



A STUDY ON ROLE OF ROUTINE FOLLOW UP CT SCAN IN TRAUMATIC BRAIN INJURY

Neurosurgery

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ABSTRACT

Traumatic brain injury (TBI) is a common problem in clinical practice and forms the major part of Neurosurgeons' work in this part of the world. Computerized Tomographic (CT) Scan is a very important tool in the diagnosis and decision making in the management of TBI. Since many of the traumatic brain lesions tend to evolve in the first few days of injury, it is a common practice among many Neurosurgeons to do routine follow up CT scan in the first few days after the initial CT, irrespective of whether there has been clinical deterioration or not. But this practice is often questioned and the literature is divided in its opinion on this issue. Hence this study has been undertaken to see whether the routine follow up CT is really indicated even in the absence of clinical deterioration and whether it has changed treatment in these patients. This study has been conducted on 71 patients with TBI including mild, moderate and severe TBI. The follow up CT showed worsening in 37 patients and resulted in change of treatment in 31 patients. Surgery was performed on the basis of worsening in follow up CT in 7 patients and 3 of these patients did not have corresponding clinical worsening. This study has vindicated the performance of routine follow up CT scan in TBI with or without clinical deterioration so that medical or surgical intervention is performed earlier to prevent major morbidity and mortality.

KEYWORDS

traumatic brain injury, computed tomography, glasgow coma scale

INTRODUCTION

Traumatic brain injury (TBI) is a very potentially devastating critically hampering condition, with potential to produce severe disability to death of the victim. Estimates indicate that about 10 million people succumb to TBI annually. The cost of medical treatment of TBI and loss of productive manpower work out to several billions of dollars annually. Moreover, a significant number of TBI victims require long term medical care due to cognitive and neurological deficits and also develop conditions like epilepsy. Hence TBI results in significant loss to the exchequer.

TBI is classified into primary injury, occurring directly due to trauma, like, intracranial hematoma, brain contusion, diffuse axonal injury, etc. and secondary injury, which is due to biochemical changes causing brain oedema, herniation, etc. Hence the treatment of TBI not only requires treatment for the current primary injury, but also prevention of the occurrence of secondary brain injury. Apart from the clinical neurological assessment, Computerized Tomographic scan (CT scan) plays an, significant role in the treatment and management of TBI. CT scan can pick up the potentially life, threatening lesions early and help in the prevention of the threat to life. CT scan can also be used in the follow up during the acute phase of TBI and can diagnose the evolving primary lesions and secondary lesions due to the primary injury, well before they manifest clinically.

Routine follow up CT scan is used routinely in many centers after the initial CT in TBI. But this practice has evoked lot of controversy. The literature seems to be divided on the utility of the routine repeat CT scan in TBI. Most studies advocate follow up imaging in CT scan only if there is worsening clinically. But significant number of studies are in favor of routine repeat imaging in CT scans.

Hence this small study has been undertaken to study as to whether the routine follow up CT scan is useful in the management of TBI in our population.

Pathogenesis Of TBI

Pathophysiology of Traumatic Brain Injury

The pathophysiological mechanisms underlying TBI are intricate and multifaceted. The first impact to the head results in primary brain injury, characterized by direct tissue damage from the force of the trauma. This can manifest as contusions, lacerations, or hematomas.

Primary Brain Injury The initial impact to the head results in direct tissue trauma, constituting primary brain injury.

This May Manifest As:

- **Contusions:** Focal areas of haemorrhagic brain parenchymal injury.
- **Lacerations:** Open wounds of the brain parenchyma.
- **Hematoma:** Extracerebral (epidural, subdural, subarachnoid) or intracerebral collections of blood.

Secondary Brain Injury: A cascade of deleterious events follows the primary injury, collectively termed secondary brain injury.

Key Components Include:

- **Cerebral Oedema:** Accumulation of fluid within brain tissue, leading to increased intracranial pressure (ICP) and potential herniation.
- **Ischemia-Reperfusion Injury:** Hypoxic-ischemic brain injury followed by reperfusion can exacerbate tissue damage through oxidative stress and inflammation.
- **Diffuse Axonal Injury (DAI)** It is caused due to widespread shearing of nerve cell axons, resulting in neuronal dysfunction and axonal loss.
- **Neuroinflammation:** Immune response within the brain, which can both protect and harm brain tissue.

Literature on the routine follow up CT scan in TBI:

The topic of routine follow-up CT scan in TBI has been a matter of intense debate and many studies have been published in this aspect.

Lee et al (1997) have studied 94 patients with TBI for whom follow-up CT scan was performed and correlated the CT findings and the Glasgow Coma Scale (GCS) score at the first and follow-up CT scan. They concluded routine follow-up CT scan can be of no value unless there was clinical deterioration¹

Brown et al (2007) in their study with 354 patients concluded that "Patients with any head injury (mild, moderate, or severe) should undergo a repeat head CT after neurologic deterioration, because it leads to intervention in over one-third of patients. Routine repeat head CT is indicated for patients with a GCS score <8, as results might lead to intervention without neurologic change."

Stippler et al., (2012) in their systematic review involving 74 studies on the routine follow-up CT scan in mild TBI, have concluded that "Routine follow-up CT scans rarely alter treatment for patients with complicated mild TBI. Follow up CT scans based on neurological decline alter treatment five times more often than routine follow-up CT scans"

Doddamani et al., (2012) studied 201 patients with routine serial CT scans and observed that 47 patients (23%) had change in treatment plan based on follow up CT and 21 patients did not have any clinical deterioration. Hence, they advocate routine follow up CT scan to detect worsening of intracranial lesions early.

Wurmb et al., (2014) in their study of routine follow up CT in severe head injuries involving 81 patients found that progression of intracranial lesions warranting change in treatment occurred in 54% of patients and hence advocate routine follow up CT scan in patients with severe head injury who are on ventilation

Umerani et al (2016) in their study involving 107 patients have concluded that repeat CT scan should be routinely performed if the initial CT scan was done within 4 hours of severe trauma and the initial CT scan did not correlate with the neurological status.

Shah et al., (2017) studied 214 patients and have observed that radiological worsening in follow up CT was seen in patients when the initial CT was done within 2 hours of trauma and routine follow up CT scan unaccompanied by neurological worsening did not alter the management. Hence they do not advocate routine follow up CT scan

Nagesh et al., (2019) have studied 1033 patients who underwent routine follow up CT scan and found that 75 patients underwent surgery on the basis of follow up CT scan without neurological deterioration. They also found that "lower GCS score at admission time with, abnormal INR, presence of midline shift and also effaced basal cisterns, and multiple lesions on initial CT" were the factors associated with the need for surgical procedure based on radiological worsening with or without neurological worsening.

Abubakar et al., (2019) in their study of 202 patients who had follow up CT scan, found that 54 of them had progression of the haemorrhagic lesions and advocate routine follow up CT scans after TBI.

Jeyaselvaseenthilkumar et al., (2019) in their study with 235 patients found increase in size of the hematoma or fresh lesions in the follow up CT scans requiring change in treatment in 9% of patients and advocated routine follow up imaging CT scans in TBI.^[23]

Moskopp et al., (2023) studied 123 patients who had routine follow up CT scan and found that deterioration in CT scan without clinical deterioration warranting surgery happened only in 1 patient. They also observed that coagulopathy was associated with rapid increase in size of intracranial haematoma. They also observed routine follow up CT scan is not indicated unless accompanied by clinical deterioration.

Inclusion Criteria:

Patients with mild, moderate and severe traumatic brain injury.

Exclusion criteria:

- 1) All the subjects on whom surgery was performed immediately after look in to the images of the initial CT scan itself
- 2) Pediatric patients
- 3) Patients with major poly-trauma with other systemic injuries

DISCUSSION

It is a well-known fact that good proportion of traumatic intracranial lesion including hematomas and contusions tend to evolve during the immediate post traumatic period. While majority of such increase in traumatic intracranial mass lesions is accompanied by clinical deterioration, a small group of these patients with traumatic intracranial lesions show increase in the size of the lesions without any clinical deterioration and may require change in the treatment regimen. Some of them even might need surgical evacuation. Hence it is a practice in many centers to perform a routine follow-up CT scan within the next 24-48 hours after the initial CT scan. But many neurosurgeons consider this as unnecessary and follow-up CT scan is needed only if there is any neurological deterioration in the form of fall in conscious level /Glasgow Coma Scale (GCS) and /or neurological deficits. The literature also seems to be divided on this topic.

In the present study an attempt has been made to evaluate the role of routine follow-up CT scans in TBI and to categorize the group of patients who would mandatorily require routine follow-up CT scans. In the present study, of the 71 patients studied, 37 (52.1%) had worsening in the routine follow-up CT scan. The management protocol

had to be changed in 31 patients, of which 24 patients had change in medical management and 7 underwent surgery. In 18 patients with worsening on follow-up CT scan without clinical worsening, 15 had change in medical treatment protocol and 3 underwent surgery. Of the 3 patients who were treated surgically, 2 were mild injuries one had severe injury.

When analyzing the prognostic factors for worsening in follow-up CT, one of the main factors was the time interval between injury and the initial CT.

Out of 37 patients who had increase in follow up CT 35 patients had taken first CT within 3 hours from the injury. Further in this 35 patients 12 patients had taken CT within 1 hour from injury. 23 patients have taken CT between 1 -3 hours. 2 patients have taken after 3 hours, it clearly shows that patients who have taken CT within 3 hours from the time of injury have likely to have increase in size of the lesion, hence it is necessary to have follow-up CT.

The second factor was the type of the traumatic lesion. Out of 37 patients who had increase in CT findings 17 had mixed lesions, 8 patients who had contusion also increased, followed by Edh with 7 patients, so it's clear that whenever patients present with mixed lesions in initial CT there could be the progression.

Out of 37 patients who had increase in CT findings 18 patients were above 50 years, 10 patients were under 30 years, and 9 patients were between 30 and 50 years. Hence it clearly shows elderly patients have high chances of progression of lesion in follow up CT.

The third factor was coagulopathy or intake of anti-platelet medication. 6 patients who were having coagulopathy/anti-platelet medication, had worsening in follow-up CT scan without clinical worsening.

The literature on this topic is divided on whether routine follow-up CT scan is indicated without any clinical worsening. Some studies have shown that there is no role for routine follow-up CT scan without clinical worsening in TBI, especially in mild and moderate TBI. They argue that even if there is worsening in routine follow-up CT scan, they alter the management very rarely. The added cost and the radiation exposure, etc. are also cited as factors against routine follow-up CT scan.

In the present study, 37 out of 71 patients (52.1%) had worsening in follow-up CT scan. 18 of these patients did not have any clinical worsening at the time of follow-up CT scan. Wurmb et al (2014) also had observed that 54% had worsening in the follow-up CT scans. Abubakar et al (2019) had shown that 54 out of 202 patients studied had progression of hemorrhagic lesions in follow-up CT scans.

In the present study, the treatment protocol had to be changed on the basis of findings in follow-up CT scan alone in 18 patients and 3 of them had surgical treatment. 2 of the 3 patients were in good neurological status (mild injury). Nagesh et al (2019) had found that 75 out of 1033 patients underwent surgery on the basis of follow-up CT alone without neurological deterioration. Doddamani et al (2012) found that 47 out of 201 patients (23%) studied had change in treatment on the basis of follow-up CT and 21 of these patients did not have any clinical deterioration at the time of follow-up CT.

In the present study, 12 patients who had initial CT within 1 hour of injury and 23 patients who had initial CT scan between 1 and 3 hours of injury had worsening in follow-up CT scan. Shah et al (2017) had observed worsening in follow-up CT scan, if the initial treatment is done within 2 hours of injury. Umerani et al (2016) advocate routine follow-up CT scan if the initial CT was done within 4 hours of injury.

In the present study, coagulopathy or anti-platelet medication intake was noted in 6 patients with worsening in follow-up CT scans. Nagesh et al and Moskopp et al also have noted that coagulopathy as an important factor in the progression of traumatic intracranial lesions.

It is seen from the present study that the routine follow-up CT scan in TBI with or without clinical worsening has an important role in managing the progressive traumatic intracranial lesions and preventing major morbidity and mortality in good number of patients. Radiological worsening without clinical worsening seems to be fairly

common and has changed the course of treatment in many patients. The cost of CT and the risk of radiation should be weighed against the potentially lifesaving role of the routine follow-up CT scan.

It also has been observed in the present study that time between the injury and the initial CT scan is an important factor in radiological worsening in follow-up CT and hence routine follow-up CT is very much indicated all patients who have the initial CT within 3 hours of injury. Intake of antiplatelet medication and presence of coagulopathy is also an important factor in the progression of the traumatic intracranial lesions and hence routine follow-up CT scan is necessary in these patients.

This is a small prospective observational study and has its limitations. The sample size is small and this study needs to be performed in a larger population. Nevertheless, this study strengthens the case for routine follow-up CT scan in TBI.

It is also observed that out of 37 patient who had progression of lesion in follow up CT 30 patients presented with initial grade of mild GCS, 4 were moderate and 3 were severe, so it clearly shows that even if the patient presents with mild GCS are likely to have progression in follow up CT hence it is best practice to have follow up CT. Out of these 30 patients who had presented with mild GCS and 25 patents have taken within first 3 hours of injury.

Type of lesion	No of cases	No. of cases with progression in follow-up scan	Percentage
Contusion	11	7	63.6%
SDH	14	1	7.1%
EDH	21	6	28.5%
Mixed lesion	25	4	16%

Out of 37 patients who had increase in CT findings 17 had mixed lesions, 8 patients who had contusion also increased, followed by Edh with 7 patients, so it is clear that whenever patients presents with mixed lesions in initial CT there could be the progression of the lesion in followup CT

CT Findings at Admission	CT Findings at Follow up						Total	
	Static		Increased		Decreased			
	N	%	N	%	N	%	N	%
Contusion	3	15.8	8	21.6	0	0	11	15.5
EDH	7	36.8	7	18.9	7	46.7	21	29.6
SDH	7	36.8	5	13.5	2	13.3	14	19.7
More than One	2	10.5	17	45.9	6	40.0	25	35.2
Total	19	100.0	37	100.0	15	100.0	71	100.0

Fisher's Exact value = 15.09, P value = **0.01***, Inference : Is Statistically Significant

Arrangement of Distribution of study subjects according based on type of initial lesion and follow up progression in CT

CONCLUSIONS

This study on 71 patients with TBI on role of routine follow-up CT scan in the treatment and also management protocol has provided the following conclusions:

1. Good proportion of posttraumatic intracranial lesions tend to progress in the initial posttraumatic period.
2. Routine follow-up CT scan has shown radiological worsening with or without clinical worsening in 52.1% of the patients studied.
3. 18 out of 37 patients who had radiological worsening without clinical worsening had change in the treatment protocol and 3 patients had surgery on the basis of the findings in the routine follow-up CT.
4. Patients who have the initial CT scan early in the posttraumatic period (less than 3 hours of injury) have high likelihood of worsening of the intracranial lesions and hence the routine follow-up CT is mandatory in these patients.
5. Intake of anti-platelet medication or the presence of coagulopathy also increase the chance of worsening of traumatic intracranial lesions and repeat imaging of CT scan is a must in these subjects.

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