

## The Utility of Repeat Head Imaging in Patients with Traumatic Intracranial Hemorrhage and Glasgow Coma Scale 15

Al-Ghafri S<sup>1\*</sup>, Maghraby N<sup>1</sup>, Nemeth J<sup>1</sup>, Al-Juma S<sup>1</sup> and Bracco D<sup>2</sup>

<sup>1</sup>Department of Emergency Medicine, McGill University Health Center, Montreal, Quebec, Canada

<sup>2</sup>Department of Anesthesia, McGill University Health Center, Montreal, Quebec, Canada

### Abstract

The current practice to manage a patient suffering from a head injury with Intracranial Hemorrhage (ICH) based on initial head Computed Tomography (CT) scan, and who does not require surgical intervention, is for the patient to be observed for neurological deterioration for a period of time and then undergo repeat head imaging within 24 hours after the injury to assess for progression of ICH.

**Objective:** The purpose of this study is to determine the frequency and type of intervention changes that are based on the results of a second repeated head CT scan done at six hours after the initial head CT scan for patients with intracranial hemorrhage, Glasgow Coma Scale (GCS) 15 and absence of neurological deficits.

**Methods:** A consecutive sample of all ICH patients based on initial head CT scan with an initial GCS 15 and no neurological deficits presented or referred to the Montreal General Hospital (MGH) Emergency Department (ED) were included.

**Results:** 31 patients who met the inclusion criteria were included in the study. None of the patients required change in the initial management plan based on the repeated head CT scan. Two patients had radiological worsening of the hemorrhage; however, neither of them had any changes in their management.

**Conclusion:** In this limited cohort of patients with mild Traumatic Brain Injury (TBI) specifically GCS 15 and without neurological deficits, routinely repeating head CT scan at six hours after the initial head CT scan did not change the management plan.

**Keywords:** Glasgow Coma Scale 15 (GCS 15); Minor head injury; Neurosurgical intervention; Traumatic Brain Injury (TBI); Traumatic Intracranial Hemorrhage (ICH)

**\*Corresponding author:** Al-Ghafri S, Department of Emergency Medicine, Residency Program, McGill Emergency Medicine Residency Program Office, Royal Victoria Hospital, 1001-Decarie, Boulevard, Room CS16237.1. Montreal, QC, H4A 3J1, Canada, Email: saif.alghafri@mail.mcgill.ca

**Received Date:** March 04, 2017

**Accepted Date:** May 06, 2017

**Published Date:** May 22, 2017

**Citation:** Al-Ghafri S, Maghraby N, Nemeth J, Al-Juma S, Bracco D (2017) The Utility of Repeat Head Imaging in Patients with Traumatic Intracranial Hemorrhage and Glasgow Coma Scale 15. J Emerg Med Trauma Surg Care 1: 002.

without any clinical deterioration resulted in neurosurgical change of management [6-14].

Reljic and colleagues conducted a systematic review and meta-analysis on the value of repeated head CT scans after traumatic brain injuries. In the subgroup of mild TBI, they reported significant heterogeneity among both prospective and retrospective studies. They found that 2.3% of mild TBI patients enrolled in all prospective studies underwent changes in management following repeat head CT scans. Moreover, only 1.5% of them received neurosurgical intervention [15].

Conversely, there were a few studies suggesting that routine repeat of head CT in mild TBI is beneficial, and may lead to management changes even in patients with no clinical deterioration [16-17]. To our knowledge there are no existing studies evaluating exclusively the need for repeat head CT scan in patients with GCS 15, and absence of neurological deficits, but who have evidence of TBI in their initial head CT scan.

This prospective cohort study will look at the frequency of change in management after the repeat (second) head CT scan, in patients with traumatic Intracranial Hemorrhage (ICH) and GCS 15 without neurological deficits. The hypothesis is that a repeat head CT scan in patients with traumatic ICH with a GCS of 15, and no neurological deficits is unlikely to result in a change of the neurosurgical management plan.

### Introduction

Mild Traumatic Brain Injury (TBI) is a major cause of morbidity and mortality worldwide resulting in a major public health and socioeconomic burden [1]. There are many guidelines existing for the investigation and management of all spectrum of TBI (Mild, Moderate and Severe). Although the indications for initial brain imaging have been well established, there is no consensus on routine repeat head imaging, especially for patients who do not need any surgical or medical interventions based on an initial head Computed Tomography (CT) scan [2-5].

Several studies evaluating the utility of repeat head CT scan in mild TBI (Glasgow Coma Scale (GCS) 13-15) have been published. It was shown that the routine repeating of head CT scans in patients

Methods

Study design & population

This was a prospective cohort study at the tertiary academic trauma center. A consecutive sample of all traumatic ICH patients with an initial GCS 15 presenting to the Montreal General Hospital (MGH) Emergency Department (ED) were included between August 2015 and February 2016.

**Inclusion criteria:** Adult patients (age above 18 years old), trauma within 24 hours, intracranial hemorrhage diagnosed on initial head CT scan and a GCS of 15 at initial assessment with no neurological deficits.

**Exclusion criteria:** Pregnant, known intracranial pathologies (tumors, ventricular peritoneal shunt and aneurysm), known coagulation disorder, penetrating head injuries and patients requiring surgical intervention based on initial head CT scan findings.

All the included patients had a repeat head CT scan at 6 hours after the initial scan. Neuroradiologists read all the CT scans.

Definition of variables

Change in management plan is defined as any treatment decision based on the repeated (second) head CT scan that had not already been made based on the initial scan. These changes include medical managements (anticonvulsant, high Intracranial Pressure (ICP) medications, anticoagulants or antiplatelet therapies), surgical managements (ICP monitoring device or operative procedures), or the decision for admission (regular floor or Intensive Care Unit (ICU)).

Data collection

McGill University Health Center (MUHC) ethical committee reviewed the study, which waived written informed consent from the patients (Gen-15-068), and to ensure patient confidentiality, the data sheet was coded. In order to collect data on any changes in the patient management plans, the treating neurosurgery team completed a form that included three direct questions regarding the management plan based on the initial head CT scan: 1. Does the patient require medical management? 2. Does the patient require surgical intervention? 3. Does the patient require admission?

After repeating the head CT scan, another set of three questions were asked: 1) What is the reason for the second head CT scan? 2) Is there a progression of the bleeding? 3) Does the repeat head CT scan change the initial strategy/suggestions? (Figure 1) Those who completed the forms were blinded to the study.

Statistical analysis

Data management and statistical analyses were undertaken using the R statistical software. Summary statistics (counts, percentages, means and standard deviations) for all variables appearing in table 1 were generated using the “table one” package.

Results

In total, 31 patients were included in the study. Of the 31 patients, 45% were male and 55% were female. All of the initial scans were

Suggestions/ strategy based on initial head CT scan:	Suggestions/ strategy based on repeat head CT scan:
1.Does the patient require medical treatment <input type="checkbox"/> Yes (Specify): <input type="checkbox"/> Mannitol <input type="checkbox"/> Hypertonic Saline <input type="checkbox"/> Anticonvulsant <input type="checkbox"/> No	1.What is the reason to do the second head CT? <input type="checkbox"/> Routine (6 hours) <input type="checkbox"/> Mandated: <input type="checkbox"/> Decrease level of Consciousness <input type="checkbox"/> Seizure <input type="checkbox"/> New neurological deficits <input type="checkbox"/> Others:
2.Does the patient require surgical intervention? <input type="checkbox"/> Yes (Specify): <input type="checkbox"/> ICP Monitoring <input type="checkbox"/> EVD <input type="checkbox"/> Burr holes <input type="checkbox"/> Craniotomy/Craniectomy <input type="checkbox"/> No	2.Is there a progression of the bleeding? <input type="checkbox"/> Yes <input type="checkbox"/> No
3.Does the patient require admission? <input type="checkbox"/> Yes (Specify): <input type="checkbox"/> ED for Monitoring <input type="checkbox"/> Ward <input type="checkbox"/> ICU <input type="checkbox"/> Other: <input type="checkbox"/> No	3.Does the repeat head CT scan change the strategy/suggestion? <input type="checkbox"/> Yes (Specify): <input type="checkbox"/> Surgical intervention <input type="checkbox"/> New medical management <input type="checkbox"/> Admission for monitoring <input type="checkbox"/> Other: <input type="checkbox"/> No

Figure 1: Neurosurgery team form.

performed according to the Canadian CT Head Rule. The second head CT scan was routinely done at 6 hours of observation after the initial head CT scan. None of the patients clinically deteriorated prior to the routine repeated scan. The location of the ICH for most of the patients was in the frontal lobe 35% (11/31), parietal lobe bleeding 13% (4/31), temporal lobe bleeding19% (6/31), Sylvian fissure bleeding 9% (3/31), cerebellar bleeding3% (1/31) and mixed location 19% (6/31). The majority of intracerebral hemorrhages were subarachnoid hemorrhages55% (17/31) (Table 1).

Twenty-nine routinely repeated head CT scans showed stable or better findings and only 2 head CT scans showed worsening of the bleeding. Despite the progression of the hemorrhage process, none required any change in management decided upon by the neurosurgical team based on the initial head CT scan.

Nineteen patients from the cohort were admitted to the ward, another nine patients were discharged home (Table 2), and two were transferred back to the referring hospitals. Only one patient was admitted to the critical care unit; however, it was for other injuries not related to the ICH (flail chest injury). Nine patients out of the nineteen patients admitted in the ward for mild TBI symptoms (mainly dizziness which persisted even after the second head CT) were admitted for observation but did not require any further medical or surgical intervention. The neurosurgical team prescribed anticonvulsants (Phenytoin 1 gram intravenously (IV)) for thirteen patients in the cohort based on their initial head CT scan. No further patients required anticonvulsants based on follow-up head CT scan.

The majority of patients were not taking blood thinners or anticoagulants77% (24/31). Of those taking antiplatelet or anticoagulant medication, 4 were taking aspirin, 1 Warfarin, 1 Dabigatran, 1 Aspirin and Clopidogrel. The patient on Warfarin received Beriplex + IV vitamin K; the patient on Aspirin and Clopidogrel received a platelet

	Number of Patients: n= 31	
Type of visit	First visit	14 (45%)
	Referred to MGH	17(55%)
Sex	Male	14 (45%)
	Female	17 (55%)
Age (mean (SD))	58.14 (20.36)	
Location of bleeding based on initial head CT scan	Frontal	11 (35.5%)
	Parietal	4 (12.9%)
	Temporal	6 (19.4%)
	Cerebellar	1 (3.2%)
	Sylvian fissure	3 (9.7%)
	Mix	6 (19.4%)
Type of bleeding based on initial head CT scan	Subdural	3 (9.7%)
	Subarachnoid	17 (54.8%)
	Intraparenchymal	3 (9.7%)
	Mixed	8 (25.8%)
Finding on repeated head CT scan	Stable/Better	29 (93.5%)
	Worse	2 (6.5%)
Patients received Anticonvulsants	Yes	13 (42%)
	No	18 (58%)
Disposition	Admission to ward	19 (61.3%)
	Intensive care unit	1 (3.2%)
	Home	9 (29.0%)
	Transferred back to referring hospital	2 (6.4%)
Comorbidities	Diabetic	2
	Hypertension	10
	Coronary artery disease	4
	Atrial fibrillation	2
	Chronic obstructive pulmonary disease	1
	Dyslipidemia	3
	Inflammatory bowel disease	1
	Hypothyroidism	1
	Cancer	2
	Stroke	1
Patients on antiplatelets or anticoagulants	Aspirin	4 (12.9%)
	Warfarin	1 (3.2%)
	Dabigatran	1 (3.2%)
	Aspirin + Clopidogrel	1 (3.2%)
	None	24 (77.4%)
Patients received reversal treatment	No	28 (90.3%)
	Beriplex + Vit K	1 (3.2%)
	Platelets	2 (6.5%)

**Table1:** Patient characteristics. MGH: Montreal General Hospital, Vit K (Vitamin K).

transfusion; and only 1 patient on Aspirin received a platelet transfusion (an 81 years old woman with mixed type and location of the bleeding) (Table 3).

Both of the patients who had radiological worsening of the ICH were females (81 and 36 years old), and not on any anticoagulants. The first patient (81 years old) was on aspirin and received a platelet

transfusion based on the initial head CT scan. Both of the patients had mixed types and locations of the bleeding (Table 4). Despite worsening head CT results, neither of these patients had a change in their management plan. Both of the patients were admitted to the neurosurgical ward for observation for persistent dizziness, as planned after the initial head CT.

## Discussion

Traumatic ICH without neurological deficits is a common presentation to a tertiary trauma center. At our institution, the standard of practice for management of this kind of patient is to observe the min the emergency department for at least 6hours after the initial head CT scan and to then repeat the CT. The neurosurgery team will then decide the disposition plan, which in some cases patients can be discharged home after the repeat (second) head CT scan.

Based on the results of this study, it appears that the second head CT scan did not have any impact on patient management, and although two patients had radiological worsening of the intracranial bleeding, neither of them required surgical or medical intervention based on the repeated head CT scan. In addition to failing to contribute to patient management, this practice also exposes patients to possibly unnecessary radiation, and significantly contributes to the cost of care.

The results from this study are congruent with previous work looking at repeat head CT scans in TBI. Sifri et al., conducted a prospective analysis study on blunt mild head injury (defined as GCS 13-15 with loss of consciousness or post-traumatic amnesia and evidence of ICH on the initial head CT scan) and found that in this group of patients with normal neurological examination within 24 hours post admission, the negative predictive value of a normal neurological examination was 100%, and repeated head CT scan didn't result in change of management or neurosurgical intervention in any of the patients [6]. These results were supported by another study that looked at high-risk criteria to determine the need for initial and delayed head CT scans. In spite of finding statistically significant differences between high and low-risk groups in terms of abnormal head CT scans, there were no significant correlation between initial and delayed scans in patients with high-risk criteria. However, the authors of this study suggested that it is prudent to repeat CT scans specifically for those who have a GCS of less than 15, or that decreases over time. There were 3 cases out of 120 included in the study that had worsened repeat CT scans but no change of management was needed in any of them [7].

P Anandalwar et al., published a retrospective study trying to assess the efficacy and safety of a protocol “Neurologic Observation without Repeat HCT” (NORH) implemented in their institute to manage the patient with Minimal Head Injury (MHI) and ICH without repeat head CT if the patients maintained or improved to a GCS of 15 at 24 hours after admission. 95 patients included in the study, 8 patients had delayed repeat HCT after admission (> 24 hours), 5 patients had scans ordered based on the surgeon’s clinical judgment and all the scans showed stable ICH and 3 patients had repeated scans based on acute change in their mental status which showed progression of ICH. However none of these patients required any surgical intervention related to ICH. The authors concluded that the implementation of the protocol is safe based on the results presented, and reinforced on the importance of serial clinical examination rather than routine repeat head CT scan [18].

	Age/Sex	Medications	Location of bleeding	Type of bleeding	Treatment received	Anticonvulsants Yes/ No
Patient 1	83/F	ASA	Mixed	Mixed	Platelets	Yes
Patient 2	86/F	ASA and Clopidogrel	Mixed	SAH	Platelets	No
Patient 3	94/F	Warfarin	Frontal	SAH	Beriplex and Vit K	No
Patient 4	63/M	Dabigatran	Mixed	SAH	None	No

**Table 3:** Characteristics of the patients on antiplatelets and anticoagulants who received medical treatments (n=4). ASA (Aspirin), Vit K (Vitamin K), SAH (Subarachnoid Hemorrhage).

	Age/Sex	TOB	LOB	AC	AP
Patient 1	36/F	Mixed	Mixed	No	No
Patient 2	81/F	Mixed	Mixed	No	Yes

**Table 4:** Patients with worsening bleeding (based on repeated head CT scan) (n=2): TOB (Type Of Bleeding), LOB (Location Of Bleeding), AC (Anticoagulants), AP (Anti-Platelets).

Based on the current study and those cited above, it could be suggested that there is little benefit to the use of repeated head CT scans in patients with ICH when the GCS is 15 and there are no neurological deficits or clinical deterioration. If this is the case, it would be reasonable to ask what type of management is most pragmatic for these patients. In 2007, Brown et al., found that in patients with mild head injury, routine repeat of brain CT scans had statistically significant longer ICU stays and did not lead to any intervention compared with selective CT scans based on clinical deterioration where it led to interventions in 5 of 15 patients [14]. Almenawar et al., conducted a retrospective series review and meta-analysis assessed the value of scheduled CT scan for mild TBI (defined as GCS13-15). 455 patients met their inclusion criteria (61.6% had initial GCS15): the patients were divided into two groups for comparison: those who had interventions based on change in their neurological status versus change in management based on head CT scan alone. A total of 25 patients required medical or surgical management (5.6%). They concluded that the intervention rate based on clinical deterioration was statistically significant compared to the rate based on CT results exclusively (2.7% and 0.6% respectively). In addition, they concluded that it is unnecessarily to repeat CT scans after mild head injury and an unchanged or improved neurological exam [19].

This is a quality of care improvement study. If we are able to provide strong evidence about the utility of repeat head CT scans in traumatic ICH in patients with GCS 15 and no neurological deficits along with identifying the characteristics of patients who we think are more likely to deteriorate or require further management, one would expect to reduce the possibly unnecessary radiation exposure and reduce the health care cost. It might also be helpful in avoiding the unnecessary transfers of patients to level one trauma centers.

Limitations

This study is conducted at a single trauma center. Small sample size and lack of patient follow-up are major limitations. This study is also the first to explore this specific population of patients with intracranial hemorrhage and GCS 15 without neurological deficits. Further studies will be needed to confirm and replicate our results.

Conclusion

Routinely repeating head CT scans in mild TBI (GCS15) and positive initial head CT scan findings with no neurological deficit did not

change the neurosurgical management in any patient. Multicenter prospective studies are needed to confirm this conclusion and possibly identify the characteristics of the patients who might deteriorate and require further neurosurgical or medical management.

Acknowledgment

The authors would like to express their gratitude to Marielle Carpenter and Ryan Tam for their contribution to the editing of this paper, Kevin McGregor and Benjamin Beland for assistance with the statistical analysis.

References

1. Rutland-Brown W, Langlois JA, Thomas KE, Xi YL (2006) Incidence of traumatic brain injury in the United States, 2003. *J Head Trauma Rehabil* 21: 544-548.
2. Stiell I, Wells G, Vandemheen K, Clement C, Lesiuk H, et al. (2001) The Canadian CT Head Rule for patients with minor head injury. *Lancet* 357: 1391-1396.
3. Haydel MJ, Preston CA, Mills TJ, Luber S, Blaudeau E, et al. (2000) Indications for computed tomography in patients with minor head injury. *N Engl J Med* 343: 100-105.
4. Stiell IG, Clement CM, Rowe BH, Schull MJ, Brison R, et al. (2005) Comparison of the Canadian CT Head Rule and the New Orleans Criteria in patients with minor head injury. *JAMA* 294: 1511-1518.
5. Wang M, Linnau K, Tirschwell D, Hollingworth W (2006) Utility of Repeat Head Computed Tomography After Blunt Head Trauma: A Systematic Review. *J Trauma* 61: 226-233.
6. Sifri ZC, Hornnick AT, Vaynman A, Lavery R, Liao W, et al. (2006) A Prospective Evaluation of the Value of Repeat Cranial Computed Tomography in Patients With Minimal Head Injury and an Intracranial Bleed. *J Trauma* 61: 862-867.
7. Türedi S, Hasanbasoglu A, Gunduz A, Yandi M (2008) Clinical decision instruments for CT scan in minor head trauma. *J Emerg Med* 34: 253-259.
8. Huynh T, Jacobs DG, Dix S, Sing RF, Miles WS, et al. (2006) Utility of neurosurgical consultation for mild traumatic brain injury. *Am Surg* 72: 1162-1165.
9. Sifri ZC, Nayak N, Hornnick AT, Mohr AA, Yonclas P, et al. (2011) Utility of Repeat Head Computed Tomography in Patients With an Abnormal Neurologic Examination After Minimal Head Injury. *J Trauma* 71: 1605-1610.
10. Washington CW, Grubb RL Jr (2012) Are routine repeat imaging and intensive care unit admission necessary in mild traumatic brain injury? *J Neurosurg* 116: 549-557.
11. Velmahos GC, Gervasini A, Petrovick L, Dorer DJ, Doran ME, et al. (2006) Routine repeat head CT for minimal head injury is unnecessary. *J Trauma* 60: 494-499.
12. Abdelfattah KR, Eastman AL, Aldy KN, Wolf SE, Minei JP, et al. (2012) A prospective evaluation of the use of routine repeat cranial CT scans in patients with intracranial hemorrhage and GCS score of 13 to 15. *J Trauma Acute Care Surg* 73: 685-688.
13. Smith JS, Chang EF, Rosenthal G, Meeker M, von Koch C, et al. (2007) The Role of Early Follow-Up Computed Tomography Imaging in the Management of Traumatic Brain Injury Patients With Intracranial Hemorrhage. *J Trauma* 63: 75-82.

14. Brown CV, Zada G, Salim A, Inaba K, Kasotakis G, et al. (2007) Indications for Routine Repeat Head Computed Tomography (CT) Stratified by Severity of Traumatic Brain Injury. *J Trauma* 62: 1339-1345.

15. Reljic T, Mahony H, Djulbegovic B, Etchason J, Paxton H, et al. (2014) Value of Repeat Head Computed Tomography after Traumatic Brain Injury: Systematic Review and Meta-Analysis. *J Neurotrauma* 31: 78-98.

16. Bee TK, Magnotti LJ, Croce MA, Maish GO, Minard G, et al. (2009) Necessity of repeat head CT and ICU monitoring in patients with minimal brain injury. *J Trauma* 66: 1015-1018.

17. Doddamani RS, Gupta SK, Singla N, Mohindra S, Singh P (2012) Role of repeat CT scans in the management of traumatic brain injury. *The Indian Journal of Neurotrauma* 9: 33-39.

18. Anandalwar SP, Mau CY, Gordhan CG, Majmundar N, Meleis A, et al. (2016) Eliminating unnecessary routine head CT scanning in neurologically intact mild traumatic brain injury patients: implementation and evaluation of a new protocol. *J Neurosurg* 125: 667-673.

19. Almenawer SA, Bogza I, Yarascavitch B, Sne N, Farrokhlyar F, et al. (2013) The Value of Scheduled Repeat Cranial Computed Tomography After Mild Head Injury. *Neurosurgery* 72: 56-64.