Computed tomography for mild traumatic brain injury

- The Diagnostic and Prognostic Role of Biomarkers in Mild Traumatic Brain Injury: An Umbrella Meta-Analysis
- Budget Impact Analysis of the Use of Specific Biomarkers GFAP and UCH-L1 in the Management of Mild Traumatic Brain Injury in Spain
- Impact of anticoagulant therapy on delayed intracranial haemorrhage after traumatic brain injury: A study on the role of repeat CT scans and extended observation
- GFAP/UCH-L1 as a Biomarker for Rapid Assessment of Mild TBI in Emergency Departments
- Efficacy of tranexamic acid in adult isolated traumatic brain injury: A multicenter retrospective study
- The role of two brain injury biomarkers, GFAP and UCH-L1, for the management of mTBI in the Emergency Department: an observational study
- Traumatic Venous Sinus Thrombosis: Patient and Practice Patterns at a Major Trauma Center
- Neuroimaging Characterization of Acute Traumatic Brain Injury with Focus on Frontline Clinicians: Recommendations from the 2024 National Institute of Neurological Disorders and Stroke Traumatic Brain Injury Classification and Nomenclature Initiative Imaging Working Group

CT scan is the standard if high-risk features are present (per Canadian CT Head Rule, New Orleans Criteria, or NEXUS-II criteria).

No imaging is needed for low-risk patients per decision rules.

A head computed tomography (CT) scan is an effective test for detecting traumatic intracranial findings after mild traumatic brain injury (mTBI). However, a head computed tomography is costly, and can only be performed in a hospital.

Despite the diagnostic gold standard represented by computed tomography (CT), its systematic performance in all patients is unadvisable for the limited prevalence of positivity, radiological risk, high cost, and complexity.

Computed tomography and magnetic resonance imaging, are unable to elucidate the degree of white matter damage and neurometabolic change.

CT scanning has low sensitivity to diffuse brain damage and confers exposure to radiation. On the other hand, MRI can provide information on the extent of diffuse injuries but its widespread application is restricted by cost, the limited availability of MRI in many centers, and the difficulty of performing it in physiologically unstable patients. Although some patients with Mild traumatic brain injury (mTBI) may be admitted to the hospital overnight, the vast majority are treated and released from emergency departments with basic discharge instructions. This group of TBI patients represents the greatest challenges to accurate diagnosis and outcome prediction. The lack of clinical tools to detect the deficits that affect daily function, have left these individuals with little or no treatment options. The injury is often seen as “not severe” and subsequently therapies have not been aggressively sought for MTBI. The diagnostic and prognostic tools for risk stratification of TBI patients are therefore limited in the early stages after injury.

CT is normal or significant only for mild swelling which may represent hyperemia.

Overuse of computed tomography (CT) for minor head injury continues despite developed and rigorously validated clinical decision rules like the Canadian CT Head Rule (CCHR).

The initial loss of consciousness, the presence of a hematoma of the scalp and the presence of at least one sign in favor of the skull base fracture seem most predictive of cranio-cerebral lesions [1)].

One of the hallmarks of concussion is that neurological signs and symptoms are imparted after biomechanical force to the brain in the absence of macroscopic neural damage [2)]. Currently, there is no test to diagnose concussion [3)].

The Canadian CT Head Rule attempts to standardize the practice of obtaining head computed tomography (CT) scans in patients with minor head injury. Previous research indicates 10 to 35 per cent of CT scans performed do not meet these guidelines. The purpose of this study was to review our use of CT scans in the evaluation of mild traumatic brain injury and to identify 1) unnecessary head CT scans (UHCT); 2) variables associated with UHCT; and 3) associated costs. Using a trauma registry, inclusion criteria were age older than 18 years, Glasgow Coma Scale of 15, and at least one head CT scan. UHCTs were those without head injury, loss of consciousness, amnesia, or neurologic complaint. The proportion of patients meeting the criteria for UHCT was 24.2 per cent. Univariate analyses revealed ages 41 to 64 years, drug use, vehicular injury, and surgery within 24 hours were associated with UHCT (all $P < 0.05$). UHCTs were associated with higher Injury Severity Scores ($P = 0.008$), ventilator days, and length of stay (all $P < 0.05$). An average cost of $1,413 per CT equals $149,778 in extra costs. This study suggests that current practices at our Level I trauma center result in UHCT. Further investigation into best practices would benefit our center by reducing costs and providing quality patient care [4)].

Perfusion CT

Perfusion CT imaging may be a useful indicator of brain dysfunction in the acute phase after injury in these patients. In a study, directly after admission perfusion CT imaging was performed in mild TBI patients with follow-up neuropsychological assessment in those with complaints and a normal non-contrast CT. Neuropsychological tests comprised the 15 Words test Immediate Recall, Trailmaking test part B, Zoo Map test and the FEEST, which were dichotomized into normal and abnormal. Perfusion CT results of patients with normal neuropsychological test scores were compared to those with abnormal test scores. In total eighteen patients were included. Those with an abnormal score on the Zoo Map test had a significant lower CBV in the right frontal and the bilateral parieto-temporal white matter. Patients with an abnormal score on the FEEST had a significant higher MTT in the bilateral frontal white matter and a significant decreased CBF in the left parieto-temporal grey matter. No significant relation between the perfusion CT parameters and the 15 Words test and the Trailmaking test part B was present. In conclusion, impairments in executive functioning and emotion perception assessed with neuropsychological tests during follow up were related to differences in cerebral perfusion at admission in mild TBI [5)].

Consecutive adult patients aged 16 years and over who presented with minor head injury at the emergency department with a Glasgow coma scale score of 13-15 between March 2015 and December 2016.

The primary outcome was any intracranial traumatic finding on CT; the secondary outcome was a potential neurosurgical lesion on CT, which was defined as an intracranial traumatic finding on CT that could lead to a neurosurgical intervention or death. The sensitivity, specificity, and clinical usefulness (defined as net proportional benefit, a weighted sum of true positive classifications) of the four CT decision rules. The rules included the CT in head injury patients (CHIP) rule, New Orleans criteria (NOC), Canadian CT head rule (CCHR), and National Institute for Health and Care Excellence (NICE) guideline for head injury.

For the primary analysis, only six centres that included patients with and without CT were selected. Of 4557 eligible patients who presented with minor head injury, 3742 (82%) received a CT scan; 384 (8%) had a intracranial traumatic finding on CT, and 74 (2%) had a potential neurosurgical lesion. The sensitivity for any intracranial traumatic finding on CT ranged from 73% (NICE) to 99% (NOC); specificity ranged from 4% (NOC) to 61% (NICE). Sensitivity for a potential neurosurgical lesion ranged between 85% (NICE) and 100% (NOC); specificity from 4% (NOC) to 59% (NICE). Clinical usefulness depended on thresholds for performing CT scanning: the NOC rule was preferable at a low threshold, the NICE rule was preferable at a higher threshold, whereas the CHIP rule was preferable for an intermediate threshold.

Application of the CHIP, NOC, CCHR, or NICE decision rules can lead to a wide variation in CT scanning among patients with minor head injury, resulting in many unnecessary CT scans and some missed intracranial traumatic findings. Until an existing decision rule has been updated, any of the four rules can be used for patients presenting minor head injuries at the emergency department. Use of the CHIP rule is recommended because it leads to a substantial reduction in CT scans while missing few potential neurosurgical lesions [6].

Computed tomography indications for mild traumatic brain injury

Computed tomography indications for mild traumatic brain injury

1)
Gueddari W, Ouardi A, Talbi S, Salam S, Zineddine A. Clinical factors predictive of traumatic brain injuries in case of mild traumatic brain injury in children: case-control study. Tunis Med. 2017 Jul;95(7):488-493. PubMed PMID: 29694653.
2)
McCrory P, Meeuwisse WH, Aubry M, et al. Consensus statement on concussion in sport: the 4th International Conference on Concussion in Sport held in Zurich, November 2012. Br J Sports Med. 2013;47(5):250-258.
3)
Domínguez DC, Raparla M. Neurometabolic aspects of sports-related concussion. Semin Speech Lang. 2014 Aug;35(3):159-65. doi: 10.1055/s-0034-1384677. Epub 2014 Aug 12. PubMed PMID: 25116209.
4)
Parma C, Carney D, Grim R, Bell T, Shoff K, Ahuja V. Unnecessary head computed tomography scans: a level 1 trauma teaching experience. Am Surg. 2014 Jul;80(7):664-8. PubMed PMID: 24987897.

5)

Metting Z, Spikman JM, Rödiger LA, van der Naalt J. Cerebral perfusion and neuropsychological follow up in mild traumatic brain injury: acute versus chronic disturbances? Brain Cogn. 2014 Apr;86:24-31. doi: 10.1016/j.bandc.2014.01.012. Epub 2014 Feb 18. PubMed PMID: 24556319.

6)

Foks KA, van den Brand CL, Lingsma HF, van der Naalt J, Jacobs B, de Jong E, den Boogert HF, Sir Ö, Patka P, Polinder S, Gaakeer MI, Schutte CE, Jie KE, Visee HF, Hunink MGM, Reijners E, Braaksma M, Schoonman GG, Steyerberg EW, Jellema K, Dippel DWJ. External validation of computed tomography decision rules for minor head injury: prospective, multicentre cohort study in the Netherlands. BMJ. 2018 Aug 24;362:k3527. doi: 10.1136/bmj.k3527. PubMed PMID: 30143521.