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Comparison of Nexus II, New Orleans and Canada cranial CT rules in Head Trauma Patients: A retrospective study.

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ABSTRACT

The imaging method of choice to precisely diagnose intracranial injuries is a head CT scan. During recent years the usage of CT in EDs has increased greater than before. Although there is a consensus to scan patients with moderate or severe head trauma urgently, an ongoing debate continues as to which patients with mild head injury should be scanned. In our study we aimed to compare the clinical effects of CCHR, NOC, and NEXUS-II rules to identify the clinically significant brain injuries. Our research was performed at a single Training and Research hospital with 200.000 annual ED visits. Acute mild head injury was defined as a closed head injury by blunt force within 24 hours, with a Glasgow Coma Scale (GCS) score of 13 to 15. All patients who visited our ER with minor head trauma were enrolled in study prospectively, and all CCHR, NOC, and NEXUS rules were evaluated separately for each patient. The determined outcome lesions were subarachnoid haemorrhage, subdural hematoma, contusion, epidural hematoma, skull fracture, intraparenchymal haemorrhage, and cerebral oedema. The sensitivity, specificity, and predictive values with 95% confidence intervals (CIs) for the performance of each rule for CT scan and each criterion of rules and all symptoms predicted to be caused by head trauma were calculated. $P < 0.05$ was considered statistically significant. A total of 140 patients were included in the study. The mean age of the patients included in the study was 55.59 ± 23.258 (median 57.00)years . Of all patients, 62.1% (n: 87) were male and 37.9% (n: 53) were female. In terms of gender, it was found that men had more minor head trauma. The mean age of male patients was 49.90 and 64.94 for female patients. Among whole study population, 43.57% (n = 61) of the patients were 65 years and older. Sensitivity, specificity, and positive predictive value negative predictive value of NOC were 87.5%, 6.57%, 44.09% and 38.46%, respectively. The sensitivity of CCHR rule was 82.81%, its specificity was 32.8%, its positive predictive value was 50.96%, and its negative predictive value was 69.4%. The sensitivity of NEXUS II rule was 93.75%, specificity was 3.94%, positive predictive value was 45.11%, and the negative predictive value was 42.85%. There are different interpretations in the literature about which rule should be used to decide performing a CT scan in patients with minor head trauma. Additional studies may be demonstrated by focusing specifically on the sensitivity and specificity of each criterion separately. Additionally, more studies should be performed especially in geriatric population to specify a criterion for each rule separately.

Keyword: Head Trauma, CT rules, Emergency Medicine

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INTRODUCTION

As of 2013, approximately 2.8 million people are affected by head trauma each year in the United States[1]. Incidence of patients admitting the emergency departments with traumatic brain injury is 453 per 100.000 person-annually Ten point nine percent of patients have moderate to severe injuries while 89.1% of injuries are mild[2,3]. Mild head injury is typically characterized as a direct injury to the cranium, after which the patient might shortly become unconscious, have short amnesia, and present with altered mental status[3]. Although patients with mild head injury do not need early surgical operations or hospitalization, a few may present with significant intracranial hemorrhage which must be identified and treated accordingly to prevent severe disabilities even death.

The imaging method of choice to precisely diagnose intracranial injuries is a head computerized tomography (CT) scan. During recent years the utilization of CT in emergency departments (ED) has increased greater than before (120%)[4]. Estimated 1 million blunt trauma patients receive cranial CT annually in the USA, with merely 6% of them having prominent intracranial conditions[5]. Although there is a consensus to scan patients with moderate or severe head trauma urgently[6],an ongoing debate continues as to which patients with mild head injury should be scanned.

Nowadays, utilization of CT for mild head injury is escalating and is found to be not cost-effective. Health care providers usually order cranial CTs not to delay treatment in case of rare complications[7,8] but they do also order cranial CTs due to non-medical factors like fear of litigation and to fulfill patients' expectancies[9-11]. Scanning each minor head injury patient with CT would result in a huge number of normal CT results which leads to unnecessary radiation exposure, growing health care costs, and ED overcrowding. Also, centers which are not able to scan patients are obligated to transfer patients to large centers, which increase costs.

Physicians must balance patient safety and the consequences of over imaging. Various cranial CT judgment criteria have been formulated to permit selective ordering of CT scans, to discharge patients without complications, and to reduce costs. The Canadian CT Head Rule (CCHR), New Orleans Criteria (NOC), and National Emergency X-Ray Utilization Study (NEXUS)-II criteria are amongst the rules which are used widely[5,12,13]. In our study we aimed to compare the clinical effects of CCHR, NOC, and NEXUS-II rules to identify the clinically significant brain injuries in minor head trauma patients.

MATERIALS AND METHOD

Our research was performed at a single Training and Research hospital with 200.000 annual ED visits. After ethics committee approval was obtained, the study was conducted prospectively during November 2015 -November 2016. Demographic features, injury

mechanisms, traumatic symptoms, and signs on CT were assessed. Acute mild head injury was defined as a closed head injury by blunt force within 24 hours, with a Glasgow Coma Scale (GCS) score of 13 to 15.

Younger than 18 year-old and pregnant patients are excluded from the study. The other exclusion criteria were as follows; the patients with a GCS score of less than 13; with unstable vital signs, with head trauma more than 24 hours ago; with penetrating head injury or depressed skull fractures; with multi-trauma; with a history of bleeding disorder or anticoagulant use.

All patients enrolled in our study were assessed by either primarily emergency medicine physicians or emergency medicine residents. All patients who visited our ED with minor head trauma were enrolled in the study prospectively, and all CCHR, NOC, and NEXUS rules were evaluated separately for each patient. The determined outcome lesions were subarachnoid hemorrhage, subdural hematoma, contusion, epidural hematoma, skull fracture, intraparenchymal hemorrhage, and cerebral edema[12].

Statistical analysis was done with SPSS (version 11.0; SPSS, Inc., Chicago, IL). Comparison of categorical data was done by Chi-square and Pearson Chi-Square tests. ROC analysis was performed to determine the effectiveness of each decision rule for detecting intracranial injury. The sensitivity, specificity, and predictive values with 95% confidence intervals (CIs) for the performance of each rule for CT scan and each criterion of rules and all symptoms predicted to be caused by head trauma were calculated. $p< 0.05$ was considered statistically significant.

RESULTS AND DISCUSSION

Demographics and Trauma Mechanisms

A total of 140 patients were included in the study. The mean age of the patients included in the study was 55.59 ± 23.258 (median 57.00) years. Of all patients, 62.1% (n: 87) were male and 37.9% (n: 53) were female. The mean age of male patients was 49.90 and 64.94 for female patients. Among whole study population, 43.57% (n = 61) of the patients were 65 years and older.

Falls were the most common trauma mechanism (62.1% (n = 87)), followed by pedestrian accidents (14.3% (n = 20)), interpersonal violence %12, 1 (n=17), and motor vehicle accidents. %11, 4 (n=16).

Table 1 details the parameters, patient count and statistical relevance of each parameter with relevant symptoms which were not included in given criteria.

	n	%	p
Lethargy	13	9.3	p<0.05*
Loss of Consciousness	13	9.3	p>0.05
Dizziness	5	3.6	p>0.05
Canada			
GCS <15 2 hours after trauma	4	2.9	p>0.05

Suspected open or displaced head base fracture	28	20	p<0.05*
Recurrent vomiting	21	15	p>0.05
Amnesia lasting more than 30 minutes	21	15	p<0.05*
Dangerous injury mechanism	44	31.4	p>0.05
Age more than 65 years	61	43.6	p>0.05
New Orleans			
Headache	102	72.9	p<0.05*
Vomiting	27	19.3	p>0.05
Older than 60 years	61	43.6	p>0.05
Drug or alcohol intoxication	7	5	p>0.05
Short term memory deficit	21	15	p<0.05*
Visible trauma on the clavicle	1	0.7	p>0.05
Seizures	1	0.7	p>0.05
NEXUS			
Age >65 years	61	43.6	p>0.05
Suspected fracture	28	20	p>0.05
Scalp hematoma	106	75.6	p>0.05
Neurologic Deficit	**0**	**0**	**-**
Abnormal behavior	**3**	**2.1**	**p<0.05***
Coagulopathy	**39**	**27.9**	**p>0.05**
Recurrent Vomiting	**28**	**20**	**p>0.05**
Altered Level of Consciousness	**14**	**10**	**p>0.05**

The most common complaint was headache in patients with minor head trauma. (n: 102, 72.9%). While 18.6% (n: 26) of the patients described vomiting, 15% (n: 21) complained of nausea. Lethargy in 9.3% (n: 13), loss of consciousness in 9.3% (n: 13), and dizziness in 3.6% (n: 5) was also observed in patients. Retrograde amnesia lasting more than 30 minutes (p: 0.033), headache (p: 0.006), lethargy (p: 0.003), suspected skull base fracture (p: 0.009), and abnormal behavior (p: 0.009) and GCS: 13 (p: 0,02) were found to be significant for predicting abnormal CT results while the other parameters of the predefined rules failed to be significant statistically alone for detecting intracranial lesions. Sensitivity, specificity, and positive predictive value negative predictive values of evaluated rules are given in table 2 indicating specificity, positive predictive value and negative predictive value were highest in CCHR. Sensitivity was found highest in NEXUS II criteria.

In our study most of the patients cranial CT was interpreted as normal (n:76,%54.3) followed by subarachnoidal hemorrhage (n:24,%17.1), subdural hematoma (n:23%16.4) contusion(n:22,%15.7). The other lesions encountered were epidural hematoma(n:12,%8,6), skull fracture (n:10,%7,1),intraparenchymal hemorrhage (n:5,%3,6) and cerebral edema(n:4,%2,9) respectively.

Table 2: Distribution of CCT results by the rules with their sensitivities and specificities

		NOK		CCHR		NEXUS II		Total
		+	-	+	-	+	-	
CT	+	n:56 (%44)	n:8 (%61,5)	n:53 (%50,9)	n:11 (%30,5)	n:60 (%45,1)	n:4 (%57,1)	n:64 (%45,7)
	-	n:71 (%56)	n:5 (%38,5)	n:51 (%49,1)	n:25 (%69,5)	n:73 (%54,9)	n:3 (%42,9)	n:76 (%54,3)
Total		n:127 (%100)	n:13 (%100)	n:104 (%100)	n:36 (%100)	n:133 (%100)	n:7 (%100)	n:140 (%100)
Sensitivity		%87,5		%82,81		%93,75		
Specificity		%6,57		%32,8		%3,94		
NPV		38.46%		50.96%		45.11%		
PPV		44.09%		69.4%		42.85%		

Demographics:

Fall and pedestrian injuries are the most common trauma mechanism in our study. In literature, motor vehicle accidents and falls have been commonly reported as trauma mechanisms[14]. In our study, we attributed the high rate of falls and pedestrian injuries to the high number of the elderly population visiting our hospital. Besides, our hospital is located in the city center and patients who have high-energy motor vehicle accidents are often referred to other hospitals closer to the highways of Istanbul. Similar to other studies[3,14,15], males mostly presented with minor head trauma.

In the literature most common symptoms due to minor head injury are headache (75%), dizziness (60%), blurred vision (75%), nausea (54%), double vision (11%), sensitivity to sound and light (%4)(16), which was in line with our results. Unlike other studies, subarachnoid hemorrhage had a higher proportion than the other clinically significant lesions13,17.

CCHR, NOC, and NEXUS-II rules have different variables directing clinicians to perform head CT in minor trauma patients. There are conflicting data in the literature as to which criterion predicts abnormal CT results more precisely. As such, Ro et al.[14] and Steill et al.[15] but not Sadegh et al.[18] and Haydel et al.[17] reported that headache was significantly correlated to abnormal CT scan. Ro et al. found an increased risk for intracranial injuries detected by CT scan when patients had a low GCS or abnormal behavior but not amnesia. Sadegh et al. found a positive correlation between GCS, amnesia and confusion, and abnormal CT scan results[18]. In our study retrograde amnesia lasting more than 30 minutes (p: 0.033), headache (p: 0.006), lethargy (p: 0.003), suspected skull base fracture (p: 0.009), abnormal behavior (p: 0.009), and a GCS of 13 (p: 0, 02) were found to be significant in predicting abnormal CT results. We conclude that all criteria of the different rules to be considered separately to further specify the rules, especially by age.

CCHR, NOC, and NEXUS-II are commonly used rules for ordering a CT scan for patients with minor head injury. These criteria remain the most accurate and cost-effective decision-making

tools for safely reducing unnecessary neurological imaging in minor head trauma. In previous large cohorts, Smits et al. found a sensitivity and a specificity of CCHR 80.3% and 44.2%, respectively; and for NOC the corresponding figures were 99.8% and 4.4%, respectively[19]. Another study conducted by Stiell et al. demonstrated that CHR had a sensitivity and a specificity of %100 and %50.6, respectively, while NOC had a sensitivity of100% and a specificity of 12.7%[15]. Kavalci et al found a sensitivity and a specificity of 76.4% and 41.7%, respectively, for CCHR; they reported that NOC had a sensitivity and a specificity of 88.2% and 6.9%,respectively[12].Ro et al. reported that CCHR had a sensitivity and a specificity for clinically important brain injury of 79.2%, and 41.3%, respectively, while NOC had corresponding figures of 91.9% and 22.4%, respectively and NEXUS-II88.7% and 46.5%, respectively[14].Boudia et al. found that Canadian CT Head Rule had a sensitivity and a specificity 95% and 65%, respectively, for clinically significant head CT findings and New Orleans Criteria had corresponding figures of 86% and 28%[3]. Overall the sensitivity and specificity of CHR, NOC, and criteria from 79.2% to 100%; 86% to 100%; 41.3% to %50.6; 4.4% to 28%, respectively for the mentioned studies. In our study, we found a low specificity for CCHR in contrast to literature and a lower specificity for NEXUS-II rule while the other sensitivity and specificity values were in agreement with the literature. Nearly half of our population consisted of patients who were older than 65 years which dictates performing CT scan no matter other clinical parameters were. This probably affected the specificity numbers of CCHR and NEXUS-II. This effect was particularly observed for NEXUS-II criteria, which we had a lower specificity compared to the literature data[14]. Also, CCHR rule contains subjective or hardly proven parameters; about which older patients may not give precise history or detail, resulting in ordering more CTs. Moreover, analysis of the criteria mentioned above which are correlated to abnormal CT scans can be also be a factor for a lower specificity.

Limitations

Our study was performed by emergency physicians who are adapted to use the above-mentioned clinical rules which might affect their sensitivities and specificities.

CONCLUSION:

There are different interpretations in the literature about which rule should be used to decide performing a CT scan in patients with minor head trauma. Additional studies may be demonstrated by focusing specifically on the sensitivity and specificity of each criterion separately. Additionally, more studies should be performed especially in geriatric population to specify a criterion for each rule separately.

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