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RESEARCH ARTICLE

UTILITY OF THE CANADIAN CT HEAD RULE FOR PATIENTS WITH mTBI FOR THE PREDICTION OF PATIENT TOMOGRAPHIC FINDINGS ATTENDED IN HOSGENAES

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ABSTRACT

Introduction: Cranioencephalic trauma is generally defined according to the World Health Organization (WHO) as any physical injury, or functional deterioration of the cranial content secondary to a sudden exchange of mechanical energy and includes mild Traumatic Brain Injury(mTBI) with a score between 15 and 13 on the Glasgow coma scale. It is estimated that 80% of patients with traumatic brain injury who enter the emergency room have a slight risk. The initial clinical approach is the fundamental basis for diagnostic and therapeutic decisions that lead to the adequate use of tools such as skull tomography. With the use of the Candian CT Head Rule (CCHR) in patients with mTIB, the first contact physician may prioritize the need for a neurosurgical approach, as well as simple skull tomography, which inherently implies adequate use of resources and avoids risk of exposure to unnecessary ionizing radiation.

Objective: To determine the correlation of the presence of tomographic findings in patients with m TBI and the risk factors explored in the implementation of the CCHR protocol, attended at the Naval General Hospital of High Specialty (HOSGENAES).

Material and Methods: An observational, transversal, analytical, prospective study was carried out to collect patients with mTBI who were admitted to the Emergency Department of the High Specialty Naval General Hospital and the initial clinical assessment was applied using Canadian CT Head Rule and subsequent imaging evaluation in a period from May 2016 to August 2017.

Results: By correlation with Kendall's Tau-b, the degree of relationship between the variables included in the CCHR and the tomographic findings was obtained, being moderate (0.2441) for Glasgow, suspicion of skull fracture (0.2758), of the skull base (0.4387). and risk mechanism (0.2222), low relation with the presence of age over 65 years (0.1824), and with a very low relation vomiting (-0.0362) and presence of amnesia (-0.0322). The linearity between the number of factors and the findings increases as the number of positive items increases, with a high ratio of 0.5521 and a P value of <0.001.

Conclusions: The sensitivity and positive predictive value of the Canadian CT Head Rule demonstrated that it captures 96.67% of patients with clinical relevance and lesions observed with computed tomography. It maintains a high specificity of 90% in terms of applicability, has a high percentage of exclusivity in the identification of healthy patients.

INTRODUCTION

The present investigation refers to traumatic brain injury that can be defined in general according to the World Health Organization (WHO) as any physical injury, or functional deterioration of the cranial content secondary to a sudden exchange of mechanical energy and includes the mild Traumatic Brain Injury (mTBI) score between 15 and 13 on the Glasgow coma scale. The main objective is the use of the Candian CT Head Rule in patients with mTBI in the emergency room, where the first contact physician can prioritize the need or not of a neurosurgical approach, as well as simple skull tomography, which inherently involves the proper use of resources and avoids the risk of exposure to unnecessary ionizing radiation. The variables that make up the

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Canadian CT Head Rule are classified as high risk (Glasgow less than 15 but greater than or equal to 13 two hours after mild traumatic brain injury, suspected skull fracture or cranial vault collapse, any sign of fracture of skull base, vomiting on more than two occasions after mTBI, and age greater than 65 years), moderate risk (mechanism of high-risk trauma, considering trampling, ejection of the motor vehicle, falling more than two meters in height or more of 5 steps, and last amnesia before the impact for more than 5 minutes), each of these components imply the need of the tomographic study which results in positive or negative findings. Therefore, it is considered an efficient tool for the management of tomographic resources.

Background

The Glasgow Coma Scale (GCS) was validated to standardize the assessment of the level of consciousness in patients with traumatic brain injury and a method of objectively determining the severity supported by this; Stiell *et al.,* developed an assessment scale in which high-risk factors were 100% sensitiveto predict the need for a neurological intervention (GCS less than 15 hours after injury, suspected fracture of the skull open or sagging, some sign of fracture of the skull base, vomiting in more than two episodes, and age greater than 65 years). The mean risk factors (amnesia after major impact at 30 minutes, mechanism of injury) were 98.4% sensitivity and the specific 49.6% for prediction of clinically important brain injury. (Stiell, 2001, pp. 1391). In Holland, a multicenter prospective study was conducted to validate and compare 2 clinical decision rules in patients with mTBI: the Canada scale (CCHR) and the New Orleans Criteria (NOC). From February 2002 to August 2004, in 4 university hospitals in the Holland, a sample of 3,181 patients with GCS with 13 to 14 points and risk factors compared to CT scans (CT scans). Of 3,181 patients with a GCS score of 13 to 15, neurosurgical intervention was performed in 17 patients (0.5%); tomographic findings were presented in 312 patients (9.8%). The sensitivity for the neurosurgical intervention was 100% for both CCHR and NOC. The NOC had a greater sensitivity for clinically important (97.7% - 99.4%) TBI compared to CCHR (83.4% - 87.2%). The specificity was very low for NOC(3.0% -5.6%) and higher for CCHR (37.2% - 39.7%). The estimated potential reduction in CT for patients with minor head injury would be 3.0% for NOC and 37.3% for CCHR. It was concluded that for patients with mild TBI and a GCS score of 13 to 15, the CCHR has a lower sensitivity than the NOC for traumatic neurocranial outcomes or clinically important data, but the CCHR identifies all cases of importance which require a neurosurgical intervention, and has a greater potential for the reduction of the use of CT. (Smits,2005,pp.1519).

In Canada, a prospective randomized controlled trial was conducted to evaluate the effectiveness of the application of the Canadian clinical decision guide as a selective tool for CT studies in multiple emergency departments from Canada. A total of 4531 patients with minor lesions of cranioencephalic trauma were included during two 12-month periods (6 months of measurement at sites considered interventional and 6 months at sites of control), using paired groups. At the intervention sites, the proportion of patients referred for CT increased from "before" (62.8%) to "after" (76.2%) (difference of + 13.3%, 95% IC: 9.7% -17.0%). At the control sites, the proportion of CT use also increased, from 67.5% to 74.1%. The change in mean image rates from "before" to "after" in intervention hospitals versus control hospitals was not significant (P = 0.16). It was concluded in the study that the Canadian guide did not reduce the rates of tomographic studies in the emergency department. (Stiell, 2010, pp. 1527). Hernan SE. *et al*., carried out a systematic review on the clinical decision guidelines for adults with minor head trauma, in relation to the Glasgow scale with a score of 15 to 13, plus risk of intracranial injury and requisition of neurosurgical intervention. Twenty-two relevant studies were identified, finding differences in patient selection, outcome definition, and reference patterns used. The Canada Guide was found to have a sensitivity of 99% to 100% and specificity from 48% to 77% for lesions requiring neurosurgical intervention. Other standards such as the New Orleans criteria, Committee on Neurotraumatology at the World Federation of Neurosurgery Society, Scandinavian criteria and Work guides in Scotland; produce similar sensitivities for lesions requiring a neurosurgical intervention, but with lower and more variable specificity values. It was concluded that the most widely investigated decision rule is the CCHR, which has consistently demonstrated high sensitivity for the identification of the lesion requiring neurosurgical intervention with an acceptable specificity to allow for the estimated use of cranial computed tomography. No other decision rule has been so extensively validated or demonstrated with acceptable results, but its exclusion criteria make it difficult to apply universally. (Harnan, 2011, pp. 245). Thekkumkara S. *et al*., India conducted a cross-sectional study to evaluate the efficacy of the Canadian CT Head Rule (CCHR) to predict the occurrence of brain lesions, the Glasgow Scale (GCS) in relation to computed tomography CT), in a clinical setting. Fifty patients with suspected lesions were included to assess the risks of injury and to associate them with the predicted damage scales, with the result that GCS did not predict CT lesions, however, when CCHR was added as predictive, sensitivity rose from 23.3% to 96.7%. It was concluded in the study that the CCDH could act as an excellent decision rule to indicate the need for a CT scan. (Anish, 2012, pp. 163).

In Turkey, they conducted a prospective cohort study to compare two clinical decision rules: the Canadian Scale Rating Criteria (CCHR) and the New Orleans Criteria (NOC) based on their diagnostic performance in patients with an injury cranioencephalic. The mean age of the patients was 45 ± 21.3 in group 1 (with traumatic brain injury) and 49 ± 20.6 in group 2 (without intracranial lesions). The most common mechanism of trauma was by fall. The sensitivity and specificity of CCHR were, respectively, 76.4% and 41.7%, whereas the sensitivity and specificity of NOC were 88.2% and 6.9%. It was concluded that the CCHR has greater specificity, Positive Predictive Value and Negative Predictive Value (VPP and NPV) for important clinical outcomes than NOC. (Kalvaci, 2014, pp. 1-5). In 2015, Arab AF. *et al*., carried out a retrospective study in Saudi Arabia with the objective of assessing unjustified tomographic (CT) studies in patients with minor cranioencephalic injury, in relation to the efficacy of the Canadian clinical decision guide. METHODS: We included 368 patients with mild TBI with CT studies in the emergency department with systematically randomized cranioencephalic trauma records, obtaining unwarranted CT prevalences, and the ability to decide on the need for CT in these patients in 3 emergency doctors. The prevalence of unwarranted CT scan by

the CCHR was 61.8% (95% confidence interval (CI) 56.5-66.9%). Approximately 5% of the sample had positive results on CT with 95% CI 2.9 to 7.6%. The CCHR correctly identified 12 cases with positive CT results with a sensitivity of 66.67%. Only 24 (6.7%) had Glasgow coma scale scores below 15 (13/14). The Glasgow coma scale correctly identified only two cases with positive CT results with sensitivity 11.11%. The percentage of skull fracture (0.9% vs. 5%, P = 0.030) was significantly lower in patients with unwarranted CT than in clinically justified CT patients. There was no standardization of criteria between emergency physicians and CCHR (κ = 35-61%). Two physicians identified all cases of justified CT with a sensitivity of 100% (95% CI: 71.51 to 100%). It was concluded that the CCHR guideline has a poor potential in the requirements of the trauma emergency center maintaining an unwarranted high prevalence of cranial CT. (Arab, 2015, pp. 591).

In the year 2016, Mata-Mbemba D. *et.al*. Carried out a retrospective cohort study in Japan, comparing the clinical decision guide for patients with mild CVA with New Orleans (NOC) comparing sensitivity and specificity, according to tomographic findings (CT). We examined the relationship between scores or elements and the presence of important CT findings. Only the Canadian was significantly associated with significant tomographic findings in the multivariate analysis and showed greater area under the ROC curve (AUC), either in the 142 patients (GCS 15-13: P = 0.0130; AUC = 0.69) or in the 67 with GCS = 15 (P = 0.0128, AUC = 0.73). Of items, "> 60 years" or "65 years" in either pattern was the strongest predictor of significant findings on CT, followed by "GCS <15 after 2 h" included only in the CCHR. It was concluded that the Reference Hospital in Japan, the CCDH performed better than the NOC in predicting results of important findings on CT. (Mata, 2016, pp. 1-7).

Objectives of the Study

The main objective of this study was to determine the correlation of the presence of tomographic findings in patients with mTBI and the risk factors explored in the implementation of the CCHR, assisted in HOSGENAES. The specific objectives were to explore the frequency of patients with tomographic findings that have presented predictive factors determined by the CCHR,correlating the existence of tomographic findings with the presence of risk factors for mTBI, considered in the CCHR,obtain the sensitivity, specificity and positive predictive value of the implantation of the CCHR in the prediction of tomographic findings, in patients with mTBI.

MATERIAL AND METHODS

Observational, cross-sectional, analytical and prospective study that included patients with mild Traumatic Brain Injury a period from May 2016 to July 2017 who entered the HOSGENAES emergency department, after signing the informed consent was applied by the physician the Canadian CT Head Rule for patients with inclusion criteria older than 16 years and with high or moderate risk according to the Canadian protocol, the exclusion criteria were: patients with any type of anticoagulant treatment or disease that alter the mechanism of clotting, clinically frank skull fracture, pregnant patients, patients under the influence of alcohol, drugs or narcotics, patients with systemic disease or extra cranial injury, patients who decide not to participate in the study and elimination: all patient who due to his current condition or previous clinical characteristic does not cooperate for the tomographic acquisition.To comply with the inclusion criteria, the patients were transferred to the imaging service for the performance of the CT scan of the skull. The Kendall Tau-b correlation statistic was used to analyze the relationship of the variables described in the Canadian CT Head Rule with the tomographic findings of cranioencephalic lesions:

- The correlation coefficient of 0 was considered unrelated.
- A correlation coefficient greater than 0, establishes positive relation, classifying the relationship as low (between 0.01 and 0.2), moderate (between 0.2 and 0.49) and strong (0.5 or greater); likewise, the expression of the percentage ratio of the variables was obtained by multiplying the correlation coefficient by 100.
- A correlation coefficient less than 0 establishes negative relation, classifying the relationship as low (between -0.01 and -0.2), moderate (between -0.2 and -0.49) and strong (-0.5 or greater); and the expression of the percentage of explanation of the dependent variable with respect to the independent variable (coefficient of determination per 100).

To corroborate the usefulness of the Canadian CT Head Rule, in the prediction of tomographic findings in mild Traumatic Brain Injury, Sensitivity, Specificity, Positive Predictive Value and Negative Predictive Value were obtained.
The data collected were analyzed using the statistical analysis program STATA version 12.0.

RESULTS

The Canadian CT Head Rules were applied to 59 people who arrived at the emergency department of the General Naval High Specialty Hospital, 26 women and 33 men, with a mean age of 54 years (minimum and maximum value of 21 and 93 years, respectively).Of the 59 respondents with the Canadian CT Head Rules, all patients underwent computerized axial tomography (CT), which found findings of injuries in 38 of them, representing 64.41% of the total.

We consulted the results of the tomographic findings in the patients with zero items during the questionnaire, finding that they were extra-cranial lesions such as subgaleal hematomas in 7 of them and 1 occipito-parietal soft tissue edema. With 51 patients remaining for direct analysis. (Table 1)

Table 1.Findings TC

Not	21	41.18%
Yes	30	58.82%
Total	51	100%

A cross-over of data was performed to obtain the number of patients with the presence of a factor or more described in the Canadian CT head rules, in which 10 patients were found to have no presence of factors, of which 1 when performing the studies had tomographic findings (Table 2).

Table 2. Frequencytable of findings and presence of factors

	Presence of factors		
Findings TC	1 ó more	Any	
Yes	29	1	30
Not	12	9	21
Total	41	10	51

Kendall's Tau-b correlation coefficient between the presence of impairment in the Glasgow Coma Scale and the tomographic findings was 0.2441 (considered a moderate positive relation), with the presence of impairment of the Scale of Glasgow on the existence of tomographic findings (Table 3).

Table 3. Correlation of tomographic findings with the Glasgow Coma Scale

	Glasgow Coma Scale		
Findings TC	Yes	Not	
Yes	4	26	30
Not	0	21	21
Total	4	47	51
Tau-b of Kendall = 0.2441			

Kendall's Tau-b correlation coefficient between the presence of cranial fracture and the tomographic findings was 0.2758, considering a moderate positive relationship between the variables, representing a 27.58% relation (Table 4).

Table 4.Correlation of tomographic findings with suspected cranial fracture

	Fracturecranial		
Findings TC	Yes	Not	
Yes	5	25	30
Not	0	21	21
Total	5	46	51
Tau-b of Kendall = 0.2758			

The relation between the tomographic findings and the existence of suspected skull base fracture was classified as a moderate positive relation, with a Kendall Tau-b coefficient of 0.4387, expressing a relation between these variables of 43.87%, (Table 5).

Table 5. Correlation of the tomographic findings with suspected skull base fracture

	Suspectedskull base fracture		
Findings TC	Yes	Not	
Yes	11	19	30
Not	0	21	21
Total	11	40	51
Tau-b ofKendall = 0.4387			

In the correlation of the presence of vomiting and the presence of tomographic findings, the relationship became negative, with a Kendall Tau-b coefficient of -0.0362, explaining a low ratio of -3.62%, (Table 6).

Table 6. Correlation of the tomographic findings with the presence of vomiting

	Vomiting		
Findings TC	Yes	Not	
Yes	1	29	30
Not	1	20	21
Total	2	49	51
Tau-b of Kendall = -0.0362			

Kendall's Tau-b correlation coefficient between the presence of age greater than 65 and the tomographic findings was 0.1824, considering a low positive relation between the variables, representing 18.24% (Table 7)

Table 7. Correlation of the tomographic findings with the age over 65 years

	Age> 65		
Findings TC	**Yes**	**Not**	
Yes	14	16	30
Not	6	15	21
Total	20	31	51
Tau-b of Kendall = 0.1824			

For the explanation of the presence of CT findings related to the presence of a risk mechanism for TBI, Kendall's Tau-b correlation coefficient was 0.2222, with a moderate positive relation between the 22.22% variables (Table 8)

Table 8. Correlation of the tomographic findings with the risk mechanism for TBI

	Mechanism of risk for TBI		
findingsTC	Yes	Not	
Yes	12	18	30
Not	4	17	21
Total	16	35	51
Tau-b of Kendall = 0.2222			

The presence of amnesia in the explanation of tomographic findings during the TCEL, becomes a negative relation, with a Kendall Tau-b correlation coefficient of 0.0322, representing 3.22%, (Table 9).

Table 9. Correlation of the tomographic findings with the presence of amnesia

	Amnesia		
Findings TC	Yes	Not	
Yes	5	25	30
Not	3	18	21
Total	8	43	51
Tau-b of Kendall = 0.0322			

The greater number of factors present in the application of the Canadian CT Head Rule questionnaire, the higher the prediction percentage of the presence of tomographic findings in the cabinet studies, this calculation was required with very high statistical significance, with a p value <0.001. (Table 10).

Table 10. Linear correlation in relation to the number of factors present in the Canadian CT Head Rule questionnaire and the presence of tomographic findings

	Total factors					
Findigs TC	0	1	2	3	4	
Yes	1	11	14	3	1	30
Not	9	10	2	0	0	21
Total	10	21	16	3	1	51
Tau-b of Kendall = 0.5521						
Valuet p = <0.001						

Regarding the usefulness of the Canadian CT Head Rule questionnaire, the sensitivity, specificity and positive predictive value of its application in patients with ECL in the prediction of the presence of tomographic findings were calculated. For the relevant calculations of these values,

reference was made to the presence and absence of tomographic findings by crossing the variable with the presence and absence of factors in the Canadian CT Head Rule, shown in Table 2.So, we obtained:(Table 11)

Table 11.

Sensitivity: 70.73%
Specificity: 90 %
Positive PredictiveValue: 96.67%

DISCUSSION

According to the high-risk variables, the Glasgow Coma Scale and suspected cranial vault fracture were found to be moderate, coinciding in the first two data with Stiell, 2001, unlike this study we did not find any relation to the variables of moderate irrigation.As in the studies of Anish, 2012 and Mata, 2016 a moderate relation is observed with respect to the Glasgow Coma Scale, which is of low sensitivity, which improves considerably when adding the rest of the components of the Canadian CT Head Rule.In this study, we obtained similar sensitivity results to those reported in the literature corresponding to 70 to 96%, (Harnan, 2011, pp. 245); However, the specificity found in this study was 90%, in controversy with some researches worldwide that mention between 40 and 60% (Kalvaci, 2014, pp1-5). Increased specificity can be explained in this project by the adjustment of patients with no presence of factors in the Canadian CT Head Rule and with the presence of tomographic findings, in which only those who had tomographic findings with significant lesions were maintained of TCE.Stiell, 2010 mentions that there is no reduction in tomography studies when applying the Canadian CT Head Rule, as well as Ara, 2015.Although there are different environmental factors and different study factors, the efficiency and effectiveness of the Canadian CT Head Rule have been verified in the different research studies, which even shows that it can be adapted to endless work environments and populations, becoming a useful tool worldwide for the screening of mild cranioencephalic trauma.

Conclusion

Given the data obtained in the implementation of the Canadian CT Head Rule, the calculation of sensitivity and positive predictive value, show that the questionnaire for prediction of CT scan findings, captures 96.67% of patients with clinical relevance and observed lesions with computed tomography; however, it maintains the existence of 29.27% of false positives, reason why it is translated that it has the facility to recognize to almost all the patients and on estimate the selection of the same ones.Likewise, it maintains a high specificity of 90%, in terms of applicability, has a high percentage of exclusivity in the identification of healthy patients, so it becomes an efficient tool for the management of tomographic resources.The Canadian CT Head Rule is a tool that can be used as a follow-up protocol by the Medical Practitioners in Emergency, in such a way that it helps them to determine in an efficient and efficient way the patients with the necessary requirement of tomographic studies. This process of action would help to reduce the cost of tomographic study surrogates in the care of patients with m TBI and jointly provide a close follow-up and monitoring of the patient, which may facilitate the decision-making of the medical staff.Therefore, it is recommended its diffusion and application in the different Naval Health Establishment, as Procedure of Action and decision making in patients with TCEL.

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