

Original Research Article

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The clinical profile and outcome of conservatively managed traumatic brain injuries and its implications on the timing of repeat CT scans

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ABSTRACT

Background: Outcome of traumatic brain injury is multi factorial. It is common to follow up the conservatively managed patients with repeated CT scans at specific intervals. The study was to observe the epidemiology of TBI and ascertain utility of repeating CT scans in conservatively managed TBI.

Methods: 318 patients with TBI admitted to a tertiary care center for a period of 1 year was studied. Adult patients, who have undergone multiple CT scans were included and patients underwent surgery or expired after first CT scan excluded. Personal details, clinical details and reason for repeated CT scan was studied. The change in management based on serial CT scans was measured as outcome.

Results: Road traffic accidents were the cause of 69.1% of TBI. 72% of the patients were male. Commonest CT finding was occurrence of mixed lesions, seen in 44.3% patients. In patients who underwent repeated CT scans, the mean number of repeat CT scans were 3.7 CT (SD=1.001), while that of elective cases were 2.40 scans (SD=0.629). The use of routine CT scan for follow up did not alter the management of patients with TBI when compared to patients who underwent elective scans as none of them underwent any surgical intervention.

Conclusions: RTA are commonest cause for TBI. Use of routine CT scans was not of advantage over elective scans as none of the patients had any change in management with use of repeat CT scans.

Keywords: Computed tomography, Neurological deterioration, Traumatic brain injury

INTRODUCTION

India is undergoing development at a rapid pace with industrialization and urbanization. With the advent of information technology and digitalisation life is moving at a very fast pace.¹ This change in scenario has brought similar challenges in social and health care delivery system.

However the incidence of non communicable diseases are on an increasing trend, placing a burden on the health care system like never before.²

As per the human development indices and indicators statistical update 2018, India belongs to a group medium income countries with human development index of 0.6

which places India at 130th position.³

The evolving problem due to mechanisation, motorization, urbanisation and a rapid changing in social and demographic fabric is the increase in incidence and the change in the type of trauma and its consequences.⁴ This is emerging as a major killer in the years to come. According to the World Health Organisation's (WHO) Global Burden of Diseases estimates in 2008, 5.1 million people worldwide died of injuries. This accounts for 9 percent of world's total mortality.⁵

In India, injuries are a leading cause of death, contributing to 11% of total deaths.⁶ It is the leading cause of mortality in age group 15-44 years.^{6,7}

Among the various types of injuries, traumatic brain injury (TBI) occupies a significant role due to high mortality, morbidity and burden to the society in a middle income nation like India. Due to the lack of infrastructure, skilled manpower, poorly developed emergency and trauma care services TBIs are a huge challenge on the health care providers.

There are numerous factors that determines the outcome of head injury patients like age, sex, severity of injury, intracranial pathology, and associated injuries. It is hence important to study the clinical profile of patients reporting to the out patient services with TBI, especially the mode of injury, time since the injury, type of injury, other associated injuries, Glasgow coma scale (GCS) at presentation, number of computed tomography (CT) scans undergone by the patient, the reason for repeated scans, was it any deterioration in GCS which prompted the patient to be taken up for the repeat CT or was it done routinely to know the progress and did the patient require any surgical intervention. It is also important to know that if there is any benefit of doing repeated routine CT scans in conservatively managed brain injury and is it unnecessary and hazardous for a patient to undergo such repeat CT scans, wherein if it does not change the management.

Objectives

To study the clinical profile and outcome of conservatively managed traumatic brain injuries; and to compare the outcomes based on number of repeat CT scans.

METHODS

It was a descriptive study conducted at casualty, ward and ICU in department of General Surgery, Kottayam and trauma ICU. This study took place for a period of one year (2017-2018).

Sample size

In a study conducted by Hyder et al assessing a second look at the utility of serial routine repeat computed tomographic scans in patients with traumatic brain injury with progression, it was found that 23% (n=67) had repeat CT without neurological decline.⁴

Using this data minimum sample size required for this study is calculated using the formula:

$$n = \frac{z\alpha^2 pq}{d^2}$$

Z_a = Z value of α error at 5% = 1.96.

P = Proportion of cases requiring change in management based on radiological changes alone =23.

$$q = 1 - P = 1 - 0.23 = 0.77$$

$$d = \text{absolute precision} = 20/100 \times 23 = 4.6$$

$$n = \frac{(1.96)^2 \times 23 \times 77}{\left[\frac{20}{100} \times 23 \right]^2}$$

$$= 318.04 = 318$$

Hence study was conducted on 318 cases.

Inclusion criteria

Patients of above 18 years of age who were admitted for TBI and underwent more than one CT scan.

Exclusion criteria

Patients who were taken up for surgery based upon the findings of the first CT scan. Patients who were discharged or who expired after the first CT scan. We also excluded patients who were on antiplatelet or anticoagulant therapy.

Procedure in Detail

Study included 318 patients who sustained traumatic brain injury by various modes and presented to casualty and admitted to wards or ICU of Government Medical College, Kottayam. Patients of traumatic brain injury above 18 years of age who are subjected to two or more CT scans of the brain were included in the study. Patients were followed for a maximum of up to 5 scans. Patients who were taken up for surgery based upon the findings of the first CT scan and patients who were discharged or who expired after the first CT scan were excluded from the study. The first CT scan of the brain was referred to as the admission CT (CT-1) and the subsequent CT scans are labelled as serial CTs (CT-2 to CT-5). The first CT scan was done soon as possible after trauma. The indications for repeating the CT scan were specified: 1) Patients showing neurological deterioration during the course of management after the first CT scan or underwent a CT scan at discharge was denoted as elective. 2) Patients on a routine follow up in patients who did not show any clinical deterioration but to look for the evolution of the lesions seen in the first CT scan denoted as routine.

Details like age, sex, time and mode of injury, interval between trauma and the CT examination, the Glasgow coma score, findings on each CT scan, presence or absence of intracranial hematoma, type, site and number of intracranial lesions, Facial bone fractures if any, reason for repeat CT scan, Number of days of hospital stay, average cost incurred during hospital stay, Interventions if any were recorded. The participants of this study was chosen based on convenience sampling. Hence the sampling was done based on the convenience

of the investigator.

The CT scan findings were recorded by the attending neurosurgeon. The alterations occurring in the management protocol based on the changes in the serial CT scans were measured as outcome.

RESULTS

The majority of the patients were of middle age and youth. 40% of patients are middle aged (18-34 years) and 35% of patients are of young age (35-59 years). Elderly patients i.e., more than 60 years accounted for the remaining 23.8% of the study (Table 1).

Table 1: Age distribution.

Age in years	Age group	Incidence
18-34	Youth	112
35-59	Middle age	130
60 and Above	Elderly	76

The vast majority of the patients were males 72% compared to females 28% (Table 2).

Table 2: Sex distribution.

Sex	No. of cases
Male	89
Female	229

Road traffic accidents are the major mode of injury leading to TBI, accounting for 69.1%. Other causes for TBI are assaults (5.3%), fall from heights (8.1%) and other causes like sports injuries (17.2%) (Table 3).

Table 3: Mode of injury.

Cause of TBI	Number of cases
Fall from height	26
Road traffic accidents	220
Assaults	17
Others	55

Table 4: Occupation.

Occupation (Kuppuswamy scale)	Incidence
Unemployed	107
Unskilled worker	87
Semi skilled worker	60
Skilled worker	45
Clerical, Shop owner, farmer	15
Semi professional	2
Professional	2

Unemployed, unskilled or semiskilled workers constitutes 33.6%, 27.3% and 18.8% respectively. Skilled workers accounts for 14.1% while clerks, shopkeepers and

farmers are 4.7%. Professionals and semi-professionals were 0.6% each of the total patients with TBI (Table 4).

52.5% of patients arrived at emergency services within 2 hours while 39.6% patients arrived at 2-6 hours. 5% of patients arrived within 6-12 hours and 2.5% only arrived beyond 24 hours (Table 5).

Table 5: Arrival at emergency services.

Timing of 1 st CT scan	Incidence
Less than 2 hours	167
2-6 hours	126
6-12 hours	16
12-24 hours	1
More than 24 hours	8

The most common clinical presentation was loss of consciousness in 71.6% of patients.

Table 6: Clinical presentation at emergency services.

Clinical Presentation	Incidence
Loss of consciousness	228
Vomiting	93
Ear, nasal bleed	63
Seizures	08
Nil symptoms	45

29.2% patients presented with vomiting and 19.8% with bleeding from ear, nose and throat. 2.5% patients presented with seizures, while 14.1% patients had no symptoms at all during presentation (Table 6).

Table 7: CT scan diagnosis.

CT scan diagnosis	Incidence
EDH	82
SDH	119
SAH	121
Pneumocephalus	55
Brain contusion	136
Brain edema	15
IVH	09
Mixed lesions	141

Most frequent CT scan lesion detected is multiple lesions occurring simultaneously in 44.3% of patients. Among single type of lesion brain parenchymal contusion was the most frequent lesion detected accounting for 42.7%. EDH, SDH and SAH were frequent lesions, 25.7% 37.4% and 38.0% respectively. While pneumocephalus, brain edema and IVH was less common 17.2%, 4.7% and 2.8% respectively (Table 7).

Skull or facial bone injuries were present in 55.34% of patients (Table 8).

Table 8: Skull and facial bone fractures.

Skull and facial bone fractures	Incidence
Present	142
Absent	176

Among the skull bone fractures most common was frontal bone fracture (52.6%) followed by occipital bone (18.4%) and parietal bone (15.7%). Less common fractures are temporal bone fractures (11.8%) and styloid (1.3%) (Table 9).

Table 9: Skull fractures.

Skull fracture	Incidence
Frontal	40
Parietal	12
Temporal	9
Occipital	14
Styloid	1

Most common facial bone fracture was zygomatic bone 46.9%. Maxilla was 28.7% and orbital bone fracture was 21.2%. Mandible fracture was least common 3.0% (Table 10).

Table 10: Incidence of facial bone fractures.

Facial bone fractures	Incidence
Maxilla	19
Orbit	14
Zygomatic complex	31
Mandible	2

Most common associated injuries was orthopedic injuries 50.9% and chest injuries 43.3%. Less common injuries are abdomen injuries 5.6% (Table 11).

Table 11: Associated injuries.

Associated injuries	Incidence of associated injuries
Chest	23
Abdomen	3
Orthopedic injuries	27

Most of the repeated CT scans; 78.9% were taken routinely in specific intervals, not due to clinical deterioration, however remaining 21.0% CT scans were taken electively (Table 12).

Table 12: Reason for repeat CT scans.

Reason for repeated CT scans	Number of CT scans
Elective	67
Routine	251

Among the patients underwent multiple CT scans 20% of patients underwent 2 CT scans, while 33% patients

underwent 3 CT scans and 30% underwent 4 CT scans during their hospital stay.

Meanwhile 11% patients underwent 5 CT scans, 3.7% patients underwent 6 CT scans, 5.2% underwent 7 CT scans and 0.3% underwent 8 CT scans (Table 13).

Table 13: Incidence number of CT scans underwent by the patient.

Total number of CT scan underwent by the patient	Incidence
CT2	66
CT3	106
CT4	96
CT5	35
CT6	12
CT7	2
CT8	1

DISCUSSION

Traumatic brain injury is one of the most common emergency coming to a surgery casualty. It occupy a significant role due to high mortality, morbidity, and burden on the society. Due to the lack of infrastructure, skilled manpower, poorly developed emergency and trauma care services, poor surgeon to patient ratio, lack of imaging and investigation facilities, poor intensive care and rehabilitation services, TBIs are a huge challenge on the health care providers. The situation is more alarming in a rural setting.

However due to emergence of better infrastructure, transportation facilities, triage and emergency services, investigational and imaging facilities have marginally improved the outcome.

There are numerous factors that determine the outcome in TBI patients namely age, sex, severity of injury, time interval between the injury and arrival to emergency services, intracranial pathology, and other associated injuries.

In our study among the conservatively managed TBIs the most common cause of brain injury was road traffic accident. It constituted 69.2% of the TBIs followed by 17.3% due to fall after slippage, accidental blunt traumas other than due to RTAs, 8.2% due to fall from heights and 5.2% due to assaults in political and domestic violence. This is in tandem with various other previous studies. Available data indicate that nearly 60% of TBIs are due to road traffic injuries (RTIs) in all parts of the world; about 20-30% are due to falls; 10% due to violence, and another 10% due to combination of work place and sports related injuries.^{8,9} In a similar study from a metropolitan South Indian city by Gururaj et al 61.6% of TBIs were due to RTA, 22.5% due to falls and 10.5% due to assaults.

This can be attributed to various factors like over speeding, driving under influence of alcohol, non-use of safety apparatus like seatbelts or helmets and usage of mobile phones while driving. However unsafe road designs and unsafe vehicles also have a major role in RTA. Head injuries related to RTA differ significantly based on category of the road users. Vulnerable road users such as pedestrians, motorcyclist and cyclists account for at least 50% of death on road.^{8,10}

In our study 72% of these patients were males, which put male to female sex ratio at 1:0.28. A similar conclusion of male predominance in TBIs with a ratio of 1:3 was obtained in the study of epidemiology of traumatic brain injuries in Indian scenario by Gururaj et al.⁸ Another study by Shekhar et al also observed a similar ratio of male predominance 1:3.¹¹ The probable reason for a male predominance may be as the male population frequently move out of their home for work and has a more exposure to risk factors and hazardous working environment.

The most common age group with TBIs reporting to our emergency services were the young and the middle age. The youth of age 18-34 years constituted 35.2% of the study population while middle age group 35-59 years were marginally high comprising of 40.9%. Elderly age group above 60 years comprised remaining 23.9%. In a similar epidemiological study from Central India the commonest age groups were 31-40 years (33%), followed by 21-30 years (26%) and 41-50 years (18%).¹²

It was also observed in our study that most of the casualties due to TBI were unemployed, un-skilled or semiskilled labourers. About 79.9% of the individuals sustaining TBI and reporting to our center were of lower or upper lower class according to the Kuppuswamy scale. The inability to afford safe housing and transportation, indulgence in more hazardous working environment and alcoholism could be attributed to this.

A vast majority of these patients reported to our hospital emergency services during the initial hours of sustaining the injury. The interval between occurrence of the TBI and hospital contact is an important factor determining survival and outcome. We observed that majority of patients, 52.5% of the 318 patients in our study reported early to our emergency services and underwent CT scan due to suspicion of a head injury in the 1st two hours after the injury. 39.6% underwent CT scan in next 4 hours. Remaining 7.8% had a delay in diagnosis due to late arrival to the emergency services of which 2.5% reported even after 24 hours after the incident. A previous study conducted in 2000 at a south Indian metro city observed that 24%, 30% and 19% patients had reached hospital in <1 hour, 2-3 hours and 4-6 hours of injury.¹³

It is quite evident that there is a significant increase in the number of patients reporting early to emergency services

over the period of time. This can be attributed to various factors like improvement in road and transportation facilities, readily availability of ambulance services, skilled healthcare manpower, increase in trauma care centers and general health awareness of the public.

The most common symptom at presentation among our study group was LOC following the injury (71.7%). Vomiting (29.2%), nasal and ear bleed (19.8%) were the next common symptoms. Seizure was a rare presentation among the study group (2.5%). However there was a significant group of patients presenting with no symptoms at all and was detected to have TBI on CT scan (14.2%).

After cross tabulation study using chi square test it was concluded that there is no relation between the mode of injury and symptomatology at presentation.

The most common CT finding in our study was the occurrence of more than one type of lesion. It was seen in 44.3% of the CT scans taken. Among all the lesions hemorrhagic contusion was present in 42.8%, which was the commonest lesion. Among the rest, SAH was present in 38.1%, SDH in 37.4%, EDH in 25.8% and pneumocephalus in 17.3% of the cases. Brain edema and IVH was present in 4.7% and 2.8% respectively. Similar results were obtained in various previous studies.^{11,12}

The study also suggested that a significant number of patients in our study group sustained a skull or facial bone fracture along with the TBI. 44.7% of the patient had either skull bone or facial bone fractures. The most common skull fracture was frontal bone fractures 12.8% and temporal bone fractures 9.1%. Least common was styloid fractures 0.3%. Most common facial bone fracture was of zygomatic complex 9.7%, followed by maxilla 6% and orbital fractures 4.4%. Least common facial fracture in conservatively managed head injury was of mandible 0.3%. The skull and facial bone fractures depend on the mode, intensity and mechanism of head injury. Protective apparatus like seatbelts and helmets reduce the impact considerably thereby reducing facial and skull fractures.

In our study group of conservatively managed TBIs the incidence of chest, abdomen and orthopaedic injuries were less. 7.2% of our study population had an associated chest injury while 8.8% had an orthopaedic injury. Only 0.9% had an abdominal trauma. This is less than in previous similar studies.¹² This could be due to our study group of only conservatively managed patients and thereby severe trauma being excluded.

It was highlighted in our study that the patients who underwent routine repeat CT scans the mean number of repeat CT scans taken were 3.7 CTs (standard deviation=1.001), while that of the elective cases were much less 2.40 CT scans (standard deviation=0.6290). It

is also noted that the routine CT scans did not alter the management in these group as none of them had undergone any surgical intervention or change in management. It was hence evident from our study that patients who underwent routine CT scan had to undergo more unwarranted CT scans than the group of patients who underwent elective CT scans. Our observation was in tandem with previous studies available.

In a similar study conducted by Brown et al it was found that most repeat head CT are performed on routine basis without neurological change. Very few patients had the management altered after repeat head CT and these patients had neurological deterioration before repeat CT head. It was concluded by the study that use of routine serial CT of head in patients without neurological deterioration is unnecessary.¹³

In an another study by Zimmermann et al it was concluded that routine use of repeat head CT scans did not change the management of patients with traumatic intra cranial hemorrhage. Close monitoring and neuro observation can help identify patients requiring neurosurgical intervention.¹⁴

Moreover these unwarranted CT scans has subjected the patient to unnecessary radiation. Every single CT scan head is equivalent to 115 chest radiographs and approximately 1 year equivalent period of natural background radiation.¹⁵ Thus the amount of radiation exposure due to routine CT head is tremendous and hazardous. Also the amount of extra cost incurred to a patient undergoing routine CT scans is much more compared to those undergoing elective CT scans. However the elective CT scans did not considerably reduce the hospital stay of patients i.e., 7.26 days (standard deviation-3.382) when compared to those with routine scans i.e., 7.45 days (standard deviation-3.122). This is as the period of closed neurological monitoring of the patients in the elective CT scan group was equal to the total hospital stay in the routine CT scan group. Hence by reducing the CT scans by routine scans did not reduce the hospital stay.

CONCLUSION

The most common cause of TBI in a tertiary care hospital in a tier II city in South India like Kottayam is road traffic accidents. Other common causes are falls and assaults. TBI has a male predominance, with a male to female ratio of 1:0.3. The most common age group with TBIs reporting to our emergency services were youth and the middle age. It was also observed in our study that most of the casualties due to TBI were unemployed, un-skilled or semiskilled labourers.

Vast majority of these patients reported to our hospital emergency services during the initial hours of sustaining the injury. The interval between occurrence of the TBI and hospital contact is an important factor determining

survival and outcome. We observed that majority of patients in our study reported early to our emergency services and underwent CT scan due to suspicion of a head injury in the 1st two hours after the injury.

The most common symptom at presentation among our study group was loss of consciousness following the injury. Vomiting, nasal and ear bleed were the next common symptoms. Seizure was a rare presentation. However there was a significant group of patients presenting with no symptoms at all and was detected to have TBI on CT scan. The most common CT finding in our study was the occurrence of more than one type of lesion simultaneously. The most common lesion was hemorrhagic contusion. SAH, SDH, EDH and pneumocephalus were the other frequent findings.

The study also suggested that a significant number of patients in our study group sustained a skull or facial bone fracture along with the TBI. The most common skull fracture was frontal bone fractures. Most common facial bone fracture was of zygomatic complex. In our study group of conservatively managed TBIs the incidence of chest, abdomen and orthopaedic injuries were less.

It was highlighted in our study that the patients who underwent routine repeat CT scans the mean number of repeat CT scans taken were 3.7 CTs (standard deviation=1.001), while that of the elective cases were much less 2.40 CT scans (standard deviation=0.629). It is also noted that the routine CT scans did not alter the management in these group as none of them underwent any surgical intervention. It was hence evident from our study that patients who underwent routine CT scan had to undergo more unwarranted CT scans than the group of patients who underwent elective CT scans. The amount of radiation exposure due to routine CT head is tremendous and hazardous. The amount of cost incurred to a patient undergoing routine CT scan is much more than those undergoing elective CT scans. However the elective CT scans did not reduce the hospital stay when compared to the group undergoing routine scan.

Hence it is concluded that routine use of repeat head CT scans did not change the management of patients with traumatic intra cranial hemorrhage. Moreover close monitoring and neuro observation can help identify patients requiring neurosurgical intervention better rather than repeating CT scans at timely intervals.

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