POSITIVE CT BRAIN DURING EARLY POSTOPERATIVE PERIOD IN HEAD INJURY PATIENTS: IMPACT ON CLINICAL COURSE AND OUTCOME

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ABSTRACT

Objectives: To assess the impact of positive postoperative CT head during the initial 72 hours on overall clinical course and outcome.

Methodology: 157 patients of head trauma who underwent cranial surgery were prospectively included. All patients underwent a repeat head CT during the initial 72 hours or as was indicated by neurological status of the patient. Data was collected about patient demographics, initial CT diagnosis, repeat CT findings, re-operation if performed, GCS at discharge, mortality and outcome in terms of GOS. Data was analysed for impact of positive finding in postoperative CT head and its impact on clinical course and outcome.

Results: The overall mean age was 34.25 ±11.59 years with a mean arrival GCS of 9.2 ±2.32. The mean time to first postoperative CT was 21.45 ±9.83 hours. The postoperative CT scan was positive in 29 (18.5%) patients in which 16 (10.2%) cases required re-intervention. Overall mortality was 19 (12.1%), of which 9 (44.1%) had a positive post-operative CT scan and 4 (21.1%) of them underwent a repeat intervention. 2.3% of patients with negative CT were re-operated while 44.8% were re-operated in the positive CT ($p < 0.0001$). Similarly, mortality was 7.8% in the negative CT group while it was 31.0% in the positive CT group ($p < 0.0001$).

Conclusions: Positive follow-up CT scan during early post-operative period can affect significantly the clinical course and neurological outcome of patients.

Key Words: Head trauma, Computed tomography, Outcome

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INTRODUCTION

Computed tomography (CT) has revolutionised the management of brain trauma and is the modality of choice for investigating patients during initial presentation and during the follow-up. The wide availability of CT with a relatively low cost and its rapidity are one of the main reasons for its acceptance as the prime investigating tool for head injury patients. More recently, high resolution and thin slice CT technology has gained popularity due to their high diagnostic performance[1,2].

The early post-operative period in patients who are operated upon for intra-cranial lesions due to trauma is the most crucial period in terms of recovery potential as well as the development of delayed traumatic lesions[3].

Extradural haematoma is one of the most common intra-cranial lesion which may arise late, increase in size and volume or recur once it has been evacuated. Similarly, expansion of acute subdural haematoma, concomitant development of parenchymal lesions, expansion of contusion, recurrent bleed in resected contusion bed, re-expansion of intra-cerebral haemorrhage as well as recurrent or new onset intra-cranial haematoma in patients operated upon for depressed skull fracture are one of the most dreaded clinical entities which may affect the clinical course of a patient who has already been operated and recovering in the ward[4,5].

There is a consensus agreement regarding performing repeat computed tomography (CT) brain during the initial 72 hours following surgery. However, the impact of a positive CT scan of brain during this period on the clinical course and outcome has been described very little[4].

We therefore aimed to conduct a prospective observational study where the impact of positive postoperative CT on clinical course and outcome is determined. This will help in optimal classification of patients according to their risk factors and improve post-operative outcome.

METHODOLOGY

This was a prospective observational study conducted between January 2015 and December 2015 after obtaining the approval of the institutional ethical committee. An informed consent was obtained from all patients before inclusion in the study and before undergoing any major interventional procedure.

Adult patients between the ages of 16 and 65 years presenting to the Department of Neurosurgery with a history of head injury who were undergoing cranial surgery for intracranial traumatic lesions were included irrespective of their gender. Patients with non-traumatic lesions such as spontaneous intra-cerebral haemorrhage (ICH), spontaneous extradural/subdural haematoma, those with pre-existing bleeding disorders and those already operated elsewhere for their primary lesion were excluded from the study. Also, patients with chronic traumatic lesions such as chronic subdural haematoma were excluded.

All patients underwent standard neurosurgical treatment on arrival, such as initial acute trauma life support (ATLS) protocol for management of airway, breathing and circulation. Diagnosis was established based on the CT brain for head trauma. Surgical decision was undertaken by the on-call neurosurgeon consultant. All surgical lesions were treated under general anaesthesia with standard surgical procedures such as craniotomy (in cases of extradural/subdural haematoma and contusion resection) while burrhole aspiration was used for ICH which required surgical evacuation. Post-operatively, patients were kept in the neurosurgical high dependency unit (HDU) and both vital signs and neurological status were monitored closely.

All patients were grouped per the severity classes of the Glasgow coma scale (GCS), the mechanism of injury, presence or absence of injury to other systems, location of the lesion and type of lesion. Initial laboratory investigations such as blood complete picture, electrolytes and blood urea, virology and coagulation profile were performed after emergency resuscitation.

Repeat post-operative CT scans were performed in all patients, where the timing was dependent upon either the neurological status of the patient or the severity of initial surgical lesion for which the patient was operated upon. For re-operation, if required, decision was undertaken by the neurosurgeon consultant per the clinical status and radiological findings.

Data was collected about patient demographics, vital parameters, laboratory investigations, clinical and neurological status (such as GCS, pupillary abnormalities, focal deficits etc.) and post-operative clinical and radiological findings. Patients were grouped as either having either a positive CT scan or not.

Positive CT scan was defined as the appearance of new lesion, recurrence of the lesion at the operated site or another site and/or expansion in size and volume of an intracranial lesion irrespective of whether it needed operative intervention or not.

Patients who underwent a repeat intervention were also grouped and their clinical course and outcome was recorded per the GCS. Overall mortality was also recorded. Patient's outcome was grouped per the GCS at discharge. GCS ≤10 was considered as unfavourable outcome while patients with 11 or above GCS were grouped as having a favourable outcome.

Data was analysed using the SPSS version 22.0. Chi square associational statistics were calculated for the pre- and post-operative risk factors. A p value of ≤0.05 was considered as showing statistical significance.

RESULTS

There were 157 patients who were operated upon for various intra-cranial traumatic lesions with 102 (65.0%) males and 55 (35.0%) females in a male to female ratio of 1.86 to 1. There were 77 (49%) cases where the mechanism of injury was RTA, 37 (23.6%) cases of fall and 23 (14.6%) cases due to crush injury. There were 3 (1.9%) cases of gunshot wound to the head, while there were no cases due to blast injury. The overall mean age was 34.25 ±11.59 years with a mean arrival GCS of 9.2 ± 2.32. The mean time since injury to presentation was 9.9 ±6.06 hours. Mean Systolic BP after resuscitation was 116.42 ±22.32 mmHg. Mean INR was 1.25 ±0.16 and mean haemoglobin level was 12.32 ±1.65 g/dL. The mean lesion volume was 43.31 ±13.17 cc. The mean time to first post-operative CT was 21.45 ±9.83 hours while the mean GCS at discharge was 11.09 ±3.86.

Overall, there were 65 (41.4%) cases of extradural haematoma (EDH), 42 (26.8%) cases of acute subdural haematoma (ASDH), 29 (18.5%) cases of cerebral contusions and 21 (13.4%) cases of intra-cerebral haemorrhage (ICH). The lesions location intra-cranially was as follows; 28 (17.8%) frontal, 73 (46.5%) parietal, 16 (10.2%) occipital, and 41 (26.1%) cases of temporal location of intra-cranial lesion.

A total of 265 CT scans were obtained for the 157 patients, with an average of 2.9 CT scans per patient (range: 1 to 4), mostly (n = 72, 45.9%) at least two CT scans in the post-operative period; one CT scan within the first 24 hours and another shortly before discharge or if indicated by neurological status change. The post-operative CT scan was positive in 29 (18.5%) of patients in which 16 (10.2%) cases required re-intervention (Table 1).

One-hundred and one (64.3%) patients were classified as having a favourable outcome at discharge while

56 (35.7%) cases were in the unfavourable group. Overall mortality was 19 (12.1%) cases of which 9 (47.4%) had a positive post-operative CT scan and 4 (21.1%) of them underwent a repeat intervention (Table 1). Study demographics, clinical features and outcome variables are presented in Table 1 & table 2 for the two follow-up CT classes.

A Mann-Whitney U test was performed to test for differences in the qualitative variables across the two groups of patients, i.e., negative post-op CT and positive CT scan. An independent samples t-test was performed to determine differences for the continuous variables. Findings of Mann-Whitney U test are summarised in table 1 while those of independent samples t-test are summarised in table 2.

DISCUSSION

A variety of surgical intra-cranial lesions are encountered in day-to-day neurotrauma practice which frequently needs surgical intervention. In almost all patients of head trauma, the diagnosis is established using CT of the brain and skull usually without contrast enhancement. Gupta and associates[6] have concluded from a survey of CT of the skull and brain that there were 62.04% cases of skull fractures, 46.33% of ICH, 30.36% of EDHs and 19.37% of ASDHs. They have also shown that most victims of surgical lesions are male patients between 20 to 40-years age groups. Numerous other studies have shown the same trends, as males are one of the most active members of our society; they have a very dynamic day-to-day life and therefore, are prone to injuries in motor vehicle accidents, falls and assault[7]. Our study also shows similar trends with overall mean age of 34.25 ±11.59 years while among the study population 65% were male patients.

Several studies have investigated the optimal timing of repeat CT in head trauma patients and many have shown that almost 50% of patients deteriorate during the initial 72 hours after trauma due to expansion of existing lesions, appearance of new haemorrhagic lesions or due to diffuse cerebral swelling[8,9]. We don't have the facility of invasive intra-cranial pressure (ICP) monitor-

Table 1: Comparative representation of clinical variables based on follow-up CT positivity

Variable	Negative CT Brain (n=128)	Positive CT Brain (n=29)	P value
	Frequency (%)	Frequency (%)	
Gender			
Male	84 (65.6%)	18 (62.1%)	0.72
Female	44 (34.4%)	11 (37.9%)	
Pupillary Abnormality	39 (30.5%)	13 (44.8%)	0.13
Lesion Location			
Frontal	26 (20.3%)	2 (6.9%)	0.08
Parietal	55 (43.0%)	18 (62.1%)	0.06
Occipital	14 (10.9%)	2 (6.9%)	0.5
Temporal	34 (26.6%)	7 (24.1%)	0.7
Type of Lesion			
Extradural Haematoma	55 (43.0%)	10 (34.5%)	0.4
Acute Subdural Haematoma	34 (26.6%)	8 (27.6%)	0.9
Contusion	23 (18.0%)	6 (20.7%)	0.7
Parenchymal Haemorrhage	16 (12.5%)	5 (17.2%)	0.5
Re-operation	3 (2.3%)	13 (44.8%)	<0.001
Mortality	10 (7.8%)	9 (31.0%)	<0.001
Outcome Group			
Favourable	89 (69.6%)	12 (41.4%)	<0.001
Unfavourable	39 (30.5%)	17 (58.6%)	

Table 2: Clinical features grouped based on follow-up CT results

Variable (mean ± SD)	CT Negative (n=128)	CT Positive (n=29)	Significance (p value)
Age (years)	34.12 ± 11.61	34.41 ± 11.74	0.93
Time Since Injury (hours)	9.95 ± 6.25	9.83 ± 5.26	0.93
Arrival GCS	9.26 ± 2.36	9.03 ± 2.11	0.64
Systolic BP (mmHg)	117.47 ± 22.86	111.79 ± 22.61	0.23
INR	1.21 ± 0.14	1.45 ± 0.08	<0.001
Haemoglobin Level (g/dL)	12.32 ± 1.67	12.28 ± 1.55	0.89
Lesion Volume (mL)	43.35 ± 13.44	43.14 ± 12.12	0.93
Time to Follow-up CT (hours)	21.56 ± 9.91	20.97 ± 9.58	0.76
GCS at Discharge	11.64 ± 3.59	8.66 ± 4.12	<0.001

ing and therefore, we have to rely on clinical findings, any progressive deterioration or appearance of new clinical features that may predict increase in ICP due to diffuse swelling or localised lesions. In some patients, such as those with severe traumatic brain injury (TBI) who cannot be interacted during a physical exam, it is mandatory to repeat CT at regular intervals. In continuation to the above-mentioned facts, it is also important to note that cerebral swelling, recurrence of operated lesions or appearance of new lesions have the same chance of occurrence as in those who have not undergone a surgical procedure.

One differentiating point in our study was that our study population were those patients who were operated for intra-cranial lesions. In this study, we noted that 18.5% of patients had positive post-operative follow-up CT and 55.1% of those (n=16) underwent a repeat operative intervention. Similarly, among patients who had a positive follow-up CT, 58.6% (n=17) of them had an unfavourable outcome. Only 2.3% (n=3) of patients among those who had a negative follow-up CT underwent an additional surgery while 44.4% of those with positive follow-up CT underwent additional surgical procedure. These findings in our study highlight the importance of follow-up CT even in those who have been operated for intra-cranial traumatic lesions. Moreover, it was noted that development of a new lesion or recurrence of the treated one as well as reoperation increases the likelihood of unfavourable outcome both in terms of neurological status (mean GCS: 8.66 ±4.11 for CT positive patients) and mortality.

One large prospective study by Brown and associates[10] investigated the routine indications of repeat head CT and its impact on management in various classes of TBI based on GCS. This study included both medically managed patients and patients who were treated surgically. They showed that follow-up CT of head if prompted by neurologic status change will lead to an intervention in approximately 37% of cases while CT without neurologic status will lead to an intervention in only 1% of patients. They have concluded that repeat head CT should be performed when prompted by change in neurologic status. However, they have recommended routine repeat head CT in patients with GCS ≤8 without neurologic change.

In our study, 38.2% of patients were with GCS ≤8 and those in whom the CT was positive included 41.4% of patients with GCS ≤8. Those in whom the CT was negative included 37.5% of patients who had a GCS of 8 or less. However, there are many patients who are with moderate or mild disturbance of GCS at presentation but do have an operable intra-cranial lesion. These patients have a risk of developing new or recurring lesions post-operatively.

In our study, there were 58.6% (n=23) patients with moderate or mild TBI who had a positive CT. This was a large proportion of patients, and not only neurologic status change but other risk factors also need to be considered. For instance, in our study, patients who had a positive follow-up CT had a mean INR of 1.45 ±0.08 and those with negative CT, had mean INR of 1.2 ±0.14 (p <0.001). Post-TBI coagulopathy due to fluid resuscitation or whole blood administration are common in traumatic patients especially those with poly-trauma and have been reported to be valid risk factors for development of post-operative intra-cranial haemorrhagic lesions.

In our study, we observed that patients who developed a post-operative intra-cranial lesion which was significant in size (causing midline shift >5mm, hydrocephalous, bleed of more than 10 mm thickness) had higher chances of re-operation (44.8%) and higher mortality (31%) as compared to patients who had negative CT (2.3% reoperation, 7.8% mortality). As mentioned earlier, our results showed that 69.6% patients with a negative post-operative CT achieved favourable outcome while in the positive CT group, favourable outcome was only 41.4% (p <0.0001). Flint and associates[11]

have investigated the expansion rates of intra-cerebral contusion after decompressive craniectomy and showed that re-expansion occurred in 58% of patients and it was associated with higher mortality and prolonged morbidity.

Takeuchi and associates[12] have shown that though a well-established protocol for routine CT head after cranial surgery is not developed, usually a CT scan is performed on individual surgeon preference or if any neurological status change occur. They demonstrated that craniotomy or decompressive craniectomy, GCS of 8 or less and absence of basal cisterns on pre-operative CT scans were highly predictive of new findings on follow-up CT scans and they have favoured that routine CT should be obtained after craniotomy or decompressive craniectomy. On the contrary, Fontes et al[13] and Khaldi et al[14] have shown that routine CT without clinical indication rarely change the clinical course and if combined with clinical criteria, a CT brain may change the clinical course in up to 30% of patients as indicated by our study.

Patients who underwent operative intervention need to be monitored closely both clinically, as well as radiologically[1,2,15]. In our country, we do not have invasive ICP monitoring facility, neither do we have sufficient intensive care facilities. This is compounded by the fact that our patients reach late and have multiple injuries due to poor rescue and pre-hospital trauma care. Neurologic status change is a good indication for repeat CT head, but pre-and intra-operative findings also affect the need for serial CT scans post-operatively. However, un-necessary CT scans can be avoided if patients are monitored closely, good operative techniques and frequent neurologic status monitoring.

CONCLUSION

Follow-up serial CT scans in patients operated for traumatic intra-cranial lesions was an important monitoring tool during the early post-operative period. It can affect significantly the clinical course and neurological outcome of patients. Significant differences were found between patients having positive follow-up CT versus patients with negative follow-up CT in terms of re-operation rate, mortality and outcome at discharge. A follow-up CT after cranial surgery should primarily be indicated on clinical grounds rather than on routine basis.

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CONTRIBUTORS

ZUR conceived the idea, planned the study, and drafted the manuscript. MMK helped acquisition of data and did statistical analysis. SA supervised the study and critically revised the manuscript. All authors contributed significantly to the submitted manuscript.