Acute management of mild traumatic brain injury

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Summary

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Mild head injury (MHI) accounts for a substantial proportion of persons admitted to a hospital for brain injury. The management of these patients remains, however, controversial. A modified classification of MHI suggests the segregation of patients with Glasgow Coma Scale scores of 15 from those with scores of 14 or 13 because the latter group is more likely to present intracranial lesions requiring neurosurgical intervention. A computed tomographic (CT) scanning is therefore recommended for all patients with GCS scores of 13 to 14 as a triage device to avoid nondetection of patients with susceptible serious intracranial complications. Patients suffering of a MHI, who have normal results on neurological examination and negative findings on a CT scan, have very small risk of requiring treatment (2%) and no risk of requiring craniotomy. They can be discharged the same day. This management increases the quality of care and decreases the financial expenses.

Keywords: mild head injury, classification, epidemiology, Glasgow Coma Scale, computed tomographic scan

Introduction

Closed head injury represents a common aspect of trauma, often requiring neurosurgical evaluation in the emergency centre. Subsequent treatment of affected patients varies according to the severity of injury. The severity of head injury is often assessed by the Glasgow Coma Scale (GCS), a point value system ranging from 3 to 15. To further elucidate the severity and associated outcome differences in head injury, the GCS score may be divided into three categories: severe, moderate and mild. There is plenty of literature on the outcome and management of severely injured patients, but the assessment of morbidity from mild head injuries and their treatment has been relatively recent. This lack of attention is partly due to the wrong believe that patients with mild traumatic head injury can not sustain permanent or irreversible brain injury. Epidemiological studies clearly demonstrate that about 80% of all patients hospitalised for an acute brain injury suffer from a mild head injury, which emphasizes the importance of appropriate management of this pathology. The purpose of this article is to give an insight in the variability of mild head injuries, the screening possibilities and the appropriate treatment modalities.

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Definition

The mild head injury (MHI) is defined as a cranial trauma with a history of loss of consciousness for <20 minutes or the presence of a posttraumatic amnesia of <24 hours, an admission GCS [1] score of 13 to 15, and the absence of focal neurological deficit [2]. This definition seems to be precise but its clinical application is often difficult and can be the origin of an important heterogeneity of clinical groups [3, 4].

The reasons for heterogeneity are: first, the duration of loss of consciousness is a pure estimation of the patient himself or a third person; second, the information about the posttraumatic amnesia (PTA) can vary widely with time passing. Nevertheless, these two subjective elements, in combination with the GCS score, represent the basic factors defining MHI.

The initial GCS score is most important, but again the clinicians have difficulties to correctly assess this score: which timepoint is appropriate to administer the GCS and how can the clinician rule out other influences intervening with the score parameters? Sedation by paramedics in the course of transport from the scene of the trauma to the hospital can profoundly affect a person's verbalisation skills. GCS scores may also be influenced by psychological stress associated with trauma and injuries to other parts of the body. A second revised scoring of the patients situation at the admission is therefore more appropriate to classify the traumatic brain-injured patients.

New classification

One of the most important and difficult duties in an emergency centre is the correct triage. This process should ensure a good outcome by early and appropriate diagnostic intervention. The clinical screening should allow to form risk group categories and to detect the few patients with susceptible serious complications in order to avoid secondary lesions. In an attempt to create a more detailed score, and in reason of the nonuniform inclusion criteria for MHI causing inconsistencies in the extent of neurobehavioural recovery, Williams et al. designed a new classification [3]. They proposed a new classification of mild head injury, based on a three-group distinction: (1) uncomplicated mild closed head injury (CHI); (2) complicated mild CHI; and (3) moderate CHI. Uncomplicated CHI includes patients with an initial (and lowest) GCS score of 13 to 15, a normal computed tomographic scan (CT), and either a normal skull x-ray or an abnormality limited to a linear or basilar skull fracture. The second category includes those with an initial (and lowest) GCS score of 13 to 15 and radiographic evidence of a focal brain lesion, depressed skull fracture, or both. Moderate MHI are defined by an initial GCS score of 9 to 12 with or without positive radiological findings. Their prospective study of 215 consecutive patients provided justification for classifying patients into these three categories because of the increased accuracy of outcome prediction by the proposed system due to an early identification of patients who were most likely to benefit from more comprehensive examinations and future rehabilitation.

Another recent study by Culotta et al. [4] also demonstrated the clinico-pathological heterogeneity of the standard classification of mild head injury. Their study included 3370 consecutive patients with nonmissile head injuries, positive loss of consciousness and admission GCS scores of 13 to 15. Their results indicate significant differences in severity of head injury among patients with admission score 13 through 15. Patients admitted with GCS scores of 13 were significantly more likely to have lesions demonstrated on CT scans and were more likely to require neurosurgical intervention within the first 24 hours than those admitted with GCS scores of 14 or 15. In their conclusions they emphasize the need of a reclassification of MHI, segregating patients with GCS scores of 15 from those with GCS scores of 14 or 13, in order to get more homogenous injury severity groups for future comparison and research of neurobehavioural outcome after MHI.

Epidemiology

A number of studies have shown that MHI accounts for a substantial proportion of all brain injury admission to hospitals [5–7]. Unfortunately there are actually no exact numbers of the incidence of MHI in Switzerland. However, we learned from recent epidemiological studies that about 80% of all patients hospitalised for an acute brain injury have a mild uncomplicated head injury, which emphasizes the socioeconomical importance of this pathology [6]. The incidence rate of MHI ranges between 130 and 200 persons/ 100,000/ year, with an estimated decline in rates amounting to about 10% per decade [5, 8, 9].

The distribution of GCS values showed that about 75% of all hospital-admitted patients with MHI present with a GCS of 15. There is a peak age incidence of 15 to 19 years, and the rate for males was about twice as high as that for females.

Motor vehicle accidents are the most common mechanism of injury (42%), followed by falls (23%), assaults (14%), bicycle, sports and others (6%, 6% and 8%). Age- and sex-specific differences are observed concerning motor vehicles, falls, assaults, and sports. Rates are highest for motorvehicle-related causes, peaking in the 15- to 24-year age group.

Pathologic changes

The history of the trauma gives always an idea of the energy transfer to the neural tissue and some information about the expected pathological lesions of the neural tissue. The degree of injury of the neural tissue correlates with the quantity of energy delivered and the time course over which it is delivered [10]. A short time course produces a disruption of the tissue (penetrating injury) whereas a prolonged time course of energy delivery occasions rather a distortion of the tissue secondary to the energy translation into movement of the structures within the confines of the skull.

The distinction between inertial forces (acceleration, deceleration) and impact forces (direct contact), which are the principle mechanisms of head injury, is helpful to understand the pathophysiological background of the traumatic lesions. The inertial forces are considered to be responsible for subdural haematomas and the so-called shearing injuries (diffuse axonal injury), whereas the impact forces rather cause haemorrhagic contusions or epidural haematomas.

The different types of lesions encountered in MHI are:

1. Damage to the scalp, skull and meninges

Scalp laceration can lead to a hypovolemic shock and should therefore be treated early. Skull fractures are classified into linear, basilar and depressed type. The depressed type are often associated with dural laceration which can lead to life threatening accumulation of blood within the cranial vault (e.g. acute epidural and subdural haematomas).

2. Injury to the brain parenchyma

Injury to the brain itself ranges in severity from transient physiologic disturbances to gross disruption of parenchyma. The mildest form, a concussion, is a transient alteration of consciousness following a nonpenetrating blow to the head. It is often accompanied by disturbances of vision, equilibrium and posttraumatic amnesia [11]. The structural and physiological basis of these phenomena is unclear, although it may involve transient torsion with malfunction of the reticular activating system [10].

A cerebral contusion consists of an area of haemorrhagic necrosis usually occurring on the crests of gyri, which is in contrast to watershed infarcts occurring in the depths of sulci. If the head is struck while immobilised, the focus of the injury will be at the impact site – a "coup" injury. If the head is not immobilised when struck, the majority of the injury may be caused to the brain at the opposite side of the impact – a "contrecoup" injury. Contrecoup lesions are thought to result from acceleration or deceleration imparted to the brain by the impact. Brain lacerations are tears in the brain parenchyma with necrosis and haemorrhage. They result from penetration by a foreign body or skull fragments, or may occur in extremely high energy trauma.

Some head-injured patients do not have parenchymal contusions, lacerations or haematomas. They have sustained widespread microscopic axonal injury evidenced by the presence of disruptured axons which retract to form spheroids. Diffuse axonal injury (DAI) is believed to result from shearing forces acting on axons during acceleration or deceleration. The functional significance of many of the axons disrupted in DAI is unknown, but it is plausible that the long projection axons from brainstem and diencephalic nuclei are interrupted. These nuclei are important in establishing the arousal state, vigilance, pain threshold and affect. Their compromise may lead to impaired concentration and irritability so frequent seen in mild head injury.

Radiological investigation

What sort of radiological investigation is appropriate in mild head injuries? Several studies showed clearly the non-utility of normal skull x-rays [12]. A consistent percentage of high-risk patients are missed on the basis of normal skull x-rays [7].

CT scan, however, is recommended for MHI, which was very well documented by Shackford et al. [13]. They studied 2766 patients with an isolated MHI admitted to seven trauma centres. Their data demonstrated that cerebral CT scan was more sensitive than a neurological examination alone to detect patients with significant intracranial lesions. They recommend a CT scan for all MHI (GCS 13–15) and emphasize that CT scan is mandatory for patients with GCS score of 13 to 14. In their opinion CT scan is to be used as a triage-device in conjunction with a neurological examination in order to focus on target groups which potentially need a neurosurgical intervention.

Another recent small study concerning the prevalence of magnetic resonance imaging (MRI) evidence of diffuse axonal injury showed that in patients with MHI and normal head CT findings, abnormalities compatible with DAI were present in the white matter in 30% of the patients [14]. These radiological abnormal signals indicate that a pathological process occurs in some mild head-injured patients which is not detected by CT scan but is revealed by MRI. These lesions may represent the pathological substrate underlying the postconcussion syndrome. Although the study group was small (20 patients), it demonstrates the greater sensitivity of MRI over CT scan and thus the potentially better paraclinical tool to predict outcome.

Treatment algorithm

Patients presenting a MHI rarely require a surgical treatment. Shackford found that 4.1% of patients with an isolated MHI required a craniotomy [13].

The surgical indications for intracranial lesions are based on a detailed neurological examination in combination with neuroradiological imaging. Surgery is indicated in patients presenting intracranial mass effect or a secondary neurological deterioration explained by an impairment of an intracranial lesion, provided that the surgical approach itself does not cause harm to eloquent cerebral areas. The surgical indications for extracranial and/or extracerebral treatment are evaluated relative to the potential risk of secondary damages. Secondary damage can for example be caused by arterial bleeding of a scalp laceration or open skull fracture with dural tear or a basal skull fracture with CSF fistula. Arterial bleeding of the scalp requires suturing on an emergency basis to prevent a hypovolemic shock. Depressed skull fractures need to be elevated if the depression is greater than the thickness of the skull, if there exists a deficit related to the underlying brain and if there exists a dural laceration. Usually peripheric burr holes are sufficient to treat these lesions, otherwise a craniotomy is mandatory. Basal skull fractures with persistent CSF rhinorrhoea require a frontobasal craniotomy to cover the bony and dural defect with a pericranial flap.

The most common surgical indications for intracranial lesions are the epidural and acute subdural haematomas [15]. The epidural haematoma is classically presented with a brief posttraumatic loss of consciousness followed by a lucid interval before appearance of secondary obtundation, contralateral hemiparesis and ipsilateral pupillary dilatation. Emergency craniotomy for evacuation is performed in any symptomatic epidural haematoma to guarantee a good outcome in 90% of the cases. The source of the haematoma is usually an arterial bleeding of the middle cerebral artery.

The common sources of acute subdural haematomas (ASDH) are an accumulation of blood around a haemorrhagic cerebral contusion or a disruptured bridging vein to the venous sinuses. Rapid surgical evacuation (craniotomy) should be considered for symptomatic ASDH that are greater than 1 cm at the thickest point. The morbidity of these lesions is higher due to the frequent parenchymal participation and correlate directly with the initial GCS score.

Chronic subdural haematomas generally occur after a trivial head trauma which has to be considered as a minor head injury although 50% of the patients cannot remember the initial trauma. The lesions begin as simple accumulation of blood, but soon a granulation tissue forms membranes encasing a core of degenerating blood. Recurrent haemorrhage occurs from these membranes leading to a gradual expansion of the lesion. Surgical evacuation of these haematomas is indicated for neurological symptomatic lesions. Two large burrholes with continued drainage during 48 hours is the treatment of choice with good results in 90% of cases.

The algorithm of conservative treatment of minor head injury is based upon the initial GCS score, the CT scan findings and the social environment of the patient: patients with a normal CT scan and neurological examination are discharged the same day in the presence of an acceptable social environment. An abnormal CT scan or abnormal neurological examination require a hospital admission for neurological observation. Depending on the 12-hour/24-hour evolution a repeat CT scan is mandatory and a neuropsychological test is desirable. The results of these two investigations will determine the further treatment modalities which will be either a longer inpatient observation period or ideally an outpatient follow-up by the neuropsychologists. Patients are discharged with a prescription of simple analgetic and eventually antiemetic drugs. There is no place for corticoid treatment nor antiepileptic medication. A clinical follow-up is usually performed by the family doctor to determine the working capacity. Patients who develop a postconcussion syndrome should be seen in outpatient clinics by the neurosurgeon and the neuropsychologist to organise the rehabilitation programme in order to prevent a possible chronification of the syndrome.

Conclusions

We actually live in a period of restructuration of our medical health system. This restructuration is primary driven by financial and quality aspects. Knowing that about 80% of all patients initially hospitalised for an acute brain injury present with a mild uncomplicated head injury and are rather younger people with a important potential of recovery, we want to emphasize the importance of the appropriate management of mild head injuries. A more aggressive attitude in the emergency centre, including appropriate CT scan studies in combination with an detailed neurologic examination, would increase the quality of care and decrease the financial expenses through an early discharge policy [16].

Future research investment should clarify the utility of MRI investigation in isolated minor head injury and its potential link to neuropsychological deficits.

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