ORIGINAL ARTICLE

Efficacy of the Canadian CT Head Rule in Patients Presenting to the Emergency Department with Minor Head Injury

Ashok Reddy[1], Fawaz Poonthottathil[2], Rani Jonnakuti[3], Roney Thomas[4]

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Abstract

Introduction: Approximately, one in three computed tomography (CT) scans performed for head injury may be avoidable. We evaluate the efficacy of the Canadian CT head rule (CCHR) on head CT imaging in minor head injury (MHI) and its association of Glasgow Coma Scale (GCS) and structural abnormality.

Materials and methods: We conducted a prospective cross-sectional study from May 2018 to October 2019 in the Department of Emergency Medicine, Pushpagiri Institute of Medical Sciences and Research Centre, Thiruvalla, Kerala. The CCHR is applied to patients with MHIs (GCS 13–15) after initial stabilization and it is ascertained, if they require a non-contrast CT head and imaging is done. For those who do not require CT head as per the CCHR are excluded from this study. After imaging the patients who have a positive finding on CT head are admitted and followed up if they underwent any neurosurgical intervention, those with no findings in CT head are discharged from the hospital. A total of 203 patients were included during study period.

Results: A total of 203 patients were included in study with mean age of 49.5 years. Approximately, 70% (142) were male. Sensitivity of CCHR for predicting positive CT finding in the present study sample was 68% and specificity was 42.5%.

Conclusion: Canadian CT head rule is a useful tool in the Emergency Department for predicting the requirement of CT in patients with MHI. Canadian CT head rule can reduce the number of CT scans ordered following MHI in ED, thus improving the healthcare costs.

Keywords: Canadian CT head rule, Efficacy, Emergency medicine, Minor head injuries.

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Highlights

The Canadian CT head rule (CCHR) is a useful tool in the Emergency Department for predicting the requirement of computed tomography (CT) in patients with minor head injury (MHI). Canadian CT head rule can reduce the number of CT scans ordered following MHI in the Emergency Department, thus improving the healthcare costs.

Introduction

Background

One of the most frequent reasons, people seek post-injury medical attention is a head injury. Most head injuries are relatively minor; however, there is ongoing debate regarding the best way to assess and care for this large patient population. Intracranial hematoma is a common cause of death and disability in patients with head injury.[1–4] In patients with head injury, recommendations vary from routine admission with CT scan or routine CT scan with selective admission. Approximately, 84% of head traumas are minor head injuries (MHIs).[5]

Minor head injury is defined as a patient with a history of loss of consciousness, amnesia, or disorientation and a Glasgow Coma Scale (GCS) score of 13–15.[6]

While the majority of patients with mild head injuries can be monitored and discharged without any problems, a tiny percentage worsen and need to have an intracranial hemorrhage, which needs to be surgically repaired. In order to effectively treat these patients, early intracranial hemorrhage detection using CT and early surgery are crucial.[7,8]

[1]Department of Emergency Medicine, NRI Medical College, Mangalagiri, Andhra Pradesh, India

[2,4]Department of Emergency Medicine, Pushpagiri Medical College, Kerala, India

[3]Department of Emergency Medicine, Siddartha Medical College, Vijayawada, Andhra Pradesh, India

Corresponding Author: Roney Thomas, Department of Emergency Medicine, Pushpagiri Medical College, Kerala, India, Phone: +91 9447468919, e-mail: drroneythomas@gmail.com

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A more targeted application of this costly, high-tech investigation for individuals with mild head injuries could result in significant savings on medical expenses.

Since the development of CT in 1974, there has been a dearth of appropriate guidelines and methodologically weak and inconclusive studies that attempted to develop guidelines. Consequently, there is an obvious need for a reliable and valid guideline that would enable physicians to use CT more selectively without compromising the care they provide to patients with MHIs.[9,10]

So, the CCHR, which is an accurate, reliable, and clinically sensible decision rule for use of CT in patients with MHI has been developed.

Goals of this investigation: To estimate the efficacy of CCHR in patients with MHI. To assess association of GCS and structural abnormality.

Materials and Methods

Study Design and Setting

We conducted a prospective cross-sectional study from May 2018 to October 2019 in the Department of Emergency Medicine, Pushpagiri Institute of Medical Sciences and Research Centre, Thiruvalla, Kerala. Whenever a trauma patient arrives in the Emergency Department, they are triaged and assigned a priority level as per ATLS protocols. The CCHR is applied to patients with MHIs (GCS 13–15) after initial stabilization and it is ascertained, if they require a non-contrast CT head and imaging is done. For those who do not require CT head as per the CCHR are excluded from the study. After imaging the patients who have a positive finding on CT head such as fracture calvarium or IC bleed are admitted and followed up if they underwent any neurosurgical intervention such as external ventricular drainage and decompressive craniectomy, those with no findings in CT head are discharged from the hospital. A total of 203 patients were included during study period.

Selection of Participants

Patients with age ≥16 years with head injury having GCS between 13 and 15 were included. Patients using any anticoagulants or with bleeding disorder or with acute neurological deficit or injury >24 hours old were excluded. The study tools used were CCHR, Head CT, and semistructured pro forma. The study variables included age, sex, chronic conditions, GCS score, vomiting, anticoagulant use, alcohol intoxication (serum alcohol level > 80 mg/dL), and arrival by emergency medical services (EMS).

Results

Of the total 203 sample population with range between 18 and 93 years of which 150 (73.9%) were <65 years and 53 (26.1%) were >65 years. Having mean age of 49.5 years. A total of 142 (70%) were male and 61 (30%) were female.

In the study sample, percentage of population in dangerous mechanism of injury was 28.6% (58), vomiting (≥2 episodes) was 14.8% (30), H/O retrograde amnesia 10.85% (22), ENT bleed 29.1% (59), hemotympanum 4.4% (9), Raccoon eyes 14.8% (30), Battles's sign 0.5% (1), depressed skull fracture 1.5% (30), and neurological clinical features 39.4% (80) (Table 1).

In the present study, sample of 203, percentage of patients with GCS 13–15 was 9.45 (19), 19.75 (40), and 70.9% (144), respectively (Table 2).

Of the 203 sample population, who underwent CT; 57.1% (116) has positive CT findings, i.e, cranial bone fractures are the most common finding followed by Subdural hemorrhage, subarachnoid hemorrhage, cerebral contusion, pneumocephalus, and intracerebral bleed; 42.9% (87) has normal CT findings (Table 2).

Association of CT Findings with Patient Presenting Features

Of these variables, retrograde amnesia, ENT bleed ($p < 0.01$), and hemotympanum ($p = 0.008$) have significant correlation with positive CT findings.

Neurological features especially post-traumatic seizures (6), pupillary abnormality (4) was 100% sensitive for positive CT findings.

Table 1: Association of CT with selected variables

	CT					
	No		*Yes*			
	Count	*Percent*	*Count*	*Percent*	χ^2	*p-value*
Dangerous mechanism of injury						
No	65	44.8	80	55.2	0.8	0.370
Yes	22	37.9	36	62.1		
Number of episodes of vomiting						
No	76	43.9	97	56.1	0.55	0.458
Yes	11	36.7	19	63.3		
History of retrograde amnesia						
No	85	47.0	96	53.0	11.49	$p < 0.01$
Yes	2	9.1	20	90.9		
ENT bleed						
No	81	56.3	63	43.8	36.29	$p < 0.01$
Yes	6	10.2	53	89.8		
Hemotympanum						
No	87	44.8	107	55.2	7.06**	0.008
Yes	0	0.0	9	100.0		
Raccoon eyes						
No	78	45.1	95	54.9	2.38	0.123
Yes	9	30.0	21	70.0		
Cerebrospinal fluid leakage from ear or nose						
No	87	42.9	116	57.1	–	–
Yes	0	0.0	0	0.0		
Battle's sign						
No	87	43.1	115	56.9	0.75	0.385
Yes	0	0.0	1	100.0		
Depressed skull fracture						
No	87	43.5	113	56.5	2.28	0.131
Yes	0	0.0	3	100.0		
Neurological clinical features						
No	59	48.0	64	52.0	3.33	0.068
Yes	28	35.0	52	65.0		

**Significant at 0.01 level

Table 2: Comparison of GCS based on CT

	CT					
	Negative findings		*Positive findings*			
GCS	*Count*	*Percent*	*Count*	*Percent*	χ^2	*p-value*
13	1	5.3	18	94.7	24.36	$p < 0.01$
14	9	22.5	31	77.5		
15	77	53.5	67	46.5		

Percentage of positive CT findings with depressed skull fracture (3) and Batlle's sign (1) was 100% (Table 1).

Comparison of GCS Based on CT

Of the total 203 patients who underwent CT scan, 53.5% (77) have GCS of 15, 22.5% (9) have GCS of 14, 5.3% (1) has GCS 13 showed negative CT findings. Positive CT findings (116) have been in 46.55 (67) in patients with GCS 15, 77.5% (31) with GCS 14 and 94.7% (18) with GCS 13 (Table 2).

Table 3: Comparison of GCS based on neurosurgical intervention done in patients

	Neurosurgical intervention done in patients					
	No		*Yes*			
GCS	*Count*	*Percent*	*Count*	*Percent*	χ^2	*p-value*
13	15	83.3	3	16.7	10.34**	0.006
14	25	80.6	6	19.4		
15	66	98.5	1	1.5		

**Significant at 0.01 level

Table 4: Efficacy of CCHR in patients with minor head injury

	Computed tomography report		
CCHR	*Positive finding*	*Negative finding*	*Total*
High risk	79	50	129
Moderate	37	37	74
Total	116	87	203

Of the 203 patients in study sample, 4.9% (10) of patients underwent neurosurgical intervention, of which one patient has GCS 15, 6 have GCS of 14 and 3 patients had GCS of 13 with a *p*-value 0.006 (Table 3).

Efficacy of Canadian CT Head Rule

A total of 8.6% (10) patients underwent neurosurgical intervention, i.e., evacuation of hematoma or elevation of depressed cranial bone fractures of 116 patients who have positive CT findings.

Of the total 203 patients who underwent CT scan, positive CT finding seen in 116 patients of which 79 were of high-risk criteria and 37 were moderate risk criteria (Table 4).

Sensitivity of CCHR for predicting positive CT finding in the present study sample was 68%, specificity was 42.5%, positive predictive value was 61.2%, and negative predictive value was 50%.

Discussion

The mean age distribution in the present study was 49.5 years with a standard deviation (SD) of 20.6 years. This finding corresponds with a study in which mean age distribution was 47 years with SD of 19.68 years,[11] where another study showed mean age distribution as 41 years (SD = 20.5) which is younger age group compared to our study.[12]

In the present study, male predominance was observed. Similarly, male predominance was observed in another study done by Anish et al. and Smits et al.[13–15]

The most common mode of injury in the present study was road traffic accidents (RTA), i.e., 54.6%. This finding corresponds to the similar results (56%) in a study done in India.[16] Other studies also show the similar predominance.[17–19]

The GCS distribution of present study sample was 70.9% (144) with GCS 15; 19.75% (40) with GCS 14 and 9.45% (19) with GCS 13. Similar GCS distribution seen in a study done by Papa et al. in UK and Thiruppathy and Muthukumar in India.[20,21]

The most common finding was cranial bone fractures which correlate with the study done in Saudi Arabia and Netherlands.[22,23]

In the present study, CCHR showed a sensitivity of 68.1%, this corresponds to the sensitivity of 66.67% study done by Arab et al. in Saudi Arabia. Specificity of the 42.5% which corresponds to the specificity of 43.36% in a study done in China, another study showed a higher specificity than a study done by Papa et al.[20]

Percentage of patients underwent neurosurgical intervention in the present study was 4.9% of 203 patients. Another study done in India by Thiruppathy and Muthukumar, showed 7% of patients underwent neurosurgical intervention. Other studies showed lesser percent of patients underwent intervention 2.1 and 2.6% done by Bouida et al. and Smits et al., respectively.[14,24]

Of 203 patients, 116 have positive CT findings, of which 57.8% had a GCS of 15, 26.7% had GCS of 14 and 15.5% had a GCS of 13. This corresponds to the GCS distribution of study done in Netherlands, which has the 64.1, 23.7, and 12.2% for GCS of 15, 14, and 13, respectively.[23]

Conclusion

Canadian CT head rule is a useful tool in the Emergency Department for predicting the requirement of CT in patients with MHI. Decrease in GCS directly related to positive CT findings. Glasgow Coma Scale, post-traumatic seizures, pupillary abnormality, depressed skull fracture, and Battle's sign have significant correlation with positive CT findings. Canadian CT head rule can reduce the number of CT scans ordered following MHI in the Emergency Department, thus improving the healthcare costs.

Limitations and Recommendations

This is a single-center study conducted on 203 subjects with MHI in the Emergency Department. It needs to be validated in other settings in bigger population. Patients with history of Seizure disorder, use of antiplatelets/anticoagulants, TBI of >24 hours duration were excluded from the study as it will interfere with the accuracy of this method and hence needs further studies after including these people.

Orcid

Ashok Reddy https://orcid.org/0000-0003-2551-7957
Fawaz Poonthottathil https://orcid.org/0009-0001-9468-9886
Rani Jonnakuti https://orcid.org/0009-0009-0271-9995
Roney Thomas https://orcid.org/0009-0000-7206-7667

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