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Original article

Definition and epidemiology of mild traumatic brain injury

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ABSTRACT

Background/objectives. – The definition of mild traumatic brain injury (mTBI), also known as concussion, has been a matter of controversy, which makes comparison between studies difficult. Incidence varies greatly from one country to another. The present article reviews definitions and epidemiology.
Methods. – Literature review.
Results. – According to the Mild TBI Committee of the American Congress of Rehabilitation Medicine, revised by the World Health Organization (WHO), mTBI is defined by a Glasgow Coma Scale score between 13 and 15 at 30 minutes post-injury, and one or more of the following symptoms: <30 min loss of consciousness; <24 hours post-traumatic amnesia (PTA); impaired mental state at time of accident (confusion, disorientation, etc.); and/or transient neurological deficit. If a focal lesion is found on computed tomography (CT) or magnetic resonance imaging (MRI), the term "complicated mild TBI" has been proposed. Incidence of mTBI is 200–300/100,000 persons per year for hospitalized patients and probably twice as high if non-hospitalized patients are included. However, a few recent population-based studies reported a much higher rate (>700/100,000). A changing pattern of epidemiology has been found in high-income countries, related to a decrease in road-accident injuries in young adults, while conversely the proportion of falls has increased with population aging.
Conclusion. – Mild TBI is a major public health concern, the epidemiology of which has greatly changed in the last twenty years.

RÉSUMÉ

Contexte/objectifs. – La définition du traumatisme crânio-cérébral léger (TCCL) ou commotion cérébrale a été longtemps discutée, ce qui rend difficile la comparaison des études publiées dans la littérature. L'incidence varie considérablement d'un pays à l'autre. L'objectif de cet article est de faire le point sur la définition et l'épidémiologie du TCCL.
Méthodologie. – Analyse de la littérature.
Résultats. – Selon les critères du « Mild Traumatic Brain Injury Committee de l'American Congress of Rehabilitation Medicine », révisés par l'Organisation mondiale de la santé (OMS), un TCCL léger est défini par un score sur l'échelle de coma de Glasgow compris entre 13 et 15, 30 min après l'accident, associé à l'un ou plusieurs des symptômes suivants : perte de connaissance de moins de 30 min ; amnésie post-traumatique de moins de 24 h ; altération de l'état mental au moment de l'accident (confusion, désorientation...) ; déficit neurologique transitoire. Si une lésion focale est détectée par le scanner ou l'IRM, le terme « TCCL compliqué » a été proposé. L'incidence du TCCL est estimée entre 200 et 300 cas pour 100 000 habitants par an pour les patients hospitalisés et probablement deux fois plus élevée si l'on inclut les patients non hospitalisés. Toutefois, quelques études en population récentes ont fait état d'un taux beaucoup plus élevé (plus de 700 pour 100 000). Dans les pays à revenu élevé, on a constaté une évolution de l'épidémiologie, liée à une diminution des accidents de la circulation chez les jeunes adultes, tandis qu'inversement, la contribution des chutes devient relativement plus importante, en raison de la tendance démographique au vieillissement de la population.

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Conclusion. – Le TCCL est un problème majeur de santé publique, dont l'épidémiologie a beaucoup évolué depuis une vingtaine d'années.

1. Definition of mild traumatic brain injury

One difficulty in analyzing the literature on mild Traumatic Brain Injury (mTBI) is the wide variety of definitions [1]. The World Health Organization (WHO) Collaborating Centre Task Force on Mild Traumatic Brain Injury found 38 different definitions used in the international literature, as well as a variety of terminologies (mild TBI, minor TBI, concussion, etc.) [2]. In a recent review for the period 1991 to 2014, Mayer et al. [3] found 9 different diagnostic criteria used by several professional medical organizations. Although this has been a matter of debate, it appears that the terms mTBI and concussion have been used synonymously, the latter being more common in sports medicine and mTBI in general medical contexts.

The WHO defines head trauma as "an acute brain injury resulting from mechanical energy to the head from external physical forces", excluding manifestations related to "drugs, alcohol, medications, caused by other injuries or treatment for other injuries (e.g., systemic injuries, facial injuries or intubation), caused by other problems (e.g., psychological trauma, language barrier or coexisting medical conditions) or caused by penetrating craniocerebral injury".

The Demographics and Clinical Assessment Working Group of the International and Interagency Initiative toward Common Data Elements for Research on Traumatic Brain Injury and Psychological Health proposed another definition: "an alteration in brain function, or other evidence of brain pathology, caused by an external force" [3].

Regarding mTBI, a group of international experts ("International Collaboration on Mild Traumatic Brain Injury Prognosis") collected 66 different criteria in the literature [4,5]. Overall, the 3 main criteria currently used are Glasgow Coma Scale (GCS) score, duration of loss of consciousness and of post-traumatic amnesia (PTA). The most common TBI severity classification is the Glasgow Coma Scale (GCS) [6], assessing 3 parameters: eye opening and verbal and motor response, with global score ranging from 3 to 15. However, infants, young children, and patients with pre-existing neurological disorders are difficult to assess on the GCS [7].

There is a relative consensus on the diagnostic criteria proposed by the Mild Traumatic Brain Injury Committee of the American Congress of Rehabilitation Medicine [8], revised by the WHO Collaborating Centre Task Force on Mild Traumatic Brain Injury [9]. According to these criteria, mTBI is defined by a GCS score between 13 and 15, 30 minutes after the injury and one or more of the following symptoms:

- loss of consciousness <30 minutes;
- PTA <24 hours;
- impaired mental state at time of accident (confusion, disorientation, etc.);
- transient neurological deficit (including focal signs, epilepsy, or non-surgical intracranial injury).

However, as Levin and Diaz-Arrastia [1] pointed out, these criteria do not set a minimum duration for these neurological manifestations.

The use of imaging in the definition has been debated, with some researchers using the term "complicated mild TBI" in case of visible lesions on CT and/or MRI, and others suggesting that these cases should be considered as "moderate TBI" [1]. However, since use of imaging is not systematically recommended and the frequency of lesion detection is highly dependent on imaging modality, most authors recommend basing diagnosis of mTBI on clinical criteria alone.

The lower and upper limits of the nosological framework of mTBI are sometimes blurred, on the one hand with moderate TBI (patients with "mild" TBI but with a GCS score of 13 and lesions on brain imaging are relatively similar to patients with moderate TBI in terms of prognosis) and on the other hand with "trivial" head trauma (i.e., without brain impact). Similarly, some related pathologies, such as whiplash or blast TBI in military practice, raise the question of related conditions, within which the existence of TBI is sometimes difficult to assess.

Finally, it should be stressed that, even within these strict criteria, there is a wide range of severity within the diagnosis of mTBI, ranging from patients with very brief minor symptoms to patients suffering 30 minutes' loss of consciousness and 24 hours' PTA.

Since the current diagnosis of mTBI has very disparate characteristics, with no specific nosological framework to classify different types at different stages, a consensual diagnostic system is needed to determine the medical, psychosocial and demographic factors that affect prognosis, potentially reducing variations in reported outcomes [1,3].

2. Epidemiology of mild traumatic brain injury

TBI is a major cause of death and disability worldwide, and accounts for a significant proportion of life-years with disability [10]. Population-based studies showed that 50–60 million people worldwide (including at least 3.5 million in the US, and 2.5 million in Europe) are affected by a new TBI each year [11,12]. The great majority of cases (60–95%) are mild TBI [13]. Projections suggest that TBI will become the third largest cause of global disease burden by 2020 [13].

Estimates of TBI incidence often involve diagnostic and selection biases [14,15]. It is widely acknowledged that incidence is underestimated because only a small proportion of cases are admitted to hospital [14].

Incidence is estimated at 200–300/100,000 persons per year for hospitalized patients and probably twice as high if non-hospitalized patients are included [13,16]. A population-based study in New Zealand, including all cases of TBI (hospitalized or not, fatal or not), reported higher incidence than expected [17]: total incidence was 790/100,000 persons per year (including 749 cases per 100,000 of mTBI). There was, as in most previous studies, a clear gender effect, with males more frequently affected than females (RR = 1.77). According to Andelic [18], this higher incidence in New Zealand was probably the result of substantial variations in the diagnostic criteria and methods used between studies, and of the case ascertainment method.

Cancelliere et al. [19] recently conducted a population-based study of the incidence of mTBI treated in emergency departments in the US from 2006 to 2012. Incidence increased significantly from 569.4 in 2006 to 807.9 in 2012. Falls were the leading external cause.

Brazinova et al. reported a living systematic review on TBI epidemiology in Europe [16]. Sixty-six studies were included and showed that crude incidence varied widely from 47.3/100,000 to

694/100,000, from one country to another. Improved standardization would enable more accurate comparison; variations in definition and case ascertainment partly explain these between-countries variations.

TBI predominantly affects young individuals, but there is a trend toward changing epidemiology in high-income countries, due to increasing incidence in pediatric and elderly subpopulations. In the New Zealand study mentioned above, conducted in 2010–2011, children (up to 14 years) and adolescents and young adults (15–34 years) represented almost 70% of cases [17]. Likewise, in the US, Cancelliere et al. [19] found that the highest rates of mTBI emergency admissions were in young children (0–4 years old), followed by young adult males (15–24 years) and females above 65 years. Ethnic disparities have also been reported; for example, in New Zealand, Maori people had a greater risk of mTBI than people of European origin (RR 1.23). In a UK population, Yates et al. found that the main risk factors for TBI were age (very young [under 5 years], adolescence and young adulthood, and older age), urban dwelling, and lower socio-economic level [20].

Lastly, common causes of traumatic brain injury include, first of all, road accidents and falls, then sports injuries and assaults [16]. In non-sport injuries, alcohol and/or drug involvement is a determining factor [21]. Falls are the leading cause of TBI in young children and the oldest age groups [16], and were the primary cause of TBI (38%) in Feigin et al.'s [17] study in New Zealand. It should be emphasized that there is a changing pattern of injury mechanisms, as the number of road-accident injuries is decreasing in high-income countries, while the proportion of falls is increasing with population aging [16]. In low-to-middle income countries, however, increasing use of motor-vehicles may result in an increase in traffic-related TBI.

Taylor et al. [22], reporting epidemiologic trends for TBI emergency admission, hospital admission and death in the USA from 2006 to 2013, found an increase in the total number of TBIs over time, but the increase was not uniform across all age groups or injury mechanisms. Males continued to have higher rates of TBI than females. The highest rates were in the oldest and youngest age groups, and the most common principal mechanisms were (in decreasing order) falls, being struck by or against an object, and motor-vehicle crashes, these three accounting for about 75% of all TBIs. However, age groups were not equally represented in these mechanisms: about half of fall-related TBIs occurred in the youngest (0–4 years) and oldest ($\geq$75 years) individuals, while the most common cause of TBI in young adults (15–24 and 25–34 years) was a motor-vehicle accident.

The prevalence of mTBI is more difficult to measure. Fros et al. [23] conducted a meta-analysis of 15 prevalence studies including 25,134 adults, and found that 12% of the sample had had serious TBI with loss of consciousness, with men being at more than double the risk of women. In a population-based survey in the USA with random sampling, Whiteneck et al. [24] found that 36.4% of respondents reported at least one mTBI in their lifetime, and 6% a moderate-to-severe injury. Interestingly, among individuals reporting TBI, 27.5% had not sought medical care.

3. Conclusion

Although this has been a matter of debate, the definition by the American Congress of Rehabilitation Medicine, revised by the WHO, seems now to be widely used and accepted by clinicians and researchers in the field. Epidemiological data converge to show that mild TBI is a major public health concern. Recent epidemiological trends suggest that there will in the near future be an increase in mTBI rates in older people, which should be taken into consideration by public health authorities.

Human and animal rights

The authors declare that the work described has not involved experimentation on humans or animals.

Informed consent and patient details

The authors declare that the work described does not involve patients or volunteers.

Disclosure of interest

The authors declare that they have no competing interest.

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