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Original Article

Canadian computed tomography head rule and New Orleans criteria in mild traumatic brain injury: Comparison at an urban tertiary care facility in Pakistan

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ABSTRACT

Background: Traumatic brain injury (TBI) is a leading cause of mortality and morbidity worldwide, with road traffic accidents being the predominant cause in Pakistan. Computed tomography (CT) scans have become the cornerstone of investigation for all TBIs, but their widespread use raises concerns about cost-effectiveness, radiation exposure, and incidental findings. This study aimed to validate the applicability of the Canadian CT head rule (CCHR) and New Orleans Criteria (NOC) in the Pakistani population and compare their sensitivity and specificity.

Methods: A cross-sectional study was conducted in a tertiary care academic hospital in Pakistan, including consecutive patients with acute, mild brain injury. The primary outcome was "clinically important brain injury," while the secondary outcome was "need for neurosurgical intervention." Univariate analysis using Chi square was performed for each variable to assess association with CT findings. Sensitivity, specificity, and accuracy were calculated to evaluate the performance of each decision rule.

Results: Most of the patients in our study had a Glasgow Coma Scale (GCS) score of 15 (92.6%). Headache was the most common parameter overall (61.7%). Clinically important CT was detected in 68 (6.7%) patients. Only 1 of the NOC and 4 CCHR variables demonstrated statistically significant association with clinically significant CT. The CCHR was 64% sensitive for detecting clinically important CTs in trauma patients with GCS of 13–15, and the NOC was 86% sensitive, with respective specificities of 70% and 33%. For predicting the need for neurosurgical intervention, the sensitivities of CCHR and NOC were 61% and 85%, and specificity was 68% and 32%, respectively.

Conclusion: We concluded that the CCHR was more specific and accurate, and it has the potential to have a greater influence on CT ordering rates than the NOC. Further studies are recommended to validate the tools for the Pakistani population.

Keywords: Canadian computed tomography head rule, Comparison, Computed tomography scan brain, Glasgow Coma Scale, New Orleans criteria, Traumatic brain injury

INTRODUCTION

Traumatic brain injury (TBI) has emerged as one of the leading causes of mortality and morbidity worldwide.[1] In Pakistan, public hospital data estimate the annual incidence of head injury to be 50/100,000, with road traffic accidents (RTAs) being the predominant cause, accounting for 62% of cases. Clinically, TBI is categorized into three distinct groups based on the Glasgow Coma Scale (GCS) score: mild (GCS 13–15), moderate (GCS 9–12), and severe (GCS ≤8).[10,12,17] Among these, mild TBI is the most prevalent type of head injury encountered in emergency departments (EDs).[11,16] With advances in modern medicine, computed tomography (CT) has become the cornerstone investigation for all TBIs, given its high efficiency in diagnosing life-threatening conditions such as intracranial hemorrhage, particularly in mild TBI cases.[7] However, the widespread use of CT scans is not without drawbacks, including concerns regarding cost-effectiveness, radiation exposure, and identification of incidental findings ("incidentalomas") that often lead to additional tests, prolonged hospital stays, and increased health-care costs.[3,5,9] According to the US Food and Drug Administration (2017), approximately one in every 10,000 patients undergoing a head CT scan develops fatal cancer, and the routine use of head CT scans for mild TBI could potentially contribute to an estimated 250 cases of fatal cancer annually to the ED's caseload.[15] Brenner and Hall further estimated that the increasing frequency of CT scans (from 20 million in the mid-1990s to approximately 60 million in the mid-2000s) contributes to 1.5–2% of all cancers.[2] These findings underscore the necessity for the implementation of guidelines to reduce the indiscriminate use of CT imaging in all TBI patients presenting to the ED. Particularly in resource-limited settings, such as Pakistan, the utilization of CT scans must be governed by clear guidelines to ensure cost-effective and radio-protective practices. This need is especially pressing given the prevalent practice of defensive medicine in the region, where clinicians may order CT scans based on uncertain clinical indications.

Worldwide, before the 1980s, no established guidelines existed for CT scan indications following brain injury, with CT scans typically recommended for patients with a GCS score ≤8.[8] Subsequently, two pivotal studies, Stiell *et al.* and Haydel *et al.*, led to the development of new guidelines: the Canadian CT Head Rule (CCHR) and New Orleans Criteria (NOC), respectively.[4,14]

Under the CCHR, patients with minor head injuries should only receive CT scans if one or more of the following criteria are met: GCS score lower than 15 at 2 h after injury, suspected open or depressed skull fracture, any sign of basal skull fracture, two or more episodes of vomiting, age 65 or older, amnesia before the impact of 30 or more minutes, dangerous mechanism (this is defined by Stiell *et al.*)[13] as "a pedestrian struck by a motor vehicle, an occupant ejected from a motor vehicle, or a fall from an elevation of 3 or more feet or 5 stairs"). The first five criteria are considered "high risk," whereas criteria 6 and 7 are considered "medium risk."

According to the NOC, CT is required for patients with minor head injury with any one of the following findings: headache, vomiting, older than 60 years, drug or alcohol intoxication, persistent anterograde amnesia (deficits in short-term memory), visible trauma above the clavicle, or seizure. The criteria apply only to patients who also have a GCS score of 15.

A review of the existing literature on clinical recommendations identified these two tools as the most commonly utilized for predicting clinically significant CT findings in patients with mild TBI.[10] There are no established nationwide guidelines in Pakistan. While Pakistani physicians may rely on international guidelines, these guidelines were developed in a vastly different health-care environment and population than in Pakistan. They, therefore may not be applicable to Pakistani patients. Consequently, this study was designed with the aspiration of eventually contributing to the development of nationwide clinical guidelines in Pakistan.

This study assesses the applicability of the CCHR and the NOC to the Pakistani population by analyzing variables of the tools against clinically significant CT scans and further provides a parallel comparison of the two tools in hopes that it provides evidence that can inform more tailored clinical decisions, potentially reducing unnecessary imaging and improving patient outcomes, thereby contributing to the enhancement of patient care in Pakistan.

MATERIALS AND METHODS

Study design and population

This study was conducted in the neurotrauma facility of a tertiary care academic hospital in Pakistan from March 2023 to June 2023. It was a cross-sectional study that included consecutive patients who had sustained an acute, mild brain injury. All patients had to fulfill the following criteria to be eligible: (1) blunt head injury causing observed amnesia, loss of consciousness, or disorientation; (2) initial presenting GCS score of 13 or more as judged by the ED physician; and (3) injury within the preceding 24 h. The exclusion criteria were ages younger than 16 years, use of oral anticoagulants, and those who could not get an early head CT. Written and informed consent was sought from the participants or the attendants of the participants if the patient was deemed unfit to consent due to low GCS. The hospital research ethics board approved this research before initiation.

Patient assessment

The emergency medicine physician assessed all patients presenting to the ED and then referred them to the Neurotrauma unit, where they were independently assessed by a neurosurgery resident. Two residents independently assessed and recorded the clinical findings in all patients, thus reducing the bias. Following the clinical evaluation, a conventional CT of the head was ordered, if not already performed in the ED.

Outcome measures

In our study, "clinically important brain injury" was calculated as the primary outcome, while "need for neurosurgical intervention" was assessed as a secondary outcome. Any acute brain injury detected by a CT scan that would typically necessitate hospitalization and neurosurgical review was considered a clinically important brain injury. Except for the scenario where the patient was neurologically stable and had no evidence of intracranial hematoma or depressed skull fracture on the CT scan, all brain injuries were treated as clinically significant. The need for neurosurgical intervention was described as the need for any of the following: surgical interventions within 7 days of head injury (demonstrated on CT): craniotomy, skull fracture elevation, or intracranial pressure monitoring.

Data analysis

Patient data entered in the database were checked for correct inclusion and incomplete data entry. All incomplete data entries were excluded. Patient data entered into the database were thoroughly reviewed for accuracy and completeness. Cases with incomplete data sheets were excluded from the analysis. The study cohort was assessed for demographic characteristics, mechanisms of injury, traumatic findings on CT scans, and the need for neurosurgical intervention. Descriptive statistics, including means and proportions as appropriate, were computed. Univariate analysis using Chi square was performed for each variable to assess association with CT findings. Sensitivity, specificity, and accuracy were calculated to evaluate the performance of each decision rule in predicting neurosurgical intervention and identifying intracranial traumatic findings on CT scans. In our study, when even one of the criteria was present in the patient, the decision rule was declared positive. We chose not to apply the distinction between high-risk and medium-risk criteria in CCHR, so all risk variables were treated and scored similarly. In addition, the efficacy of the CCHR and the NOC was evaluated specifically for patients presenting with a GCS score of 15. Prediction of neurological procedures and clinical outcomes based on imaging was conducted following the methodologies established in the original studies of both decision rules. No laboratory reports have been included in this study as our institute does not routinely send blood toxicology reports in mild TBI patients, and only clinical signs and symptoms have been taken into account when assessing the presence and severity of intoxication, such as slurred speech, alcoholic fetor, or nystagmus. Using a sensitivity of more than 90% for both rules, we calculated a sample size requirement of at least 1000 patients. For all comparisons, a two-sided $P < 0.05$ was considered statistically significant. Statistical analysis was performed with the Statistical Package for the Social Sciences (SPSS) (version 26.0; SPSS, Inc., Chicago, IL).

RESULTS

On the basis of inclusion criteria, a total of 1009 patients were included in this study. The demographic details and characteristics of the patient population are presented in Table 1. In our setup, relatively few patients had clinical signs of open or depressed fracture (0.5%), drug or alcohol intoxication (0.4%), or use of anticoagulation (1.2%). The most common presentation of the patients was a GCS score of 15 (92.6%). Clinically, important CT was detected in 68 (6.7%) patients, with the highest proportion of patients found with a GCS score of 15 (72%) [Figure 1]. An extradural hematoma (24 patients; 35%) was the most prevalent traumatic finding on a CT scan, followed by brain contusion (19 patients, 27.9%) [Figure 2]. Neurosurgical intervention was performed for 21 patients (0.02%), with extradural hematoma in 10 cases, brain contusion in four cases, subdural hematoma in two cases, and subarachnoid hemorrhage in one case.

To validate the tools against our sample population, we analyzed each point on the guideline against the clinically important brain injury, stratified as CT positive and CT negative. The univariate analysis showed that headache was the only NOC criterion, out of 7, which showed a statistically significant association with clinically significant brain injury; it was also the most frequently reported risk factor overall. In comparison, 4 of 7 CCHR criteria were statistically significant: vomiting, GCS <15, a sign of basilar fracture, and open or depressed fracture, in order of decreasing frequency [Table 2].

A parallel comparison of the two rules' predictive accuracies with regard to the patients who had a GCS score of 13–15 was made. The CCHR was 64.7% sensitive for detecting clinically important CTs in trauma patients in this cohort, and the NOC was 86.7% sensitive, with respective specificities of 70% and 33.7%. The sensitivities for the need for neurosurgical intervention were 61.9% and 85.7% for CCHR and NOC, respectively, and their respective specificities were 68.3% (accuracy: 68.1%) and 32.8% (accuracy: 66.1%) [Table 3].

A similar head-to-head comparison was made in the subgroup with a GCS score of 15. The CCHR was found to be 46.7% sensitive and 73.3% specific for clinically important brain injury, while the NOC showed 80% sensitivity and 33.2% specificity. The CCHR showed

Table 1: Patient demographics and characteristics.

Characteristics	GCS 13–15 *n*=1009		GCS 15 *n*=934	
	Number (*n*)	Percentage	Number (*n*)	Percentage
Gender				
Male	728	72.2	668	71.5
Female	281	27.8	266	28.5
Age				
Mean	34.96±14.61		34.83±12.41	
40 or below	707	70.1	659	70.6
41–60	247	24.5	225	24.1
Above 60	55	5.5	50	5.4
Mechanism of trauma				
RTA	590	58.5	545	58.4
Fall	294	29.1	271	29
Assault	59	5.8	56	6
Industrial trauma	4	0.4	4	0.4
Others mechanisms	62	6.1	58	6.2
Associated body trauma				
Spine trauma	65	6.4	53	5.7
Maxillofacial trauma	140	13.9	126	13.5
Chest trauma	9	0.9	8	0.9
Abdominopelvic trauma	5	0.5	5	0.5
Long bone fracture	49	4.9	44	−4.7
Disposal				
Admit	24	2.4	17	1.8
Retain	160	15.9	119	12.7
Discharge	777	77.0	753	80.6
Advised admission, but LAMA	4	0.4	4	0.4
Refer to other department	44	4.4	41	4.4
Need of surgery on 1st CT scan				
Yes	21	2.1	15	1.6
No	988	97.9	919	98.4
Repeat CT scan needed/advised.				
Yes	84	8.3	57	6.1
No	880	87.2	840	89.9
To be decided on Re-assessment	45	4.5	37	4

RTA: Road traffic accident, GCS: Glasgow Coma Scale, CT: Computed tomography, LAMA: Leave against medical advice

72.9% accuracy in detecting the need for neurosurgical intervention and 33.9% accuracy for detecting clinically important CTs [Table 4].

DISCUSSION

This cross-sectional study, consisting of 1009 mild TBI patients, is the first to assess the applicability of CCHR and NOC to the Pakistani population and make parallel comparisons of the two guidelines' predictive accuracy in the same. It was carried out in accordance with stringent methodological criteria, as proposed by similar studies undertaken in different populations.[6,7,11,13,17] The inclusion and exclusion criteria were adopted from a larger comparative study by Stiell *et al*., which critically validated the tools in 2005. We did not include children, as we believe that pediatric cases require more specific criteria and should be the subject of a separate, extensive study. Demographically speaking, our average patient was a young male, a victim of an RTA, who landed in the ED with a GCS of 15. These demographics align closely with those reported in previous validation studies, enabling us to contextualize our findings within the existing body of evidence.[11,13]

In an attempt to assess the applicability of the tool to the Pakistani population, each scoring point on the guideline was analyzed against clinically significant CTs. We found only headaches to be significantly associated with a positive CT. This is directly opposed to the original finding of Haydel *et al*.[4] who proposed that all points on the criteria hold statistically significant associations with clinically significant brain injury and are reliable clinical predictors. Similarly, for CCHR, we did not find age more than 65, the presence of amnesia, and dangerous mechanism of injury

Table 2: Predictors of clinically important CT findings.

	CT positive *n* (%)	CT negative *n* (%)	Total *n* (%)	*P*-value
CCHR				
Vomiting	29 (15.6)	157 (84.4)	186 (18.4)	<0.001
GCS less than 15	19 (25.3)	56 (74.7)	75 (7.4)	<0.001
Dangerous mechanism*	5 (7.5)	62 (92.5)	67 (6.7)	0.477
Age equal or more than 65	6 (12.5)	42 (87.5)	48 (4.8)	0.097
Retrograde amnesia*	4 (16.0)	21 (84.0)	25 (2.5)	0.082
Signs of basilar fracture	6 (42.9)	8 (57.1)	14 (1.4)	<0.001
Open or depressed fracture	2 (40.0)	3 (60.0)	5 (0.5)	0.039
NOC				
Headache	55 (8.8)	568 (91.2)	623 (61.7)	<0.001
Trauma above clavicle	7 (8.1)	79 (91.9)	86 (8.5)	0.588
Age more than 60	6 (10.9)	49 (89.1)	55 (5.5)	0.205
Retrograde amnesia	5 (21.7)	18 (78.3)	23 (2.3)	0.016
Seizure	2 (12.5)	14 (87.5)	16 (6.6)	0.294
Drug or alcohol intoxication	0 (0.0)	4 (100)	4 (0.4)	0.756

*Minor criteria. CT: Computed tomography, GCS: Glasgow Coma Scale, CCHR: Canadian CT head rule, NOC: New Orleans criteria

Table 3: Sensitivity and specificity of CCHR and NOC for patients with GCS 13–15 (*n*=1009).

	CCHR		NOC	
	Positive	**Negative**	**Positive**	**Negative**
Clinically important brain injury				
Positive	44	24	59	9
Negative	282	659	623	318
Sensitivity	64.7%		86.7%	
Specificity	70.0%		33.7%	
Accuracy	69.7%		37.3%	
Need for neurosurgical intervention.				
Positive	13	8	18	3
Negative	313	675	664	324
Sensitivity	61.9%		85.7%	
Specificity	68.3%		32.8%	
Accuracy	68.1%		66.1%	

CCHR: Canadian CT head rule, NOC: New Orleans criteria, GCS: Glasgow Coma Scale

Table 4: Sensitivity and specificity of CCHR and NOC for patients with GCS 15 (*n*=934).

	CCHR		NOC	
	Positive	**Negative**	**Positive**	**Negative**
Clinically important brain injury				
Positive	26	23	41	8
Negative	226	659	585	300
Sensitivity	53.0%		83.7%	
Specificity	74.5%		33.9%	
Accuracy	73.3%		36.5%	
Need for neurosurgical intervention.				
Positive	7	8	12	3
Negative	245	674	614	305
Sensitivity	46.7%		80.0%	
Specificity	73.3%		33.2%	
Accuracy	72.9%		33.9%	

CCHR: Canadian CT head rule, NOC: New Orleans criteria, GCS: Glasgow Coma Scale

to be statistically reliable indicators of brain injury, as was concluded by Stiell *et al*. in their original study.[14]

Several factors could be hypothesized to explain these findings. First, the genetic and ethnic characteristics of the Pakistani population vary greatly from those where CCHR and NOC were originally developed, Canada and the Netherlands. Second, we did not follow-up with the patients for the development of traumatic sequelae and subsequent utilization of health-care services, which may have potentially obscured predictors of clinical brain injury. However, all patients were assessed as stable and fit for discharge based on their clinical status and negative CT findings, once by a neurosurgery resident and then by an ED physician; therefore, while the likelihood of this occurrence

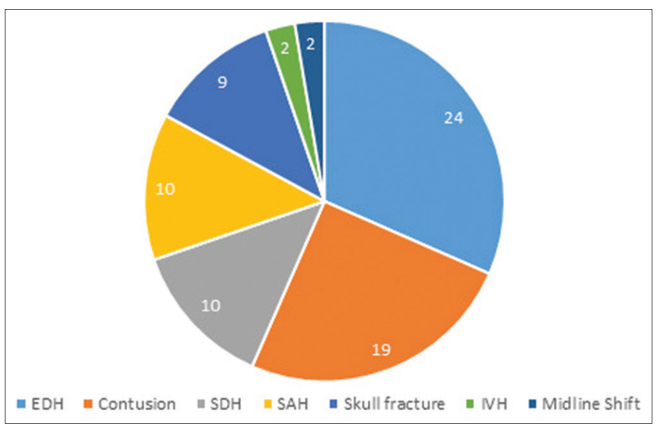

Figure 1: Computed tomography scan findings (*n* = 68).

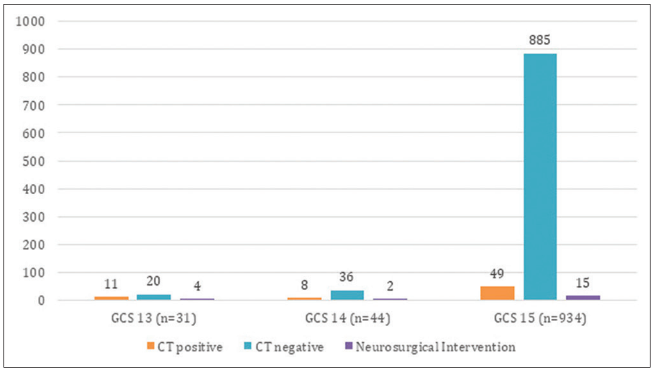

Figure 2: Neurocranial traumatic computed tomography findings and neurosurgical interventions by patient Glasgow Coma Scale (GCS) score on presentation,Y axis shows number(n) of patients.

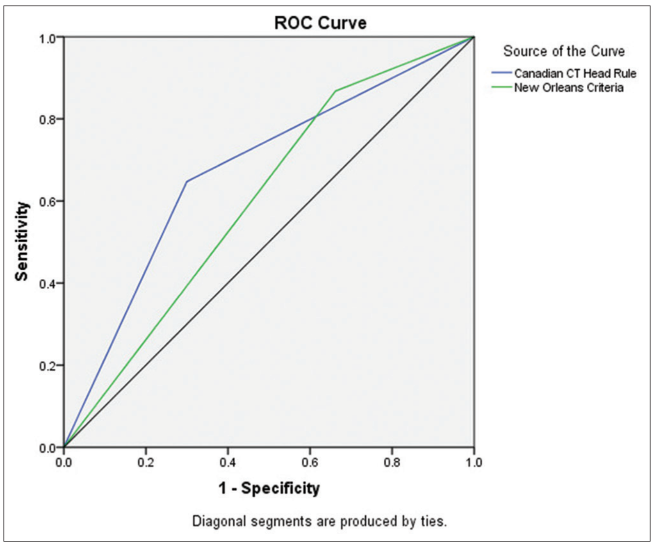

Figure 3: Receiver operating characteristic (ROC) curves for the Canadian computed tomography head rule and New Orleans criteria.

is low, we acknowledge that we have no definitive means to confirm it.

Further, we compared CCHR and NOC in their predictive accuracy for both outcome measures in patients with mild TBI, i.e., GCS 13–15. The sensitivity of CCHR to detect clinically significant brain injury was comparable to NOC (64% vs. 86%) and also to the need for neurosurgical intervention (62% vs. 85%) [Figure 3]. However, the specificity of CCHR was significantly greater than that of NOC in predicting clinically significant brain injury (70% vs. 33%) as well as the need for neurosurgical intervention (68% vs. 32%). Since the NOC was originally developed for application to GCS 15 patients, we carried out a subgroup analysis in this population. We found a similar trend for comparative sensitivity, specificity, and accuracy of CCHR and NOC. These findings are comparable in their pattern to those reported by Stiell *et al*.; however, the numbers vary immensely.[14] Several population-specific characteristics could explain these findings, the determination of which was beyond the scope of this study.

This study has some potential limitations, although the majority of them are applicable in the same way to the analysis of both rules. Although not all eligible cases were enrolled, there was no evidence of selection bias; however, we did not include characteristics of excluded patients. Physicians had to take time away from their busy clinical schedules to examine patients and willingly fill out data forms for patient enrollment. This was not possible in many situations. Finally, there is a lack of follow-up after discharge for traumatic sequelae.

CONCLUSION

This research externally validated the CCHR and NOC in the Pakistani population and compared the two guidelines in parallel. CCHR demonstrated higher specificity and accuracy than the NOC with comparable sensitivity than the NOC in patients with mild TBI, i.e., GCS 13–15. Similar findings were observed in a subgroup of GBS 15. While Pakistani physicians may now use this study to influence their practice, further research with a larger sample size, multiple institutions, and follow-up is recommended.

Ethical approval

The research/study was approved by the Institutional Review Board at Jinnah Postgraduate Medical Centre, number NO.F.2-81/.2022-GENL/355/JPMC, dated December 31, 2022.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

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Conflicts of interest

There are no conflicts of interest.

Use of artificial intelligence (AI)-assisted technology for manuscript preparation

The authors confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript, and no images were manipulated using AI.

REFERENCES

1. Brenner DJ, Hall EJ. Computed tomography--an increasing source of radiation exposure. N Engl J Med 2007;357:2277-84.

2. Cawood TJ, Hunt PJ, O'Shea D, Cole D, Soule S. Recommended evaluation of adrenal incidentalomas is costly, has high false-positive rates and confers a risk of fatal cancer that is similar to the risk of the adrenal lesion becoming malignant; time for a rethink? Eur J Endocrinol 2009;161:513-27.
3. Centers for Disease Control and Prevention, National Center for Injury Prevention and Control. Report to congress on traumatic brain injury in the United States: Epidemiology and rehabilitation. Atlanta, GA: Centers for Disease Control and Prevention; 2015.
4. Haydel MJ, Preston CA, Mills TJ, Luber S, Blaudeau E, DeBlieux PM. Indications for computed tomography in patients with minor head injury. N Engl J Med 2000;343:100-5.
5. Haydon NB. Head injury: Audit of a clinical guideline to justify head CT. J Med Imaging Radiat Oncol 2013;57:161-8.
6. Kavalci C, Aksel G, Salt O, Yilmaz MS, Demir A, Kavalci G, *et al*. Comparison of the Canadian CT head rule and the new orleans criteria in patients with minor head injury. World J Emerg Surg 2014;9:31.
7. Klang E, Beytelman A, Greenberg D, Or J, Guranda L, Konen E, *et al*. Overuse of head CT examinations for the investigation of minor head trauma: Analysis of contributing factors. J Am Coll Radiol 2017;14:171-6.
8. McMicken DB. Emergency CT head scans in traumatic and atraumatic conditions. Ann Emerg Med 1986;15:274-9.
9. Mitchell J, Parangi S. The thyroid incidentaloma: An increasingly frequent consequence of radiologic imaging. Semin Ultrasound CT MR 2005;26:37-46.
10. Orlando A, Levy AS, Carrick MM, Tanner A, Mains CW, Bar-Or D. Epidemiology of mild traumatic brain injury with intracranial hemorrhage: Focusing predictive models for neurosurgical intervention. World Neurosurg 2017;107:94-102.
11. Papa L, Stiell IG, Clement CM, Pawlowicz A, Wolfram A, Braga C. Performance of the Canadian CT Head rule and the new orleans criteria for predicting any traumatic intracranial injury on computed tomography in a United States Level I trauma center. Acad Emerg Med 2012;19:2-10.
12. Saboori M, Ahmadi J, Farajzadegan Z. Indications for brain CT scan in patients with minor head injury. Clin Neurol Neurosurg 2007;109:399-405.
13. Stiell IG, Clement CM, Rowe BH, Schull MJ, Brison R, Cass D, *et al*. Comparison of the Canadian CT head rule and the New Orleans criteria in patients with minor head injury. JAMA 2005;294:1511-8.
14. Stiell IG, Wells GA, Vandemheen K, Clement C, Lesiuk H, Laupacis A, *et al*. The Canadian CT Head rule for patients with minor head injury. Lancet 2001;357:1391-6.
15. U.S. Food and Drug Administration. What are the Radiation Risks of CT? 2017. Available from: https://www.fda.gov/radiation-emittingproducts/radiationemittingproductsandprocedures/medicalimaging/medicalxrays/ucm115329.htm [Last accessed on 2024 Apr 17].
16. Umerani M, Abbas A, Sharif S. Traumatic brain injuries: Experience from a tertiary care center in Pakistan. Turk Neurosurg 2014;24:19-24.
17. Wintermark M, Sanelli PC, Anzai Y, Tsiouris AJ, Whitlow CT, ACR Head Injury Institute. Imaging evidence and recommendations for traumatic brain injury: Conventional neuroimaging techniques. J Am Coll Radiol 2015;12:e1-4.

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