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Research Paper

Evaluation of causes of brain CT scan in patients with minor trauma

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ABSTRACT

Background: Computerized tomography (CT) scan is one of the widely used imaging modalities for the diagnosis of anomalies and diseases. Nonetheless, increased exposure to the radiations is one of its overlooked side effects.

Objective: The aim of this study was to determine the causes of cerebral CT scan in patients with minor trauma.

Method: In this cross-sectional study, 550 patients with minor head trauma referred to (XXX) were evaluated. The data are collected and completed using a questionnaire comprising of variables such as age, sex, type of trauma, trauma severity, CT scan results, associated symptoms based on NEXUS II, CCHR and NOC criteria and underlying diseases. The data were analyzed using statistical tests and SPSS software version 22.

Result: The mean age of patients was 32.5 years and 62% of patients were male. 67% of the patients visited the hospital on their own. The cause of the trauma in 29% patients was car accident, 19% fall from height and 16.5% conflict. Scalp lesions were seen in 30.5%, hematomas in 4.9%, dizziness in 8.9%, history of comorbidities in 5.8%, episode of vomiting less than 2 in 7.3%, episode of vomiting more than 2 times in 1.1%, headache with score $\geq$7 in 5.8%, headache with score $\leq$7 in 23.1%, postoperative forgetfulness in 0.2%, raccoon eyes in 0.2% and nose bleeding in 1.5%. Findings of CT scan were abnormal in 0.2% of patients. The patient's condition declared cleared in 94.5% cleared and 5.5% referred to a neurosurgery. Statistically, CT scan had significant role in predicting the patient's neurosurgery counseling status ($P < 0.05$).

Conclusion: The majority of patients with minor head trauma had normal brain CT scan and was discharged without the need for neurosurgery counseling. Therefore, it seems necessary to reduce brain CT scans without indication to reduce the radiation dose among patients with minor head trauma.

1. Introduction

Traumatic brain injury accounts for 7000 death, 60,000 hospitalization and more than 60,000 emergency department visit, annually, in the United State [1,2]. Minor head trauma/injury is defined as a blunt injury that is characterized with short amnesia, loss of consciousness for a brief period, or altered mental state, which is a result of blunt trauma to the head and are among the most commonly treated injuries in emergency department [3].

Neurocranial traumatic lesion is identified using head/brain computed tomography (CT) scan [3]. It is considered as a gold standard to determine emergency life-threatening neurocranial pathology [4,5]. Nonetheless, CT scan should be wisely used among patients as it is associated with pharmacological sedation, radiation-induced malignancies and increased financial burden [6]. A number of guidelines are designed to evaluate patients with mild trauma injury who might need CT scan such as NICE (National Institute for Health and Clinical Excellence) [7], NOC (New Orleans Criteria) [8], ACEP (American College of Emergency Physician) [9] and CCHR (Canadian Computed tomography Head Rules) [10]. Some of the common indications of head CT from these guidelines include amnesia, advanced age and vomiting. Nonetheless, the overuse of CT still remains a problem [11].

The aim of this study is to determine the use of CT scan among minor head trauma patients referred to the emergency department

The Research was approved by the Committee of Research Ethics of Taleghani Hospital, Kermanshah (IR.KUMS.REC.1398.926).

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of our center. We present the findings from the CT scan and evaluate the significance of CT scan in the referral to the neurosurgery department/unit.

2. Methods

This retrospective surgery was conducted at (XXX) in 2018 (January–December) including the patients (all ages) who were referred to the hospital with head trauma. Minor head trauma was reported as the loss of consciousness (or history) with Glasgow Coma Scale of 13–15, with normal primary neurological investigation (sensation in arms and legs, and normal cranial nerve examination).

Patients with abnormal vitals, apparent skull injury, bleeding disorders, requiring emergency exploratory laparotomy, pregnancy and seizures were excluded from the study.

Data of all the patient following in the inclusion criteria during the period of study were elevated for NOC, Nexus-II and CCHR criteria as reported in other studies [12]. The findings of the CT scan were evaluated by two blinded independent radiologists. The data regarding demographic information, history of the patient, cause of the trauma and CT findings were obtained for all the patients and recorded in the questionnaire, particularly designed for the research.

Statistical analysis was performed using SPSS version21, Quantitative variables were described as mean, median and standard deviation. Qualitative variables were presented as percentages and frequencies. The correlation between the variables was determined using logistic regression.

The research was approved by the committee of research ethics of (XXX).

The work has been reported in line with the STROCSS criteria [13].

3. Results

A total of 550 CT scans were evaluated in this study, where the average age of the patients was 32.5 ± 19.66 years (Fig. 1). The highest frequency of the patients was aged 25–35 years (26.2%). A total of 324 males (62.2%) and 208 (37.8%). 369 (67.1%) of the patients were not referred through ambulatory service and 181 (32.9%) referred from ambulatory service. The highest frequency of the cause of trauma was car accidents, 160 patients (29.1%) (Fig. 2).

Scalp lesions were found in 168 patients (30.5%), Scalp hematomas were found in 27 patients (4.9%), lightheadedness was reported in 49 patients (8.9%), history of other diseases in 32 patients (5.8%), two or less episodes of vomiting in 40 patients (7.3%), more than 2 episodes of vomiting 6 patients (1.1%), headache with more than 7 VAS (visual analogue scale) score in 32 patients (5.8%), headache with VAS less than 7 in 127 patients (23.1%), amnesia and racoon eyes in 1 patient (0.2%), patients insistence was reported in 151 patients (27.5), respectively and nose bleeding in 8 patients (1.5%). One patient had 13 GCS (0.2%) and other was between 14 and 15.

1 patient (0.2%) had abnormal CT findings whereas, 99.8% patients were presented with normal CT. 520 patients (94.5%) were discharged without the referral to neurologist or neurosurgeon. The absorbed radiation dose of CT scan was 350 in 112 patients (20.4%) and 450 in 438 patients) 79.6%).

The N Slice radiation dose of CT scan was 19 in 112 patients (20.4%) and 33 in 438 patients (79.6%).

Determining the predictors of patients' outcome with minor head trauma: In order to determine the factors affecting the outcomes of the patient's condition in minor head trauma cases, logistic multivariate regression method was used. The regression model includes independent variables (age, gender, patient referral, trauma mechanism, etc.) and a two-state dependent variable that was the outcome of the patient's condition (discharge or neurosurgery consultation). The findings of logistic multivariate regression analysis and the coefficients of these predictor variables were used in the equation to predict the outcome of the patient's condition, presented in Table 1.

The results of logistic multivariate regression showed that trauma mechanism, type of fall and brain CT scan findings are statistically significant ($p < 0.05$). These variables are significantly correlated with patients' status i.e. discharge or neurosurgery consultancy.

4. Discussion

In a recent study by Shobeirian et al. [12], conducted in Tehran, Iran, reported that 31.8% CT were not indicated according to CCHR criteria and 30% of those using NOC. 15.3% of all the scan were overused (not ordered as per the defined criteria), which were mostly in younger patients.

Easter et al. [14] conducted a systematic study on adults presented with minor head trauma with GCS ≥ 13. The incidence of

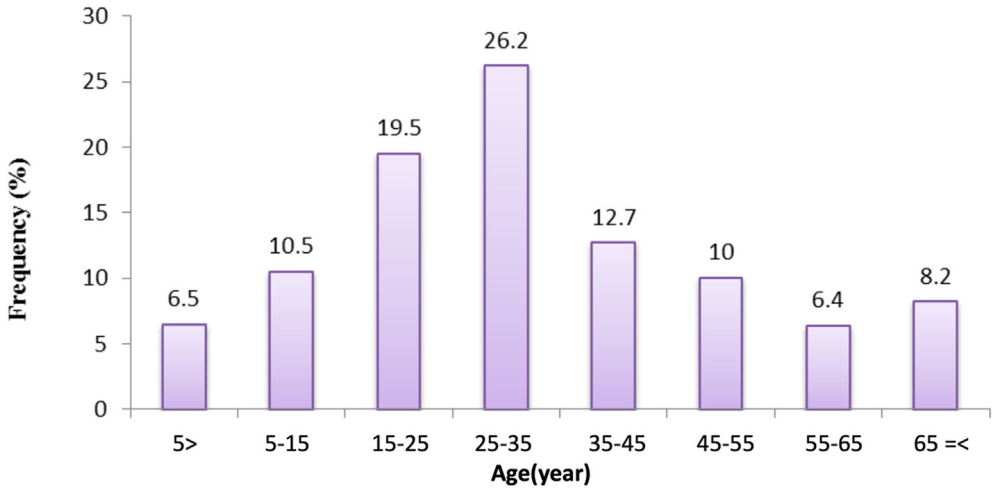

Fig. 1. Graph of age distribution of patients at the time of study.

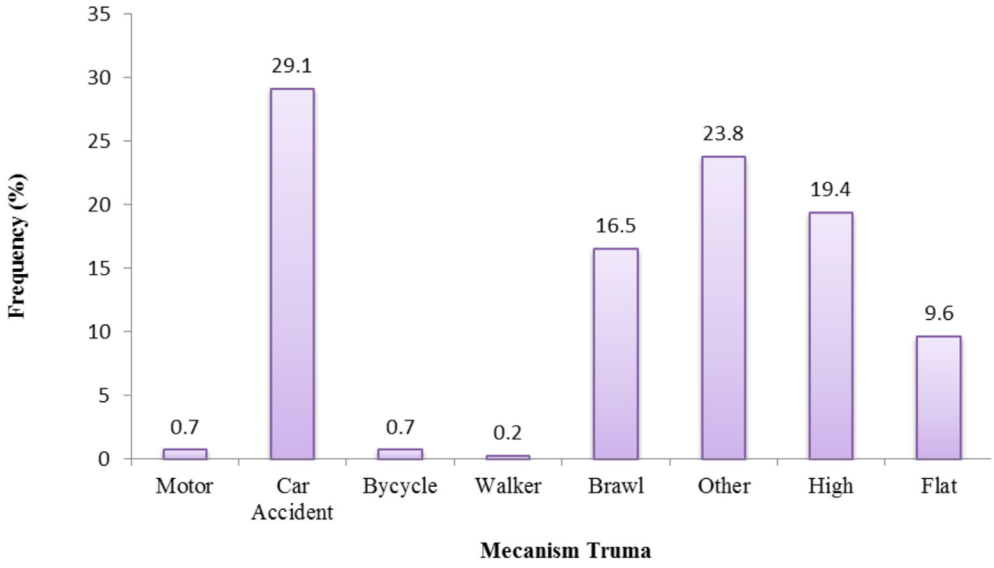

Fig. 2. Frequency values of patients' trauma mechanism.

Table 1
Multivariate regression analysis of predictors of patient status outcome in patients with minor head trauma.

Variable	coefficient	Standard deviation	p-value	Odds-ratio	Confidence level) 95%
Age	0.011	0.011	0.333	1.011	0.989–1.033
Sex	−0.232	0.431	0.591	0.793	0.341–1.846
Patient Referral Location	0.043	0.55	0.938	1.044	0.355–3.065
Trauma mechanism	−0.838	0.243	0.001	0.432	0.268–0.696
direct trauma	−0.873	0.474	0.065	0.418	-.165–1.057
Type of falls	−1.151	0.373	0.002	0.316	0.152–0.657
Scalp lesions	−1.001	0.624	0.109	0.368	0.108–1.249
Scalp hematomas	0.793	0.737	0.282	2.21	0.522–9.366
lightheadedness	0.344	0.616	0.577	1.41	0.422–4.712
history of other diseases	1.383	0.729	0.058	3.98	0.956–16.64
two or less episodes of vomiting	0.06	0.748	0.936	1.062	0.245–4.599
more than 2 episodes of vomiting	0.645	1.211	0.594	1.906	0.178–20.45
headache with more than 7 VAS	0.939	0.791	0.235	2.558	0.573–12.04
headache with VAS less than 7	0.914	0.526	0.082	2.495	0.89–6.99
nose bleeding	−18.49	1.3694	0.99	9.2×10^{-9}	0–0
patients insistence	−1.18	0.911	0.193	0.305	0.051–1.82
CT findings	4.22	2.1	0.045	68.44	1.1–4.2525

intracranial injury was 7.1% among 23,079 patients. The outcomes of the study indicated that skull fracture, pedestrian hit by motor vehicle, GCS of 13 and 2 or more episodes of vomiting are significantly associated with intracranial injury seen in CT scan. Our study concluded that the cause of trauma, type of trauma and findings of CT scan are important factors to determine patient's conditions. Haydel et al. [8] reported that CT scan among patients with minor head trauma should be limited to certain indications in the patients such as headache, vomiting, seizure, short term memory dysfunction, physical evidence of trauma in head and neck region, and age over 60 years. All or at least one of these indications can predict positive CT findings. Melnick et al. [15] concluded that, using all four guidelines for CT criteria, 10–35% of CT scans conducted in their center for minor head trauma were not recommended.

DeAngelis et al. [16] conducted a study on minor head trauma patients that were evaluated for using NEXUS (National Emergency X-Ray Utilization Study) II rule for the indication of CT scan. The findings of the study reported that according to the rule, non-indicated CT was obtained in 23.1% whereas indicated CT was not obtained in 2% patients. The study concluded that the adherence to the rule is important to choose the candidates of CT scan.

Osmond et al. [17] presented a CATCH rule for conducting CT scan among children with minor head trauma. The rule indicated that patients with one high indication (GCS < 15 two hours after the injury, opened or depressed skull fracture, worsening headache and irritability upon examination) or ones with three medium risk indications (basal skull fracture, large hematoma of scalp, dangerous cause of injury) are in greater need of neurosurgical consultancy and are likely to have positive indications in the CT scan. Furthermore, Pediatric Emergency Care Applied Research Network (PECARN) rule is also a good predictor of CT scan among high risk pediatric patients, with good sensitivity and negative predictive value [18].

Biochemical parameters, like increased blood glucose, ubiquitin C-terminal hydrolase -L1 (UCH-L1) can also be studied and utilized as an indicator for positive CT findings [19,20].

Our study does not provide data regarding the analysis of these biomarkers; however, future studies can indicate the usage of these parameters, that can bypass the need of CT scan and reduce financial burden on health care centers. During the study period, obtaining the medical history of the patients was a challenge due to the loss of consciousness. Some of the patients did not have any

next-of-kin and therefore, underwent routine analysis. With the regain of consciousness, history was obtained from these patients to make sure they fulfill inclusion criteria of the study. Additionally, geriatric patients are more prone to falls and severe injuries. Our study does not include age-specific analysis in this area.

5. Conclusion

Adherence to the criteria of CT scan in mild head trauma patients is important to avoid the misuse of the modality and unnecessary exposure to the radiations. Type of trauma and fall and findings of CT scan are important parameters to determine the need of referral to neurosurgical ward. Indications of CT scan should be precisely monitored in these patients.

Ethical approval

All procedures performed in this study involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

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Author contribution

Dr. Bareza rezaei: conceptualized and designed the study, drafted the initial manuscript, and reviewed and revised the manuscript.

Dr. Saleh Salehi zahabi and Dr. Hooman Rafiei: Designed the data collection instruments, collected data, carried out the initial analyses, and reviewed and revised the manuscript.

Dr. Amir Salehi and Dr. Faranak Torabi: Coordinated and supervised data collection, and critically reviewed the manuscript for important intellectual content.

Conflict of interest statement

The authors deny any conflict of interest in any terms or by any means during the study.

Guarantor

Dr. Bareza rezaei.

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Provenance and peer review

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Human and animal rights

No animals were used in this research. All human research procedures followed were in accordance with the ethical standards of the committee responsible for human experimentation (institutional and national), and with the Helsinki Declaration of 1975, as revised in 2013.

Consent for publication

Informed consent was obtained from each participant.

Availability of data and materials

All relevant data and materials are provided with in manuscript.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ijso.2020.11.024.

References

[1] Coronado VG, Xu L, Basavaraju SV, McGuire LC, Wald MM, Faul MD, et al. Surveillance for traumatic brain injury-related deaths; United States, 1997–2007. Morbidity and Mortality Weekly Report (MMWR) 2011;60. 21544045.
[2] Faul M, Wald MM, Xu L, Coronado VG. Traumatic brain injury in the United States; emergency department visits, hospitalizations, and deaths. College of Osteopathic Medicine, Michigan State University; 2010. p. 2002–6.
[3] Bouida W, Marghli S, Souissi S, et al. Prediction value of the Canadian CT head rule and the new Orleans criteria for positive head CT scan and acute neurosurgical procedures in minor head trauma: a multicenter external validation study. Ann Emerg Med 2013;61(5):521–7. https://doi.org/10.1016/j.annemergmed.2012.07.016. published Online First: Epub Date.
[4] Burstein B, Upton JEM, Terra HF, Neuman MI. Use of CT for head trauma: 2007–2015. Pediatrics 2018;142(4):e20180814. https://doi.org/10.1542/peds.2018-0814. published Online First: Epub Date.
[5] 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(2):171–6.
[6] Stanley RM, Hoyle JD, Dayan PS, Atabaki S, Lee L, Lillis K, et al. Emergency department practice variation in computed tomography use for children with minor blunt head trauma. J Pediatr 2014;165(6):1201–6. https://doi.org/10.1016/j.jpeds.2014.08.008. published Online First: Epub Date.
[7] Marincowitz C, Lecky F, Allgar V, Sheldon T. Evaluation of the impact of the NICE head injury guidelines on inpatient mortality from traumatic brain injury: an interrupted time series analysis. BMJ open 2019;9(6):e028912.
[8] 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(2):100–5.
[9] Melnick ER, Genes NG, Chawla NK, Akerman M, Baumlin KM, Jagoda A. Knowledge translation of the American College of Emergency Physicians' clinical policy on syncope using computerized clinical decision support. Int J Emerg Med 2010;3(2):97–104.
[10] Eagles D, Stiell IG, Clement CM, Taljaard M, Kelly A-M, Mason S, et al. International survey of emergency physicians' awareness and use of the canadian cervical-spine rule and the canadian computed tomography head rule. Acad Emerg Med 2008;15(12):1256–61. https://doi.org/10.1111/j.1553-2712.2008.00265.x. published Online First: Epub Date.
[11] Melnick ER, Shafer K, Rodulfo N, Shi J, Hess EP, Wears RL, et al. Understanding overuse of computed tomography for minor head injury in the emergency department: a triangulated qualitative study. Acad Emerg Med 2015;22(12):1474–83.
[12] Shobeirian F, Ghomi Z, Soleimani R, Mirshahi R, Sanei Taheri M. Overuse of brain CT scan for evaluating mild head trauma in adults. Emerg Radiol 2020. https://doi.org/10.1007/s10140-020-01846-6. published Online First: Epub Date.
[13] Agha R, Abdall-Razak A, Crossley E, Dowlut N, Iosifidis C, Mathew G. STROCSS 2019 Guideline: strengthening the reporting of cohort studies in surgery. Int J Surg (London, England) 2019;72:156–65. https://doi.org/10.1016/j.ijsu.2019.11.002. published Online First: Epub Date.

[14] Easter JS, Haukoos JS, Meehan WP, Novack V, Edlow JA. Will neuroimaging reveal a severe intracranial injury in this adult with minor head trauma?: the rational clinical examination systematic review. JAMA 2015;314(24): 2672–81. https://doi.org/10.1001/jama.2015.16316. published Online First: Epub Date.
[15] Melnick ER, Szlezak CM, Bentley SK, Dziura JD, Kotlyar S, Post LA. CT overuse for mild traumatic brain injury. Joint Comm J Qual Patient Saf 2012;38(11): 483–9. https://doi.org/10.1016/S1553-7250(12)38064-1. published Online First: Epub Date.
[16] DeAngelis J, Lou V, Li T, Tran H, Bremjit P, McCann M, et al. Head CT for minor head injury presenting to the emergency department in the era of choosing wisely. West J Emerg Med 2017;18(5):821–9. https://doi.org/10.5811/westjem.2017.6.33685. published Online First: Epub Date.
[17] Osmond MH, Klassen TP, Wells GA, Correll R, Jarvis A, Joubert G, et al. CATCH: a clinical decision rule for the use of computed tomography in children with minor head injury. Can Med Assoc J 2010;182(4):341–8. https://doi.org/10.1503/cmaj.091421. published Online First: Epub Date.
[18] Lorton F, Poullaouec C, Legallais E, Pimmel JS, Chêne MA, Leroy H, et al. Validation of the PECARN clinical decision rule for children with minor head trauma: a French multicenter prospective study. Scand J Trauma Resuscitation Emerg Med 2016;24(1):98. https://doi.org/10.1186/s13049-016-0287-3. published Online First: Epub Date.
[19] Alexiou GA, Sotiropoulos A, Lianos GD, Zigouris A, Metaxas D, Nasios A, et al. Blood glucose levels may aid the decision for CT scan in minor head trauma. Dis Markers 2019;2019:1065254. https://doi.org/10.1155/2019/1065254. published Online First: Epub Date.
[20] Alexiou GA, Lianos GD, Sotiropoulos A, Voulgaris S. Novel biomarkers may aid the decision for CT scan in emergency settings in mild head trauma. Biomarkers Med 2019;13(13):1055–7. https://doi.org/10.2217/bmm-2019-0277. published Online First: Epub Date.