= Concussion =

Concussion , from the Latin concutere (" to shake violently ") or concussus (" action of striking together ") , is the most common type of traumatic brain injury . The terms mild brain injury , mild traumatic brain injury (MTBI) , mild head injury (MHI) , minor head trauma , and concussion may be used interchangeably , although the last is often treated as a narrower category . Although the term " concussion " is still used in sports literature as interchangeable with " MHI " or " MTBI " , the general clinical medical literature now uses " MTBI " instead . In this article , " concussion " and " MTBI " are used interchangeably . Frequently defined as a head injury with a temporary loss of brain function , concussion causes a variety of physical , cognitive , and emotional symptoms , which may not be recognized if subtle .

Treatment involves monitoring as well as physical and cognitive rest (reduction of such activities as school work , playing video games and text messaging) . Symptoms usually resolve within three weeks , though they may persist or complications may occur .

Those who have had one concussion seem more susceptible to another , especially if the new injury occurs before symptoms from the previous concussion have completely resolved . There is also a negative progressive process in which smaller impacts cause the same symptom severity . Repeated concussions may increase the risk in later life for dementia , Parkinson 's disease , and / or depression .

A variety of signs accompany concussion including somatic (such as headache) , cognitive (such as feeling in a fog) , emotional (such as emotional changeability) , physical signs (such as loss of consciousness or amnesia) , behavioral changes (such as irritability) , cognitive impairment (such as slowed reaction times) , and / or sleep disturbances . Fewer than 10 % of sports @-@ related concussions among children are associated with loss of consciousness .

Due to varying definitions and possible underreporting , the rate at which concussion occurs annually is not accurately known , but is estimated to be more than 6 per 1 @,@ 000 people . Common causes include sports injuries , bicycle accidents , car accidents , and falls , the latter two being the most frequent causes among adults . In addition to a blow to the head , concussion may be caused by acceleration forces without a direct impact , and on the battlefield , MTBI is a potential consequence of nearby explosions .

It is not clear exactly what damage is done and how the symptoms are caused , but stretching of axons and changes in ion channels are involved . Cellular damage has reportedly been found in concussed brains , but it may have been due to artifacts from the studies . It is currently thought that structural and neuropsychiatric factors may both be responsible for the effects of concussion .

= = Signs and symptoms = =

Concussion is associated with a variety of symptoms , which typically occur rapidly after the injury . Early symptoms usually subside within days or weeks . The number and type of symptoms any one individual suffers varies widely .

= = = Physical = = =

Headache is the most common MTBI symptom . Others include dizziness , vomiting , nausea , lack of motor coordination , difficulty balancing , or other problems with movement or sensation . Visual symptoms include light sensitivity , seeing bright lights , blurred vision , and double vision . Tinnitus , or a ringing in the ears , is also commonly reported . In one in about seventy concussions , concussive convulsions occur , but seizures that take place during or immediately after concussion are not ' post @-@ traumatic seizures ' , and , unlike post @-@ traumatic seizures , are not predictive of post @-@ traumatic epilepsy , which requires some form of structural brain damage , not just a momentary disruption in normal brain functioning . Concussive convulsions are thought to result from temporary loss or inhibition of motor function , and are not associated either with epilepsy or with more serious structural damage . They are not associated with any particular sequelae , and

have the same high rate of favorable outcomes as concussions without convulsions .

= = = Cognitive and emotional = = =

Cognitive symptoms include confusion , disorientation , and difficulty focusing attention . Loss of consciousness may occur , but is not necessarily correlated with the severity of the concussion if it is brief . Post @-@ traumatic amnesia , in which events following the injury cannot be recalled , is a hallmark of concussion . Confusion , another concussion hallmark , may be present immediately or may develop over several minutes . A person may repeat the same questions , be slow to respond to questions or directions , have a vacant stare , or have slurred or incoherent speech . Other MTBI symptoms include changes in sleeping patterns and difficulty with reasoning , concentrating , and performing everyday activities .

Concussion can result in changes in mood including crankiness , loss of interest in favorite activities or items , tearfulness , and displays of emotion that are inappropriate to the situation . Common symptoms in concussed children include restlessness , lethargy , and irritability .

= = Mechanism = =

The brain is surrounded by cerebrospinal fluid , which protects it from light trauma . More severe impacts , or the forces associated with rapid acceleration , may not be absorbed by this cushion . Concussion may be caused by impact forces , in which the head strikes or is struck by something , or impulsive forces , in which the head moves without itself being subject to blunt trauma (for example , when the chest hits something and the head snaps forward) .

Forces may cause linear , rotational , or angular movement of the brain , or a combination of them . In rotational movement , the head turns around its center of gravity , and in angular movement it turns on an axis not through its center of gravity . The amount of rotational force is thought to be the major component in concussion and its severity . Studies with athletes have shown that the amount of force and the location of the impact are not necessarily correlated with the severity of the concussion or its symptoms , and have called into question the threshold for concussion previously thought to exist at around 70 ? 75g .

The parts of the brain most affected by rotational forces are the midbrain and diencephalon . It is thought that the forces from the injury disrupt the normal cellular activities in the reticular activating system located in these areas , and that this disruption produces the loss of consciousness often seen in concussion . Other areas of the brain that may be affected include the upper part of the brain stem , the fornix , the corpus callosum , the temporal lobe , and the frontal lobe . Angular accelerations of 4600 , 5900 , or 7900 radian / s2 are estimated to have 25 , 50 , or 80 % risk of MTBI respectively .

= = = Pathophysiology = = =

In both animals and humans , MTBI can alter the brain 's physiology for hours to years , setting into motion a variety of pathological events . As one example , in animal models , after an initial increase in glucose metabolism , there is a subsequent reduced metabolic state which may persist for up to four weeks after injury . Though these events are thought to interfere with neuronal and brain function , the metabolic processes that follow concussion are reversible in a large majority of affected brain cells ; however , a few cells may die after the injury .

Included in the cascade of events unleashed in the brain by concussion is impaired neurotransmission , loss of regulation of ions , deregulation of energy use and cellular metabolism , and a reduction in cerebral blood flow . Excitatory neurotransmitters , chemicals such as glutamate that serve to stimulate nerve cells , are released in excessive amounts . The resulting cellular excitation causes neurons to fire excessively . This creates an imbalance of ions such as potassium and calcium across the cell membranes of neurons (a process like excitotoxicity) .

At the same time , cerebral blood flow is relatively reduced for unknown reasons , though the

reduction in blood flow is not as severe as it is in ischemia . Thus cells get less glucose than they normally do , which causes an " energy crisis " .
Concurrently with these processes , the activity of mitochondria may be reduced , which causes cells to rely on anaerobic metabolism to produce energy , increasing levels of the byproduct lactate .

For a period of minutes to days after a concussion , the brain is especially vulnerable to changes in intracranial pressure , blood flow , and anoxia . According to studies performed on animals (which are not always applicable to humans) , large numbers of neurons can die during this period in response to slight , normally innocuous changes in blood flow .
Concussion involves diffuse (as opposed to focal) brain injury , meaning that the dysfunction occurs over a widespread area of the brain rather than in a particular spot . It is thought to be a milder type of diffuse axonal injury , because axons may be injured to a minor extent due to stretching . Animal studies in which primates were concussed have revealed damage to brain tissues such as small petechial hemorrhages and axonal injury . Axonal damage has been found in the brains of concussion sufferers who died from other causes , but inadequate blood flow to the brain due to other injuries may have contributed . Findings from a study of the brains of deceased NFL athletes who received concussions suggest that lasting damage is done by such injuries . This damage , the severity of which increases with the cumulative number of concussions sustained , can lead to a variety of other health issues .
The debate over whether concussion is a functional or structural phenomenon is ongoing . Structural damage has been found in the mildly traumatically injured brains of animals , but it is not clear whether these findings would apply to humans . Such changes in brain structure could be responsible for certain symptoms such as visual disturbances , but other sets of symptoms , especially those of a psychological nature , are more likely to be caused by reversible pathophysiological changes in cellular function that occur after concussion , such as alterations in neurons ' biochemistry . These reversible changes could also explain why dysfunction is frequently temporary . A task force of head injury experts called the Concussion In Sport Group met in 2001 and decided that " concussion may result in neuropathological changes but the acute clinical symptoms largely reflect a functional disturbance rather than structural injury . "
In summary , and extrapolating from animal studies , the pathology of a concussion seems to start with the disruption of the cell membrane of nerve cells . This results in a migration of potassium from within the cell into the extracellular space with subsequent release of glutamate which potentiates further potassium shift , in turn resulting in depolarization and suppression of nerve activity . In an effort to restore ion balance , the sodium @-@ potassium ion pumps increase activity , which results in excessive ATP (adenosine triphosphate) consumption and glucose utilization . Lactate accumulates but , paradoxically , cerebral blood flow decreases , which leads to a proposed " energy crisis . " After this increase in glucose metabolism , there is a subsequent lower metabolic state which may persist for up to 4 weeks after injury . A completely separate pathway involves a large amount of calcium accumulating in cells , which may impair oxidative metabolism and begin further biochemical pathways that result in cell death . Again , both of these main pathways have been established from animal studies and the extent to which they apply to humans is still somewhat unclear .

= = Diagnosis = =

Head trauma recipients are initially assessed to exclude a more severe emergency such as an intracranial hemorrhage . This includes the " ABCs " (airway , breathing , circulation) and stabilization of the cervical spine which is assumed to be injured in any athlete who is found to be unconscious after head or neck injury . Indications that screening for more serious injury is needed include worsening of symptoms such as headache , persistent vomiting , increasing disorientation or a deteriorating level of consciousness , seizures , and unequal pupil size . Those with such symptoms , or those who are at higher risk for a more serious brain injury , may undergo brain imaging to detect lesions and are frequently observed for 24 ? 48 hours . A brain CT or brain MRI

should be avoided unless there are progressive neurological symptoms , focal neurological findings or concern of skull fracture on exam .

Diagnosis of MTBI is based on physical and neurological examination findings , duration of unconsciousness (usually less than 30 minutes) and post @-@ traumatic amnesia (PTA ; usually less than 24 hours) , and the Glasgow Coma Scale (MTBI sufferers have scores of 13 to 15) . Neuropsychological tests exist to measure cognitive function and the international consensus meeting in Zurich recommended the use of the SCAT2 test . Such tests may be administered hours , days , or weeks after the injury , or at different times to demonstrate any trend . Increasingly , athletes are also being tested pre @-@ season to provide a baseline for comparison in the event of an injury , though this may not reduce risk or affect return to play .

If the Glasgow Coma Scale is less than 15 at two hours , or less than 14 at any time , a CT is recommended . In addition , a CT scan is more likely to be performed if observation after discharge is not assured or intoxication is present , there is suspected increased risk for bleeding , age greater than 60 , or less than 16 . Most concussions , without complication , cannot be detected with MRI or CT scans . However , changes have been reported on MRI and SPECT imaging in those with concussion and normal CT scans , and post @-@ concussion syndrome may be associated with abnormalities visible on SPECT and PET scans . Mild head injury may or may not produce abnormal EEG readings .

Concussion may be under @-@ diagnosed because of the lack of the highly noticeable signs and symptoms while athletes may minimize their injuries to remain in the competition . A retrospective survey in 2005 suggested that more than 88 % of concussions are unrecognized .

Diagnosis can be complex because concussion shares symptoms with other conditions . For example , post @-@ concussion symptoms such as cognitive problems may be misattributed to brain injury when , in fact , due to post @-@ traumatic stress disorder (PTSD) .

= = = Classification = = =

No single definition of concussion , minor head injury , or mild traumatic brain injury is universally accepted . In 2001 , the expert Concussion in Sport Group of the first International Symposium on Concussion in Sport defined concussion as " a complex pathophysiological process affecting the brain , induced by traumatic biomechanical forces . " It was agreed that concussion typically involves temporary impairment of neurological function that heals by itself within time , and that neuroimaging normally shows no gross structural changes to the brain as the result of the condition .

However , although no structural brain damage occurs according to the classic definition , some researchers have included injuries in which structural damage has occurred and the National Institute for Health and Clinical Excellence definition includes physiological or physical disruption in the brain 's synapses . Also , by definition , concussion has historically involved a loss of consciousness . However , the definition has evolved over time to include a change in consciousness , such as amnesia , although controversy continues about whether the definition should include only those injuries in which loss of consciousness occurs . This debate resurfaces in some of the best @-@ known concussion grading scales , in which those episodes involving loss of consciousness are graded as being more severe than those without .

Definitions of mild traumatic brain injury (MTBI) were inconsistent until the World Health Organization 's International Statistical Classification of Diseases and Related Health Problems (ICD @-@ 10) provided a consistent , authoritative definition across specialties in 1992 . Since then , various organizations such as the American Congress of Rehabilitation Medicine and the American Psychiatric Association in its Diagnostic and Statistical Manual of Mental Disorders have defined MTBI using some combination of loss of consciousness (LOC) , post @-@ traumatic amnesia (PTA) , and the Glasgow Coma Scale (GCS) .

Concussion falls under the classification of mild TBI , but it is not clear whether concussion is implied in mild brain injury or mild head injury . " MTBI " and " concussion " are often treated as synonyms in medical literature but other injuries such as intracranial hemorrhages (e.g. intra @-@ axial hematoma , epidural hematoma , and subdural hematoma) are not necessarily precluded in

MTBI or mild head injury , as they are in concussion . MTBI associated with abnormal neuroimaging may be considered " complicated MTBI " . " Concussion " can be considered to imply a state in which brain function is temporarily impaired and " MTBI " to imply a pathophysiological state , but in practice few researchers and clinicians distinguish between the terms . Descriptions of the condition , including the severity and the area of the brain affected , are now used more often than " concussion " in clinical neurology .

= = = Grading systems = = =

At least 41 systems measure the severity , or grade , of a mild head injury , and there is little agreement about which is best . In an effort to simplify , the 2nd International Conference on Concussion in Sport , meeting in Prague in 2004 , decided that these systems should be abandoned in favor of a ' simple ' or ' complex ' classification . However , the 2008 meeting in Zurich abandoned the simple versus complex terminology , although the participants did agree to keep the concept that most (80 ? 90 %) concussions resolve in a short period (7 ? 10 days) , and although the recovery time frame may be longer in children and adolescents .

In the past , the decision to allow athletes to return to participation was frequently based on the grade of concussion . However , current research and recommendations by professional organizations including the National Athletic Trainers ' Association recommend against such use of these grading systems . Currently , injured athletes are prohibited from returning to play before they are symptom @-@ free during both rest and exertion and until results of the neuropsychological tests have returned to pre @-@ injury levels .

Three grading systems have been most widely followed : by Robert Cantu , the Colorado Medical Society , and the American Academy of Neurology . Each employs three grades , as summarized in the following table :

= = Prevention = =

Prevention of MTBI involves general measures such as wearing seat belts and using airbags in cars . Older people are encouraged to reduce fall risk by keeping floors free of clutter and wearing thin , flat , shoes with hard soles that do not interfere with balance .

Protective equipment such as headgear has been found to reduce the number of concussions in athletes and improvements in the design of helmets may decrease the number and severity further . New " Head Impact Telemetry System " technology is being placed in helmets to study injury mechanisms and may generate knowledge that will potentially help reduce the risk of concussions among American Football players . Changes to the rules or enforcing existing rules in sports , such as those against " head @-@ down tackling " , or " spearing " , which is associated with a high injury rate , may also prevent concussions .

= = Treatment = =

After exclusion of neck injury , observation should be continued for several hours . If repeated vomiting , worsening headache , dizziness , seizure activity , excessive drowsiness , double vision , slurred speech , unsteady walk , or weakness or numbness in arms or legs , or signs of basilar skull fracture develop , immediate assessment in an emergency department is warranted . After this initial period has passed , there is debate as to whether it is necessary to awaken the person several times during the first night , as has traditionally been done , or whether there is more benefit from uninterrupted sleep .

Physical and cognitive rest should be continued until all symptoms have resolved with most (80 ? 90 %) concussions resolving in seven to ten days , although the recovery time may be longer in children and adolescents . Cognitive rest includes reducing activities which require concentration and attention such as school work , video games , and text messaging . It has been suggested that even leisure reading can commonly worsen symptoms in children and adolescents and proposals

include time off from school and attending partial days . Since students may appear ' normal ' , continuing education of relevant school personnel may be needed .

Those with concussion are generally prescribed rest , including adequate nighttime sleep as well as daytime rest . Rest includes both physical and cognitive rest until symptoms clear and a gradual return to normal activities at a pace that does not cause symptoms to worsen is recommended . Education about symptoms , their management , and their normal time course , can lead to an improved outcome .

For persons participating in athletics , the 2008 Zurich Consensus Statement on Concussion in Sport recommends that participants be symptom free before restarting and then progress through a series of graded steps . These steps include :

complete physical and cognitive rest

light aerobic activity (less than 70 % of maximum heart rate)

sport @-@ specific activities such as running drills and skating drills

non @-@ contact training drills (exercise , coordination , and cognitive load)

full @-@ contact practice

full @-@ contact games .

Only when symptom @-@ free for 24 hours , should progression to the next step occur . If symptoms occur , the person should drop back to the previous asymptomatic level for at least another 24 hours . The emphasis is on remaining symptom free and taking it in medium steps , not on the steps themselves .

Medications may be prescribed to treat sleep problems and depression . Analgesics such as ibuprofen can be taken for headache , but paracetamol (acetaminophen) is preferred to minimize the risk of intracranial hemorrhage . Concussed individuals are advised not to use alcohol or other drugs that have not been approved by a doctor as they can impede healing . Activation database @-@ guided EEG biofeedback has been shown to return the memory abilities of the concussed individual to levels better than the control group .

About one percent of people who receive treatment for MTBI need surgery for a brain injury . Observation to monitor for worsening condition is an important part of treatment . Health care providers recommend that those suffering from concussion return for further medical care and evaluation 24 to 72 hours after the concussive event if the symptoms worsen . Athletes , especially intercollegiate or professional , are typically followed closely by team athletic trainers during this period but others may not have access to this level of health care and may be sent home with minimal monitoring .

People may be released after assessment from hospital or emergency room to the care of a trusted person with instructions to return if they display worsening symptoms or those that might indicate an emergent condition such as : change in consciousness , convulsions , severe headache , extremity weakness , vomiting , new bleeding or deafness in either or both ears .

= = Prognosis = =

People who have had a concussion seem more susceptible to another one , particularly if the new injury occurs before symptoms from the previous concussion have completely gone away . It is also a negative process if smaller impacts cause the same symptom severity . Repeated concussions may increase a person 's risk in later life for dementia , Parkinson 's disease , and depression .

MTBI has a mortality rate of almost zero . The symptoms of most concussions resolve within weeks , but problems may persist . These are seldom permanent , and outcome is usually excellent . The overall prognosis for recovery may be influenced by a variety of factors that include age at the time of injury , intellectual abilities , family environment , social support system , occupational status , coping strategies , and financial circumstances . People over age 55 may take longer to heal from MTBI or may heal incompletely . Similarly , factors such as a previous head injury or a coexisting medical condition have been found to predict longer @-@ lasting post @-@ concussion symptoms . Other factors that may lengthen recovery time after MTBI include psychological problems such as substance abuse or clinical depression , poor health before the injury or additional injuries sustained

during it , and life stress . Longer periods of amnesia or loss of consciousness immediately after the injury may indicate longer recovery times from residual symptoms . For unknown reasons , having had one concussion significantly increases a person 's risk of having another . Having previously sustained a sports concussion has been found to be a strong factor increasing the likelihood of a concussion in the future . Other strong factors include participation in a contact sport and body mass size . The prognosis may differ between concussed adults and children ; little research has been done on concussion in the pediatric population , but concern exists that severe concussions could interfere with brain development in children .

A 2009 study found that individuals with a history of concussions might demonstrate a decline in both physical and mental performance for longer than 30 years . Compared to their peers with no history of brain trauma , sufferers of concussion exhibited effects including loss of episodic memory and reduced muscle speed .

= = = Post @-@ concussion syndrome = = =

In post @-@ concussion syndrome , symptoms do not resolve for weeks , months , or years after a concussion , and may occasionally be permanent . About 10 % to 20 % of people have post concussion syndrome for more than a month . Symptoms may include headaches , dizziness , fatigue , anxiety , memory and attention problems , sleep problems , and irritability . There is no scientifically established treatment , and rest , a recommended recovery technique , has limited effectiveness . Symptoms usually go away on their own within months . The question of whether the syndrome is due to structural damage or other factors such as psychological ones , or a combination of these , has long been the subject of debate .

= = = Cumulative effects = = =

Cumulative effects of concussions are poorly understood , with this being even more true in children . The severity of concussions and their symptoms may worsen with successive injuries , even if a subsequent injury occurs months or years after an initial one . Symptoms may be more severe and changes in neurophysiology can occur with the third and subsequent concussions . Studies have had conflicting findings on whether athletes have longer recovery times after repeat concussions and whether cumulative effects such as impairment in cognition and memory occur .

Cumulative effects may include psychiatric disorders and loss of long @-@ term memory . For example , the risk of developing clinical depression has been found to be significantly greater for retired American football players with a history of three or more concussions than for those with no concussion history . Three or more concussions is also associated with a fivefold greater chance of developing Alzheimer 's disease earlier and a threefold greater chance of developing memory deficits .

= = = CTE = = =

Chronic traumatic encephalopathy , or " CTE " , is an example of the cumulative damage that can occur as the result of multiple concussions or less severe blows to the head . The condition was previously referred to as " dementia pugilistica " , or " punch drunk " syndrome , as it was first noted in boxers . The disease can lead to cognitive and physical handicaps such as parkinsonism , speech and memory problems , slowed mental processing , tremor , depression , and inappropriate behavior . It shares features with Alzheimer 's disease .

= = = Second @-@ impact syndrome = = =

Second @-@ impact syndrome , in which the brain swells dangerously after a minor blow , may occur in very rare cases . The condition may develop in people who receive a second blow days or weeks after an initial concussion , before its symptoms have gone away . No one is certain of the

cause of this often fatal complication , but it is commonly thought that the swelling occurs because the brain 's arterioles lose the ability to regulate their diameter , causing a loss of control over cerebral blood flow . As the brain swells , intracranial pressure rapidly rises . The brain can herniate , and the brain stem can fail within five minutes . Except in boxing , all cases have occurred in athletes under age 20 . Due to the very small number of documented cases , the diagnosis is controversial , and doubt exists about its validity . A 2010 Pediatrics review article stated that there is debate whether the brain swelling is due to two separate hits or to just one hit , but in either case , catastrophic football head injuries are three times more likely in high school athletes than in college athletes .

= = Epidemiology = =

Most cases of traumatic brain injury are concussions . A World Health Organization (WHO) study estimated that between 70 and 90 % of head injuries that receive treatment are mild . However , due to underreporting and to the widely varying definitions of concussion and MTBI , it is difficult to estimate how common the condition is . Estimates of the incidence of concussion may be artificially low , for example due to underreporting . At least 25 % of MTBI sufferers fail to get assessed by a medical professional . The WHO group reviewed studies on the epidemiology of MTBI and found a hospital treatment rate of 1 ? 3 per 1000 people , but since not all concussions are treated in hospitals , they estimated that the rate per year in the general population is over 6 per 1000 people .

Young children have the highest concussion rate among all age groups . However , most people who suffer concussion are young adults . A Canadian study found that the yearly incidence of MTBI is lower in older age groups (graph at right) . Studies suggest males suffer MTBI at about twice the rate of their female counterparts . However , female athletes may be at a higher risk for suffering concussion than their male counterparts .

Up to five percent of sports injuries are concussions . The U.S. Centers for Disease Control and Prevention estimates that 300 @,@ 000 sports @-@ related concussions occur yearly in the U.S. , but that number includes only athletes who lost consciousness . Since loss of consciousness is thought to occur in less than 10 % of concussions , the CDC estimate is likely lower than the real number . Sports in which concussion is particularly common include football and boxing (a boxer aims to " knock out " , i.e. give a mild traumatic brain injury to , the opponent) . The injury is so common in the latter that several medical groups have called for a ban on the sport , including the American Academy of Neurology , the World Medical Association , and the medical associations of the UK , the U.S. , Australia , and Canada .

Due to the lack of a consistent definition , the economic costs of MTBI are not known , but they are estimated to be very high . These high costs are due in part to the large percentage of hospital admissions for head injury that are due to mild head trauma , but indirect costs such as lost work time and early retirement account for the bulk of the costs . These direct and indirect costs cause the expense of mild brain trauma to rival that of moderate and severe head injuries .

= = History = =

The Hippocratic Corpus , collection of medical works from ancient Greece , mentions concussion , later translated to commotio cerebri , and discusses loss of speech , hearing and sight that can result from " commotion of the brain " . This idea of disruption of mental function by " shaking of the brain " remained the widely accepted understanding of concussion until the 19th century . The Persian physician Muhammad ibn Zakar?ya R?zi was the first to write about concussion as distinct from other types of head injury in the 10th century AD . He may have been the first to use the term " cerebral concussion " , and his definition of the condition , a transient loss of function with no physical damage , set the stage for the medical understanding of the condition for centuries . In the 13th century , the physician Lanfranc of Milan 's Chiurgia Magna described concussion as brain " commotion " , also recognizing a difference between concussion and other types of traumatic brain

injury (though many of his contemporaries did not) , and discussing the transience of post @-@ concussion symptoms as a result of temporary loss of function from the injury . In the 14th century , the surgeon Guy de Chauliac pointed out the relatively good prognosis of concussion as compared to more severe types of head trauma such as skull fractures and penetrating head trauma . In the 16th century , the term " concussion " came into use , and symptoms such as confusion , lethargy , and memory problems were described . The 16th century physician Ambroise Paré used the term commotio cerebri , as well as " shaking of the brain " , " commotion " , and " concussion " .

Until the 17th century , concussion was usually described by its clinical features , but after the invention of the microscope , more physicians began exploring underlying physical and structural mechanisms . However , the prevailing view in the 17th century was that the injury did not result from physical damage , and this view continued to be widely held throughout the 18th century . The word " concussion " was used at the time to describe the state of unconsciousness and other functional problems that resulted from the impact , rather than a physiological condition .

In 1839 , Guillaume Dupuytren described brain contusions , which involve many small hemorrhages , as contusio cerebri and showed the difference between unconsciousness associated with damage to the brain parenchyma and that due to concussion , without such injury . In 1941 , animal experiments showed that no macroscopic damage occurs in concussion .

= = Research = =

Minocycline , lithium and N @-@ acetylcysteine show tentative success in animal models .

Measurement of predictive visual tracking is being studied as a screening technique to identify mild traumatic brain injury . A head @-@ mounted display unit with eye @-@ tracking capability shows a moving object in a predictive pattern for the person to follow with their eyes . People without brain injury will be able to track the moving object with smooth pursuit eye movements and correct trajectory while it is hypothesized that those with mild traumatic brain injury cannot .