Scholars Journal of Applied Medical Sciences
Abbreviated Key Title: Sch J App Med Sci
ISSN 2347-954X (Print) | ISSN 2320-6691 (Online)
Journal homepage: https://saspublishers.com

OPEN ACCESS

Neurosurgery

Study on Repeat CT Scans in the Traumatic Brain Injury Management

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DOI: 10.36347/sjams.2021.v09i11.010 | **Received:** 23.11.2020 | **Accepted:** 05.12.2020 | **Published:** 16.11.2021

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Abstract **Original Research Article**

Introduction: In recent trauma practice, a Computed Tomography (CT) scan is the initial study of choice to regulate the type, extent and severity of traumatic brain injury as well as to control the management protocol. There are no guidelines on the necessity of repeat CT scan. ***Objective:*** Our main aim in this present study was to determine whether serial CT scans demonstrated momentous change from the findings in the first CT scan and whether repeat scans had influence on management possibilities. ***Methodology:*** This cross sectional study was carried out at Department of Neurosurgery, Rangpur Medical College Hospital, from January 2016 to June 2017 where 80 patients' data were evaluated on the basis of their history, clinical examination. On admission, a detailed history of the illness was taken from the patient or attendant, thorough neurological and general examinations were carried out, and findings of the performed investigations were recorded. On admission GCS were recorded. ***Result:*** In the study, out of all patients of group I maximum 40% patients belonged to 25 to 34 years age range and in group II maximum 35% belonged to 25 to 34 years age group. Also group I, 95% were male and 5% were female and in group II, 92.5% were male and 7.5% were female. ***Conclusion:*** From our result, we can conclude that for detecting new lesions or enlargement of existing lesions in traumatic brain injury repeat CT scans were found to be of significance which results in changing of management in a substantial percentage of patients.

Keywords: Repeat CT scan, Traumatic brain injury, hematoma.

INTRODUCTION

A traumatic brain injury (TBI), also known as an intracranial injury, is a brain injury caused by outside force. TBI may be classified on the basis of severity, mechanism (closed or penetrating head injury) or other characteristics (e.g. occurring at a specific location or in a wide area). Head injury is a wider category which can damage other structures such as the scalp and skin.

Traumatic brain injury is often the result of a serious sport injury or car accident. Immediate or delayed signs may include confusion, blurred vision and focus problems. Children can cry out persistently or be irritable.
Cognitive: amnesia, inability to speak or understand the language, mental confusion, concentration difficulties, difficulty in thinking and understanding, inability to create new memories or inability to recognize common things
Behavioral: abnormal laughter and weeping, aggression, impulsiveness, Irritability, lack of restraint or a persistent repetition of words or actions
Mood: frustration, anxiety, depression or apathy
Body: blackout, dizziness, fainting or tiredness
Eyes: dilated pupils, eyes of a raccoon or unequal pupils
Muscular: weakness or muscle tightness
Gastrointestinal: vomiting or nausea

Patients suffering from severe head trauma do less well. Approximately60 percent would recover fully, with an estimated 25 percent left with a mild degree of impairment. In around 7 to 10 percent of cases, death or a persistent vegetative condition will result. A number of events following the injury will result in more injury, in addition to the harm done at the time of injury. These processes include changes in the flow of cerebral blood and pressure inside the skull. Some of the imaging techniques used for diagnosis include magnetic resonance imaging (MRIs) and computed tomography (CT).Prevention measures include the use of seat belts and helmets, not drinking and driving, fall prevention efforts in older adults and safety measures for children. Depending on the injury, the treatment needed may be minimal or may include interventions such as medications, emergency surgery or surgery years later. Rehabilitation may include physical therapy, speech therapy, recreation therapy, occupational therapy, and vision therapy. These can also be useful for therapy, promoting education and community support programs.

TBI is a worldwide leading cause of death and disability, especially in children and young adults. Males are twice as often suffering traumatic brain injuries as females. Traumatic brain injury is characterized as brain damage that is caused by external mechanical force, such as rapid acceleration or deceleration, impact, blast waves or projectile penetration. Brain function is temporarily or permanently impaired, and with current technology, structural damage can or may not be detectable. TBI is one of two subgroups of acquired brain injury (brain damage that happens after birth); the other subgroup is non-traumatic brain injury that does not require direct mechanical force (examples include stroke and infection). All traumatic brain injury is head injury, although the latter word can also apply to injuries to other areas of the head. Similarly, brain injuries come under the umbrella of injuries to the central nervous system and neuron trauma. The scientific literature on neuropsychology, the term “traumatic brain injury” is commonly used to refer to non-penetrating traumatic brain injuries. TBI is typically categorized according to severity, clinical features of the injury, and cause (the causative forces).Classification relating to the process distinguishes TBI into closed and penetrating head injury. A closed injury (also known as non-penetrating, or blunt) occurs when the brain is not exposed. When an object pierces the skull and enters the durra mater, the outermost membrane surrounding the brain, a penetrating, or open, head injury occurs. Brain injuries can be categorized into mild, moderate, and extreme categories. The Glasgow Coma Scale (GCS), the most commonly used method for classifying TBI severity, measures a person’s level of consciousness on a scale of 3–15 based on verbal, motor, and eye-opening stimulus reactions. It is usually accepted that a TBI with a GCS of 13 or higher is mild, 9–12 moderate, and 8 or higher seriously. Young children have similar systems. The GCS grading system, however, has limited capacity to predict results. Of this reason, other classification schemes like the one shown in the table are also used to help assess severity. A current model developed by the Department of Defense and Veterans Affairs uses all three GCS criteria after resuscitation, the post-traumatic amnesia (PTA), and loss of consciousness (LOC) duration time of the injury happened. This will help to treat the disease.

Traumatic brain injury typically results from a violent blow or jolt to the head or body. An object that enters brain tissue, such as a bullet or shattered piece of skull, also can cause traumatic brain injury. Mild traumatic brain injury affect human brain cells for the time being. More-serious traumatic brain injuries can consequence in bruising, torn tissues, bleeding and other physical damage to the brain. These injuries can result in long-term difficulties or death. Traumatic brain injury can have wide-ranging physical and psychological effects. Some signs or symptoms may seem immediately after the traumatic event, while others may appear days or weeks later.

Traumatic brain injury is very common to men than women with highest incidence between the ages of 15 and 24 years and in those in 75 years and older. The most common cause of head injuries remains motor vehicle accident accounting for more than 50% followed by fall which accounts for 20% to 30%. The remainder is accounted for by act of violence and sports injuries.

Unfortunately the majority of people who sustain head injuries belong to younger and highly productive age groups which make it all the more necessary for taking effective measures. There has been an increase in awareness in recent years of the need for taking care of such cases in specialized neurosurgical centers. Besides age, outcome of crania cerebral injury depends upon severity of primary injury, intracranial pathologies like hematoma and type of injuries. Mortality and morbidity from head injuries result from secondary brain damage from failure of adequate cerebral perfusion from circulatory shock, failure of cerebral oxygenation from disturbance of pulmonary ventilation and rise in intracranial pressure due to mass lesion and cerebral edema leading to fall in cerebral perfusion pressure and to herniation of brain is a major factor in poor outcome. Almost all patients dying from severe head injury have path morphological evidence of cerebral ischemia, cerebral auto regulation impaired with areas of hyper perfusion and hypo perfusion [1-3].

In recenttrauma practice, a computed tomography (CT)scan is the initial study of choice to regulate the type, extent and severity of traumatic brain injury as well as tocontrol the management protocol. However, there are noguidelines on the requirement or the value of repeat CT scan. There are reports highlighting the importance of serial CTscans in patients with head trauma while others feel it tobe unnecessary in most patients [4].

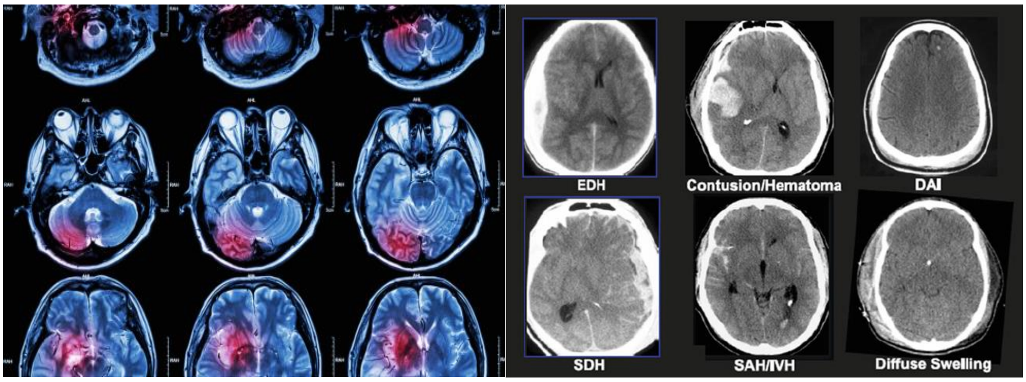

Fig 1a and 1b: Traumatic brain injury in repeat scan [5]

Our main goal in this present study was to determine whether serial CT scansdemonstrated momentous change from the findings in thefirst CT scan and whether repeat scans had influence onmanagement possibilities.

OBJECTIVE

General Objective:

- To evaluate theefficacy of repeat CT scans in the traumatic brain injury management

Specific Objective:

- To identify intracranial lesions on serial CT scans
- To estimate changes in intracranial lesions on serial CT scan of the patients

METHODOLOGY

Study type: This study was a cross sectional analytical study.

Place and period of the study

This study was conducted at Department of Neurosurgery, Rongpur Medical College Hospital, Rongpur from January 2016 to June 2017.

Study Population

Patients with head injury with and without evidence of skull fracture in plain X- ray were evaluated during the study.

Sample Size

The sample size was determined by the following formula-

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

Where,
n= the desired sample size.
z= the standard normal deviation, usually set at 1.96 at 5% level which corresponds to 95% confidence level.
p= the assumed target proportion to have a particular characteristics, here, p=0.50
q= 1-p=0.50
d= expected range of error, level considered as 5%, which is assumed as 0.05.
Putting the values in the above equation the sample size n is estimated as $(1.96)^2$x 0.50x 0.50/ $(0.05)^2$= 384
n= 384 (target sample size)
During the study duration only 80 patients were available to be included.

Sample Techniques
Purposive Sampling

Group- I: Adult patients with head injury with evidence of skull fracture on plain X-ray.
Group- II: Adult patients with head injury with no evidence of skull fracture on plain X- ray.

Inclusion Criteria

- Adult patients (Age 18-70 years) with head injury.
- Plain X-ray skull with anterior-posterior and lateral view.
- CT scan of brain with bone window.

Exclusion Criteria

- Patients who were on anticoagulant therapy.
- EDH due to post surgical complication.
- Patient admitted with poor GCS (<9).
- Patients who were not willing to participate in this study.

Data Collection

A questionnaire was prepared as per protocol and it was filled with the information from of history, clinical examination and investigations by study group.

Data Management

On admission, a detailed history of the illness was taken from the patient or attendant, thorough neurological and general examinations were carried out, and findings of the performed investigations were recorded. On admission GCS were recorded. Relevant associated medical conditions were recorded carefully.

Data Analysis

Data were presented in tabulated form. The entered data were cross-checked and verified. Comparative analysis was done between group I and group II based on presence or absence of EDH in both the study groups were done using Chi-square test with the help of software, SPSS 23.

RESULT

In the study, out of all patients of group I maximum 40% patients belonged to 25 to 34 years age range and in group II maximum 35% belonged to 25 to 34 years age group . Also group I, 95% were male and 5% were female and in group II, 92.5% were male and 7.5% were female. The following figure is given below in detail:

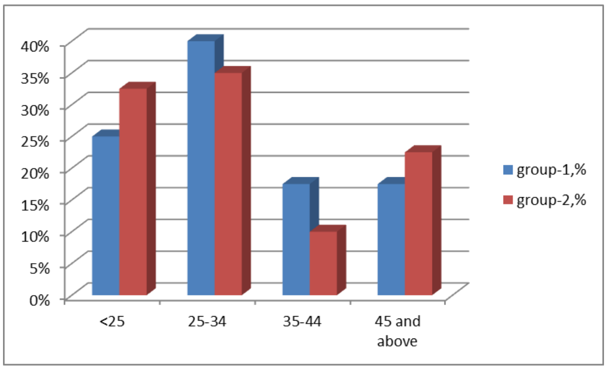

Fig-2: Age distribution between group I and group II

Figure-3 shows gender distribution of group I and group II where in group I, 95% were male and 5% were female and in group II, 92.5% were male and 7.5% were female. Male female ratio was 19:1 in group I and 12.33:1 in group II. The following figure is given below in detail:

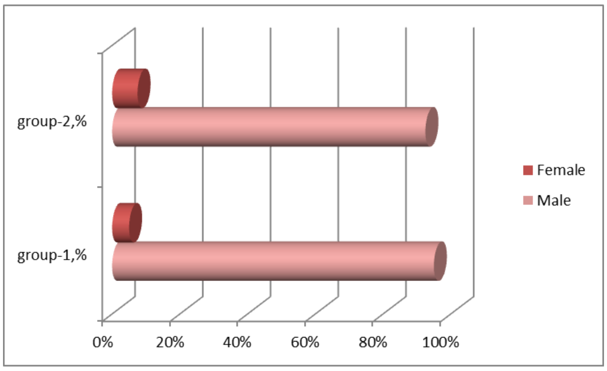

Fig-3: Gender Distribution

In Table-1 shows Distribution of the patients according to occupation (n=80) where most of the patients were students in both the groups. In group- I, which is about 27.5% and in group-II, 22.5%. The other most common occupation was labor and service holders in both groups which were 17.5%, 15% and 15%, 10% respectively in each group. The following table is given below in detail:

Table-1: Distribution of the patients according to occupation (n=80).

Occupation	Group I Frequency (%), n=40	Group II Frequency (%), n=40
Student	11 (27.5%)	9 (22.5%)
Labor	7 (17.5%)	6 (15%)
Service holder	6 (15%)	4 (10%)
Cultivator	5 (12.5%)	7 (17.5%)
Businessman	4 (10%)	5 (12.5%)
Garments-worker	2 (5%)	1 (2.5%)
House wife	2 (5%)	3 (7.5%)
Rickshaw puller	1 (2.5%)	2 (5%)
Others	2 (5%)	3 (7.5%)
Total	40 (100%)	40 (100%)

In table-2 In table-1 shows distribution of intracranial lesions on serial CT scans where CT-1 and CT-2 was done in all patients. 40 underwent CT-3, 10 had a CT-4 while 3 had a CT-5.the following table is given below in detail:

Table-2: Distribution of intracranial lesions on serial CT scans

CT scan finding	CT-1, (%) n=80	CT-2, (%) n=80	CT-3, (%) n=40	CT-4, (%) n=10	CT-5, (%) n=3
Normal	(6.6)	(7.6)	(4.8)	(10)	0
EDH alone	(15.8)	(15.8)	(17.3)	(20)	(66.7)
SDH alone	(11.8)	(10.8)	(10.4)	0	0
Contusions alone	(33.9)	(34.9)	(44.3)	(50)	(33.3)
Mixed lesions	(27.5)	(27.5)	(25.7)	(20)	0
DBE	(2)	(1)	(1.1)	0	0
DAI	(1.4)	(1.3)	(2.2)	0	0
IVH	(1)	(1)	(1.1)	0	0

In Table-3 shows **c**hanges in intracranial lesions on serial CT scan where the changes in the intracranial lesions in the serial CTs werecategorized as; same in size, increase in size, decrease in size/disappearance. The following table is given below in detail:

Table-3: Changes in intracranial lesions on serial CT scan

variable	CT-1 toCT-2,n(%)	CT-2 toCT-3,n(%)	CT-3 toCT-4,n
EDH:	(84.4)	(60)	2
Same	(6.1)	(26.6)	
Increase	(9.5)	(13.4)	
Decrease			
SDH :			
Same	(79.2)	(66.7)	
Increase	(12.5)	(11)	
Decrease:	(8.3)	(13.3)	
Contusion:			4
Same	(82.5)	(73.7)	1
Increase	(11.7)	(13.1)	
Decrease	(8.5)	(13.2)	
Mixed:			1
Same	(69)	(45.4)	1
Increase	(21.8)	(36.4)	
Decrease	(9.2)	(18.2)	

In Table-4 shows Change in management in relation to clinical status and timing of first CT scan where wider availability of CT scan has resulted in a tendency to scan earlier in peripheral or regional hospitals. It is thus particularly important to recognize how to detect further evolution of intracranial processes of patients. The following table is given below in detail:

Table-4

Time between injury & CT-1	CT-2 No. of patients undergoing Craniotomiesn (%) Routine follow up CT on clinical worsening		CT-3 No. of patients undergoing Craniotomiesn (%): Routine follow up CTon clinical worsening	
<6 h	5	16	1	6
>6 h	3	4	2	0

DISCUSSION

Head CT scan is the investigative test used in virtually every trauma center to define the anatomy of the injured brain in patients with TBI. Patients with severe injury, often characterized by large hematomas and/or signs of elevated intracranial pressure, often have primary surgical treatment.

In this study, patient's age ranged from 18 years to 70 years and the highest number of patients was in most active periods of life, in third decade 25 to 34 years of age 40% in group-I and 35% in group-II. One study found the maximum incidence was between the ages of 11 to 65 years. This is because, the working people avail themselves of traffic more than others and victimized to RTA.

Male are more prone to this due to more exposure. However females were less affected, working females were more commonly affected. The gender distribution reflects of this part of the world where women are less exposed to traffic as they remain mostly confined to domestic work.

During study, out of 80 patients 75 (93.75%) patients were male and 5 (6.25%) patients were female of which 95% were male in group I and 92.5% in group II. The ratio between male and female 15:1. One study showed that sufferers of EDH, male and female ratio 4:1. Another study told that the male female ratio was 11.75:1. Male are more prone to this due to more exposure. However females were less affected, working females were more commonly affected. The gender distribution reflects of this part of the world where women are less exposed to traffic as they remain mostly confined to domestic work.

Significant variations in post-traumatic hematomas and thepresence of new hematomas may occur without changes in the clinical status of the patient. One of the major aims of neuron trauma controlling is detection before deterioration, allowing for early treatment of new mass lesions that requiresurgery. Wider accessibility of CT scan has resulted ina tendency to scan previous in peripheral or regional hospitals. Itis thus predominantly important to recognize how to detectadditional evolution of intracranial processes of patients.

The initial CT scan may be followed by a second CT within 24 to 48 h for recognition of evolving lesions. The need for serialCT scans and quantification of the yield of these in terms ofchange in the lesions seen on the first CT, development of newlesions and the role of serials CTs in influencing managementrequires clarification.Several studies have recommended that patients withsignificant head injury undergo serial scanning to allowprompt intervention to minimize secondary brain injury [6-8].

It has also been recommended that as many a time, a CT is done within an hour or two after head injury, and that, in these patients, repeat scans should be attained to study progression of hemorrhagic lesions.At the same time, there are reports questioning the need of routine repeat CT scans. Some of the studies the time interval between trauma and subsequent CTs is not mentioned while in a few, the clinical status at the time of repeat CT is not detailed.

But in other studies also reported that CT is not a good functional assessment of the injured brain. Mild TBI is usually defined as patients who are awake, with a GCS score of 13–15. Although routine repeat head CT seems rational in patients who cannot be followed clinically, their role is less clear in patients with mild TBI who are awake and can be more accurately evaluated with serial neurological examinations.

The role of repeat head CT has been debated. Currently, there is not conclusive evidence that repeat head CT helps. In fact, several studies have demonstrated that clinical care does not change, regardless of the repeat head CT results without accompanying clinical deterioration [9-10].

Conclusion

From our analysis we can conclude that for detecting new lesions or enlargement of existing lesions in traumatic brain injury repeat CT scans were found to be of significance which results in changing of management in a substantial percentage of patients. Further study is needed for better outcome near future. Patients with mild head injury with fracture skull should be referred to tertiary centers for further evaluation and detection of EDH. Patients with mild head injury without fracture skull should be observed in local centers if any deterioration occurs then they should be referred to a tertiary center.

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