



## REVIEW ARTICLE

## Diagnosis of Concussion in a Victim of Road Traffic Accident

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### Abstract

**Introduction:** Cerebral concussion is a minor and reversible functional abnormality and due its relatively minor nature it usually goes undetected and underreported. Despite increased knowledge and awareness of concussion and its long-term sequelae, effective measures of diagnosis, prognosis and treatment still appear to be deficient.

**Case:** A three-wheel driver was brought in following a fatal road traffic accident, with extensive chest injuries and no significant head injury. He was well-oriented of time, place and person with an episode of loss of consciousness, but a significant and extensive retrograde amnesia. He was complaining of mild intermittent dizziness and headache, but otherwise clinically well.

**Discussion:** Post-concussion symptoms are controversial and debatable among medical experts, as the symptoms are not always consistent and predictable. Post-concussion symptoms are non-specific to traumatic brain injury, as similar symptoms are also reported in patients with no trauma to the brain and healthy individuals.

**Conclusion:** Concussion and its sequelae are still contestable, not only due to the lack of specificity, availability of studies and gold-standard biomarkers, but also due to its subjective nature in diagnosis, and its significant overlap with other physical, neurological and psychiatric conditions.

### Keywords

Concussion, Loss of consciousness, Retrograde amnesia, Post-concussion symptoms, Biomarkers

recurrent concussions among the players of the National football league of the United States [2]. Even though this theory was brought to light after a great struggle, it then became a frequent topic of conversation and concept of motion pictures. Cerebral concussion is a minor and reversible functional abnormality [3] and due its relatively minor nature it usually goes undetected and underreported. The term concussion was derived from a Latin word which means 'shake violently', and it is purely a physiologic state in comparison to a brain injury and is sometimes interchangeably used with 'mild traumatic brain injury'.

In adults the dominant cause for head injury are falls and road traffic accidents, whereas in adolescents it is commonly due to accidents during contact sports, which is second only to road traffic accidents. It is reported that some deliberately conceal the symptoms of concussion, in order to avoid hospitalization and rehabilitation [4]. Despite several theories and hypotheses, pathophysiology of concussion still remains unclear. Recently N-acetylaspartate (NAA) is considered to be a bio-marker of the white matter of the brain that is found to occur in lower concentrations of those suffering from concussion and post-concussion syndrome (PCS) [5].

Despite increased knowledge and awareness of concussion and its long-term sequelae, effective measures of diagnosis, prognosis and treatment still appear to be deficient. Moreover, the mode of injury, clinical features and interpretation of clinical signs and symptoms may be a few reasons for the delay in timely diagnosis.

### Introduction

Concussion was initially a recognized entity in boxers, and was thought to be confined to that particular sport [1]. It gained prominence and much awareness globally in the year 2002, when Bennet Omalu described the concept of Chronic Traumatic Encephalopathy due to



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A role of a forensic pathologist becomes crucial in circumstances with suspicion of a concussion, as it would greatly influence the categorization of hurt, thus playing a major role in justice being served to a victim. This paper discusses a case of a victim of road traffic trauma, who presented with extensive chest injuries and a clinical picture suggestive of concussion.

## Case

A driver of a three-wheeler was admitted to Colombo North Teaching Hospital following a road traffic trauma. He was said to have had a head-on collision with an approaching car. On admission his blood pressure was 112/79 mmHg, pulse rate 59/minute, oxygen saturation of 84% and his glasgow coma scale (GCS) was 15/15. There was a scalp laceration a few non-lethal facial injuries, with no underlying fractures clinically. A pneumothorax was suspected on the left side of the chest, and an intercostal (IC) tube was inserted immediately. It was said that he was found unconscious at the site of the accident, but had regained consciousness at the triage.

Following the above mentioned immediate measures, a thorough evaluation and management was carried out. His non-contrast CT (NCCT) Brain including bone window did not reveal any skull bone fractures, cerebral haemorrhages, or infarction. Scalp laceration was then sutured. Chest radiograph revealed fractures of the 9<sup>th</sup> and 10<sup>th</sup> ribs on the left side of the chest, with underlying pneumothorax, with the IC tube that was in correction position. Right side of the chest contained a hemothorax, which was drained to a volume of 400 ml. NCCT chest confirmed these findings and further revealed contusions of the right lung. A focused assessment with sonography in trauma (FAST) confirmed that there was no free fluid or visceral organ damage in the abdomen.

His blood pressure dropped to 78/52 mmHg towards the evening, and his condition begins to further deteriorate. He was transfused with two units of blood during this period. An expanding surgical emphysema was identified with bilateral pneumomediastinum. He was then intubated and transferred to SICU. He was started on oral feeding and since acinetobacter was positive in his endo-tracheal tube secretions 7 days following admission, endo-tracheal tube was replaced by tracheostomy tube under general anaesthesia. He had clinically improved and was transferred back to the ward on day 13 following hospital admission. He was given IV morphine during the hospital stay.

He was brought in for medico-legal examination on day 20 post-admission. He was clinically well, but complaining of intermittent mild dizziness with headache, and was free of tracheostomy tube. He was very well oriented of time, place and person. On detailed history taking he says, that the last thing he remembered was 'having to' pick up his child from

school. He completely denies any memory of driving the trishaw, meeting with an accident and being brought to hospital. But he says, he remembers being treated in the ICU and being connected to various machines. His wife corroborates with his history by saying that when she had visited him after he was transferred to the ward, he had told her to take care of her, as she was 'pregnant' with their second child. But actually their second child is now 1½ years old. All he remembers is his eldest son, but has no memory of the birth of his second child and the incidents afterwards, including the accident up to his stay in the ICU.

He has no past history of head injury or similar complaints and denies any previous accidents. He is a mason by profession, and has undergone a thyroidectomy for papillary carcinoma of the thyroid gland few years ago. He and his wife deny being under influence of alcohol or any other drugs at the time of the road traffic accident, as they claim that he had quit smoking and consuming liquor following his thyroidectomy surgery.

A psychological assessment revealed he is unlikely to be malingering and that there are no underlying psychological conditions. The important evidence obtained from the history taking is he was suffering from retrograde amnesia and to some extent of anterograde amnesia as well.

## Discussion

This patient, who was brought in following a fatal road traffic accident, had extensive chest injuries and no significant head injury, except for a small scalp laceration, which was sutured under local anaesthesia. His chest injuries which include a hemothorax and pneumothorax were managed meticulously, any fatal or for that matter even a mild head injury was ruled out, with the aid of NCCT Brain. He was given ICU care for 13 days and was transferred back to the ward. An interview with him during the medico-legal examination revealed that he was well-oriented of time, place and person at the time of examination. He has a small episode of loss of consciousness, but a significant and extensive retrograde amnesia along with somewhat significant anterograde amnesia. Possible causes for such amnesia like psychological conditions, alcohol intoxication and malingering were ruled out with certain degree of certainty. He was complaining of mild intermittent dizziness and headache, but otherwise clinically well. Cases with retrograde amnesia after administration of sedatives and general anaesthesia have also been reported [6,7]. Concussion is defined as a transient paralytic state due to head injury, which is of instantaneous onset, and does not show any evidence of structural cerebral injury and is always followed by amnesia from the actual moment of the accident [8]. It is believed that the brain undergoes axonal injuries, either transient or permanent, during diffuse brain injury. The

relatively minor form with transient injuries is grouped as 'concussion' and the group with severe injury is termed as 'diffuse axonal injury' [9]. Mild concussion is a mild disturbance in neurological function without an episode of loss of consciousness whereas cerebral concussion is described as trauma-induced, transient and reversible neurologic dysfunction that leads to an episode of loss of consciousness lasting less than 6 hours. In cerebral concussion there may be a slight element of physiological neurological dysfunction due to acceleration/deceleration forces acting on the brain, without a severe anatomical alteration in the axons [10].

Having said all this, the patient mentioned in this paper, although he immediately became unconscious, the brain did not contain any structural disruptions, which can be confirmed by the brain radiographs and persistently normal GCS levels. In addition to this, the scalp laceration was not lethal and is inadequate to have caused any fatal brain injuries.

Post-concussion symptoms are controversial and debatable among medical experts, as the symptoms are not always consistent and predictable [11]. Post-concussion symptoms are non-specific to traumatic brain injury, as similar symptoms are also reported in patients with no trauma to the brain [12] and healthy individuals [13]. Patients with concussion suffer from a wide range of symptoms such as headache, dizziness, retrograde amnesia, disorientation, language impairments, loss of consciousness, mood disruptions, cognitive deficits, sleep disorders, sensitivity to light and sound, gait imbalances. It is not necessary that all these symptoms need to be present in each case. Loss of consciousness was once believed to be diagnostic of concussion, but it has been understood that it presents only in 1-14% of the patients with concussion [14]. The extent and severity of these symptoms varies greatly. Headache is said to be the commonest post-concussion symptom followed by dizziness [14]. Both anterograde and retrograde amnesia, headache and dizziness were complained by this patient, at the time of medico-legal examination, and could be considered symptoms of post-concussion, even though they are non-specific.

His loss of consciousness denotes that he has experienced well beyond mild concussion, but since the duration of loss of consciousness is within 6 hours, he falls into the category of cerebral concussion, and any progression into a state of diffuse axonal injury can be safely disregarded, which is further supported by absence of any symptoms of brainstem compromise. The reason for loss of consciousness is said to be the transient damages in the reticular activating system at the junction of midbrain and thalamus, where the rotational forces due to the impact act upon [15], which does not cause any permanent structural abnormality to the brain tissue.

One of the prime duties of a forensic expert is

categorization of injuries based on proper scientific reasoning. When taking into consideration the entire spectrum of injuries found in this patient, they are fatal in the ordinary course of nature, as these injuries would definitely result in death in the absence of prompt and proper medical management. But if the patient has had only contained features of concussion and the symptoms of post-concussion, this would have been categorized under limb 'h' of Section 311 of Chapter 16 of the Penal Code, in which injuries that 'endanger' life are included. An injury is said to endanger life, when there is an existing threat to life [16]. In concussion there is a there is a risk of asphyxiation due to tongue falling back and aspiration of vomitus during the time of unconsciousness [17], even though it cannot be proven in a clinical set-up, or for that matter at an autopsy, beyond a shadow of uncertainty. But factors that could mimic concussion such alcohol intoxication, cervical injury, migraine, chronic pain, vestibular or visual dysfunction, psychiatric disorders like depression or a combination of conditions [18] will be definitely questioned in court. The wife of this victim says, that she was told that it was her husband who was at fault in the accident, according to the investigating police and circumstantial evidences. One can argue that this patient was malingering and was using his anterograde and retrograde amnesia as a protective shield from getting penalized for his offence. Confirming or excluding such act was beyond my capacity.

## Conclusion

Concussion and its sequelae are still contestable, not only due to the lack of specificity, availability of studies and gold-standard biomarkers [19], but also due to its subjective nature in diagnosis, and its significant overlap with other physical, neurological and psychiatric conditions. The probability of developing a progressive neurodegenerative disorder is said to increase with repetitive concussions, therefore a medical expert should be able to diagnose, treat and provide guidance and recommendations to prevent recurrent injury.

## Compliance with Ethical Standards and Consent

This case report is about a clinical and medico-legal examination of a victim of a road traffic trauma. Informed, written consent was obtained prior to the examination. The manuscript does not contain any details to reveal the identity of the patient.

This manuscript has not been submitted to any other journals, and is the original work of the authors and has not been published elsewhere.

## Adherence to National and International Regulations

Not applicable.

## Consent for Publication

Not applicable.

## Availability of Data and Material

No objections in sharing data.

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## Author Statement

Yalini Thivaharan: Medico-legal examination, Writing-Original Draft, Conceptualization, Literature survey;

Indira Deepthi Gamage Kitulwatte: Writing-Reviewing and Editing, Supervision.

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