as a pre-morbid cause to sustain injury. 95(89.6%) had mild head injury and 11(10.4%) had moderate type of head injury following the accident. Out of 106 patients enrolled in this study, only 49(46.2%) have red flag sign for ordering a CT scan while 57(53.8%) have no explainable reason for ordering a CT scan of head (Table 2).

Association of different clinical findings with head CT positivity

Among the total ordered CT scan only 25(23.58%) were positive for intracranial findings while the rest have no significant abnormality (Table 2). We found that there was significant clinical association of tested variables with positivity of CT scan. However focal neurological deficit (P-value 0.931) and vomiting more than one episode (P value 0.814) was not significant (Table 2).

When these variables (red flag signs) were subjected to bivariate analysis (Table 2) with positive findings on NCCT scan of head, the overall regression model was significant [F (7, 98) = 5.604, $p < 0.001$. $R^2 = 0.286$].

DISCUSSION

TBI is a worrying public health problem worldwide.⁸ CT imaging is critical both in the diagnosis and management of TBI, particularly important is its role for triaging in the acute setups in determination of which patients require urgent neurosurgical attention.^{9, 10} Identifying clinical predictors to predict intracranial lesions are necessary to screen the patients before CT scan. However, predicting factors

for intracranial injury in TBI vary between studies and guidelines.¹ Our study included clinical predictors of head injury as guided by NICE guideline as inclusion criteria.⁶

We found fall injury 70(66%) as the most common cause for TBI, followed by RTA 28(26.4%). Study done by Tanat Vaniyapong, et al.¹ found traffic accident (63.4%) as the most common mechanism of TBI followed by falling (26.0%). Similarly, Sah SK et al³ also found RTA (60%) as the most common etiology for TBI followed by fall injury (20%), physical assault (12%) and pedestrian injuries (8%), done in CMC Bharatpur.

In study done by Tanat Vaniyapong, et al.¹ SDH (36.9%) was the most clinically important TBIs followed by SAH (20.9%). CT positivity for clinically important traumatic brain injury (ciTBI) was identified in 244 cases (21.0%). Multivariable analysis showed factors for ciTBI were a diffuse headache, neurological deficits, signs of skull base fracture, Glasgow Coma Scale Score <13–14 after 2 h of observation, wound at the scalp, palpable skull fracture, dangerous mechanism, and vomiting 2 times or more. Loss of consciousness, amnesia, intoxication, and age were not predictors for ciTBI.

Yogi N, et al.⁴ reported vomiting, LOC, seizure and headache were the significant predictors of abnormal CT scans. There were 28.7% abnormal CT scans in the study. Contusions (10.4%) and linear fractures (8.4%) were the commonest abnormalities seen in CT scan followed

by EDH (6.5%), traumatic SAH (6.3%), SDH (5.3%) and depressed fractures (2.7%)

In our study fracture of skull bone was found as most common CT finding in 15.10% followed by SAH (4.71%) and EDH (3.78). This is similar to study reported by Gupta Prashant K et al¹¹ where they found skull bone fracture (62.40%) as most common finding on CT scan head following head injury. 25 (23.58%) abnormal CT finding was reported in our study which is comparable with finding noted in above two studies.^{1,4}

Sah SK, et al.³ observed distribution of patients in accordance with consciousness level was found to be 54% with mild TBI (GCS score 12 to 14), 28% with moderate TBI (GCS score 11 to 8) and 18% with severe TBI (GCS score less than 7). In our study we find 89.6% of patients with mild injury and 11.4% with moderate head injury. No patients with severe head injury were noted in our observation.

Though univariate analysis was insignificant with variables focal neurological deficit and more than one episode of vomiting, Multivariate analysis model was significant with tested variables; the most significant ones were sign of base of skull fracture and more than one episode of vomiting in our study.

Stein, et al.¹² justify routine CT scan based on their experience on MTBI patients. In 1990 they reviewed 658 cases of mild head injury (GCS 13-15) where 18% of cases had abnormal CT scan and 5% required surgery.¹² None of the patient with normal CT scan had neurologic deterioration while being observed.¹³ Similarly Falimirski, et al.¹⁴ and Miller EC et al¹⁵ also have suggested routine use of CT in minor head injuries based on the findings of his study of GCS 15 patients.

Proponents of routine scanning argue that high incidences of intracranial abnormalities has been seen in cranial CT scans of minor head injury patients whereas those advocating the use of selective scanning argue that, while a small percentage of patients may indeed have abnormal scans, the overwhelming majority of these will not be clinically significant.^{16,17}

CONCLUSION

Patients presenting with traumatic head injury in the emergency services may have one or more red flag signs of brain injury which can be identified by a proper history and physical examination. Patients who do not have any of the red flag signs of brain injury usually do not require NCCT head for ruling out significant intracranial abnormalities. In our study, most of CT findings were normal. The variables (clinical predictors of brain injury) suspected open or depressed skull fracture, any sign of base of skull fracture, post traumatic seizure, LOC or amnesia after head injury shows significant impact on CT positivity to detect brain

injury when tested with bivariate analysis. So patients with any of the above clinical features needs immediate NCCT scan of head in case of traumatic head injury.

A multicenter case-control study with a larger sample size can be conducted for development of protocol hypothesized by this study in our setting.

DECLARATIONS

Acknowledgement

We express our sincere thanks to Department of General Practice and Emergency Medicine, Tribhuvan University Teaching Hospital, Kathmandu for giving us the opportunity to conduct this study in the premises.

Conflict of Interest

None

Funding

None

Ethical Clearance

Ethical clearance was obtained from IRC IOM TUTH before conducting this study and a written consent was also taken from department of General Practice and Emergency Medicine, Tribhuvan University Teaching Hospital before data collection.

Consent for the Study

Written informed consent was taken from the patients and from patient relatives in case pediatric and unconscious patients before taking case details.

Consent for Publication

It Was taken from researches as mentioned in authorship declaration form.

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