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Trauma related

Blunt kidney trauma

The kidney is injured in approximately 10% of all significant blunt abdominal trauma. Of those, 13% are sports-related when the kidney, followed by testicle, is most frequently involved. However, the most frequent cause by far is motor vehicle accident followed by falls. The consequences are usually less severe than injuries involving other internal organs.

Sports related injury

Organized sport. Blunt injuries to the kidney from helmets, shoulder pads, and knees are described in football, and in soccer, martial arts, and all-terrain vehicle accidents. A literature review of peer-reviewed articles in May 2009 demonstrated that urogenital injuries are uncommon in team and individual sports, and that most of them are low-grade injuries, cycling being the most commonly associated, followed by winter sports, horse riding and contact/collision sports. A special situation has existed in the athletic participant with a single kidney. Formerly, the American Academy of Pediatrics Committee on Sports Medicine and Fitness advised against such children and adolescents from participating in contact sports. However, a study of 45,000 children with kidney injuries demonstrated no kidney loss in any contact sport. Sledding, skiing and rollerblading did, however, result in such loss. Further, data from the National Athletic Trainers’ Association High School Injury Surveillance Study, an observational cohort study during the 1995-1997 academic years, have been used to compare incidence rates for sport-specific injuries to specific organs. There were over 4.4 million athlete-exposures, defined as 1 athlete participating in 1 game or practice. Student athletes incurred kidney injuries most often playing football (12 injuries) or girls’ soccer (2 injuries). The American Academy of Pediatrics currently recommends a "qualified yes" for participation by athletes with single kidneys in contact/collision sports although some physicians remain reluctant to acquiesce.

Diagnosis

In blunt injury, imaging is indicated if there is gross hematuria, or if the patient exhibits shock together with either gross or microscopic hematuria.

Investigation

The imaging modality of choice is contrast-enhanced, computed tomography (CT) which is readily available in most emergency departments of moderate or above size. Scan times have become shorter with each generation of scanners and current scans are quick and accurately demonstrate renal injuries together with associated injuries to other abdominal or retroperitoneal organs.
**Treatment**

Unlike ultrasound examination (FAST), CT provides anatomic and functional information that allows for accurate grading of the injury which is partly responsible for a growing trend toward conservative management (intravenous fluids, close monitoring, watchful waiting) of renal trauma. Conservative management does not apply in situations where extensive urinary extravasation or devitalized areas of renal parenchyma are found and especially if associated with injuries to other abdominal organs; these cases are complication-prone and much more likely to require surgery. That being said, a retrospective study suggests that primary conservative treatment of blunt kidney rupture seem to lead to less surgery, especially less open surgery and less blood and renal parenchyma loss compared to a strategy of initial surgery.

**References**

**Blunt trauma**

"Blunt force trauma" redirects here. For the band, see Blunt Force Trauma (band). For the album, see Blunt Force Trauma (album).

For the song by Damageplan, see New Found Power.

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Blunt trauma, blunt injury, non-penetrating trauma or blunt force trauma refers to physical trauma caused to a body part, either by impact, injury or physical attack; the latter usually being referred to as blunt force trauma. The term refers to the initial trauma, from which develops more specific types such as contusions, abrasions, lacerations, and/or bone fractures. Blunt trauma is contrasted with penetrating trauma, in which an object such as a bullet enters the body.
Variations

Blunt abdominal trauma

Blunt abdominal trauma (BAT) makes up 75% of all blunt trauma and is the most common example of this injury. The majority occurs in motor vehicle accidents, in which rapid deceleration may propel the driver into the steering wheel, dashboard, or seatbelt causing contusions in less serious cases, or rupture of internal organs from briefly increased intraluminal pressure in the more serious, dependent on the force applied.

There are two basic physical mechanisms at play with the potential of injury to intra-abdominal organs — compression and deceleration. The former occurs from a direct blow, such as a punch, or compression against a non-yielding object such as a seat belt or steering column. This force may deform a hollow organ thereby increasing its intra-luminal or internal pressure, leading to rupture. Deceleration, on the other hand, causes stretching and shearing at the points at which mobile structures, such as the bowel, are anchored. This can cause tearing of the mesentery of the bowel, and injury to the blood vessels that travel within the mesentery. Classic examples of these mechanisms are a hepatic tear along the ligamentum teres and injuries to the renal arteries.

When blunt abdominal trauma is complicated by 'internal injury', the liver and spleen (see blunt splenic trauma) are most frequently involved, followed by the small intestine.

In rare cases, this injury has been attributed to medical techniques such as the Heimlich Maneuver, attempts at cardiopulmonary resuscitation, and manual thrusts to clear an airway. Although these are rare examples, it has been suggested that they are caused by applying unnecessary pressure when administering such techniques. Finally, the occurrence of splenic rupture with the mildest of blunt abdominal trauma in those convalescing from infectious mononucleosis is well reported.

Diagnosis

In all but the most obviously trivial injuries, the first concern is to exclude anything that might be quickly or immediately life threatening. This is resolved by ascertaining that the subject's airway is open and competent, that breathing is unlabored, and that circulation — i.e. pulses that can be felt, is present. This is sometimes described as the "A, B, C's" — Airway, Breathing, and Circulation — and is the first step in any resuscitation. Then, the history of the accident or injury is amplified with any medical, dietary (timing of last oral intake) and past history, from whatever sources such as family, friends, previous treating physicians that might be available. This method is sometimes given the mnemonic "SAMPLE". The amount of time spent on diagnosis should be minimized and expedited by a combination of clinical assessment and appropriate use of technology, such as diagnostic peritoneal lavage (DPL), or bedside ultrasound examination (FAST) before proceeding to laparotomy if required. If time and the patient's stability permits, CT examination may be carried out if available. Its advantages include superior definition of the injury, leading to grading of the injury and sometimes the confidence to avoid or postpone surgery. Its disadvantages include the time taken to acquire images, although this gets shorter with each generation of scanners, and the removal of the patient from the immediate view of the emergency or surgical staff.

Recently, criteria have been defined that might allow patients with blunt abdominal trauma to be discharged safely without further evaluation. The characteristics of such patients would include absence of intoxication, no evidence of lowered blood pressure or raised pulse rate, no abdominal pain or tenderness and no blood in the urine. To be considered low risk, patients would need to meet all low-risk criteria.
Blunt trauma

Blunt abdominal trauma in sports (mainly football, soccer, ice hockey, lacrosse)

The majority of contact-collision injuries, usually blunt trauma, should have been witnessed in high school or collegiate games where the athletic training staff are trained to keep their eyes on the play. This may allow some departure from Acute Trauma Life Support (ATLS) and SAMPLE guidelines in the initial assessment, although the principles always apply. The major priority then becomes: (a) separating contusions and musculo-tendinous injuries from injuries to solid organs and the gut, and (b) recognizing potential and/or developing blood loss, and reacting accordingly. Blunt injuries to the kidney from helmets, shoulder pads, and knees are also described in football, and in soccer, martial arts, and all-terrain vehicle accidents.

Treatment

In every case where the presumption of internal injury has been sufficient to trigger the diagnostic steps outlined above, intravenous access will be established and crystalloid solutions and/or blood will be administered at rates sufficient to maintain the circulation. Thereafter, further treatment will depend on the grade of organ damage estimated by the prior investigations and will vary from close observation with the ability to intervene quickly, or surgery, open or laparoscopic.

References
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. A
Concussion

2010 *Pediatrics* review article focusing on children and adolescents noted that fewer than 10% of sports-related concussions had associated 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 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 known whether the brain in concussion is structurally damaged or whether there is mainly a loss of function with only physiological changes. Cellular damage has reportedly been found in concussed brains, but it may have been due to artifacts from the studies. It is now thought that structural and neuropsychiatric factors may both be responsible for the effects of concussion.

**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 more being 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

Main article: Concussion 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:

<table>
<thead>
<tr>
<th>Guidelines</th>
<th>Grade I</th>
<th>Grade II</th>
<th>Grade III</th>
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</thead>
<tbody>
<tr>
<td>Cantu</td>
<td>Post-traumatic amnesia &lt;30 minutes, no loss of consciousness</td>
<td>Loss of consciousness &lt;5 minutes or amnesia lasting 30 minutes–24 hours</td>
<td>Loss of consciousness &gt;5 minutes or amnesia &gt;24 hours</td>
</tr>
<tr>
<td>Colorado Medical Society</td>
<td>Confusion, no loss of consciousness</td>
<td>Confusion, post-traumatic amnesia, no loss of consciousness</td>
<td>Any loss of consciousness</td>
</tr>
<tr>
<td>American Academy of Neurology</td>
<td>Confusion, symptoms last &lt;15 minutes, no loss of consciousness</td>
<td>Symptoms last &gt;15 minutes, no loss of consciousness</td>
<td>Loss of consciousness (IIIa, coma lasts seconds, IIIb for minutes)</td>
</tr>
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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 a person 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 the same as 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.

Affective results of concussion include 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/s$^2$ 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 weeks, 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. Concussion 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 to the damage. Findings from a study of the brains of dead 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 it is still somewhat unclear.1]
Diagnosis

Health care providers examine head trauma recipients to ensure that the injury is not a more severe emergency such as an intracranial hemorrhage. Assessment 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.

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 to show up on MRI and SPECT imaging in concussed people with 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. The lack of the highly noticeable signs and symptoms may lead clinicians to miss the injury, and 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 of concussion can be complicated because it shares symptoms with other conditions. For example, post-concussion symptoms such as cognitive problems may be misattributed to brain injury when they are in fact due to post-traumatic stress disorder (PTSD).

Prevention

Main article: Prevention of concussions

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 potentially help reduce the risk of concussions among American Football players. Changes to the rules or the practices of 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 checking for signs of neck injury, observation should be continued for several hours. If any of the following develop: 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 immediate assessment in an emergency department is warranted. After this initial danger period has passed, there is debate 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.

The key is physical and cognitive rest until no more symptoms are present with most (80–90%) concussions resolving in a 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. A 2010 *Pediatrics* article on sports-related concussions in children and adolescents states that reading, even leisure reading, can commonly worsen symptoms. This article suggested such methods as time off from school and attending partial days. Since students can appear physically normal, teachers and other school personnel may need to be updated about current views on concussion.

Concussion sufferers are generally prescribed rest, including plenty of sleep at night as well as daytime rest. Rest includes both physical and cognitive rest until symptoms clear. Health care providers recommend a gradual return to normal activities at a pace that does not cause symptoms to worsen. Education about symptoms, how to manage them, 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 persons be symptom free before restarting and then, not all at once, but rather 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, and full-contact games. Only if a person is symptom free for 24 hours, should he or she proceed to the next step. If symptoms occur, the person should drop back to the previous asymptomatic level for at least another 24 hours. This is not a race. The person should go easy and take his or her time. The emphasis is on remaining symptom free and taking it in medium steps, not on the steps themselves.

Medications may be prescribed to treat symptoms such as sleep problems and depression. Analgesics such as ibuprofen can be taken for the headaches that frequently occur after concussion, but paracetamol (acetaminophen) is preferred to minimize the risk for complications such as 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 athletes, 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 no medical person monitoring them unless the situation gets worse.

Patients may be released from the hospital to the care of a trusted person with orders to return if they display worsening symptoms or those that might indicate an emergent condition, like: unconsciousness or altered mental status, convulsions, severe headache, extremity weakness, vomiting, or 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. Problems 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 published in *Brain* 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

Main article: Post-concussion syndrome

In post-concussion syndrome, symptoms do not resolve for weeks, months, or years after a concussion, and may occasionally be permanent. 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.
Dementia pugilistica
Main article: Dementia pugilistica
Chronic encephalopathy 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 called dementia pugilistica, or “punch drunk” syndrome, which is associated with boxers, can result in cognitive and physical deficits such as parkinsonism, speech and memory problems, slowed mental processing, tremor, and inappropriate behavior. It shares features with Alzheimer's disease.

Second-impact syndrome
Main article: 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 Zakariya Rāzi 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.

References


External links

• "Facts about Concussion and Brain Injury and Where to Get Help" (http://www.cdc.gov/ncipc/tbi/default.htm) US Centers for Disease Control and Prevention
• "Concussion in High School Sports" (http://www.cdc.gov/ncipc/tbi/Coaches_Tool_Kit.htm) US Centers for Disease Control and Prevention
• Concussions and Our Kids: America's Leading Expert On How To Protect Young Athletes and Keep Sports Safe (http://books.google.com/books?id=_f5LxbHnu5EC&printsec=frontcover&dq=Robert+Cantu&hl=en&sa=X&ei=jhUJUvDrE4Xu2QW2poDwAw&ved=0CC8Q6AEwAA#v=onepage&q=Robert+Cantu&f=false), Robert Cantu, M.D. and Mark Hyman, New York: Houghton Mifflin Harcourt, 2012. Dr. Cantu is a neurologist and Mr. Hyman, a sports journalist. They have written a book for the interested layperson.

Helmet removal (sports)

In organized athletics, few situations give rise to greater anxiety than the ‘downed athlete’. Obvious causes include head and neck injury, or both, with no immediate means of excluding neck injury in the athlete unable to give a history. Compounding the problem is the potential for the athlete’s airway being compromised. Such a situation requires effective triage with the penalty of the athlete's injury being worsened or made permanent, if the initial steps taken are not appropriate. Paradoxically, the equipment designed to prevent or mitigate injury, such as helmets, face masks, neck rolls and shoulder pads, will contribute to the complexity of the steps needed to be taken. Finally, environmental challenges, such as the difficulty of first responders moving on an ice arena, or maneuvering an ambulance through inadequate access routes, will add to the problem if not previously addressed by inspection of facilities and, in the best circumstances, rehearsal.
Potential for inadvertent injury

There is a hierarchy of serious consequences of athletic injury, at the top of which is head and neck injury. Consequently, when a potential head or neck (or combined injury) is observed, the level of anxiety in training and medical staff rises. This concern relates to the possibility of the bony and protective structures of the neck, the cervical spine and its ligaments, having been fractured and torn, but the nerve cord escaping initial injury, only to be injured inadvertently by responders' efforts to assist the player.

The consequence of injury to the nerve cord is, in the worst of circumstances, quadriplegia. This is an inappropriate time for practice conflicts to arise and the potential is real, although the less so the more organized the situation. For example, Emergency Medicine Technicians (EMTs) and Paramedics are trained to remove helmets while athletic training staff and the NCAA believe that the helmet should be left in place, unless the athlete's airway is compromised and cannot be managed otherwise.

This potential conflict relates to the design of the helmet used in the situation to which each of the parties most frequently responds. With EMTs and paramedics, it is most often motor vehicle accidents. With athletic training staff, it is exclusively athletic events unless acting in the role of 'Good Samaritan'. Helmets worn by motorcyclists and four-wheel operators are usually of an integral design making removal of the face mask either impossible or extremely difficult. Consequently, management of a compromised airway demands removal of the helmet.

On the other hand, helmets worn in football and ice hockey, are designed specifically so that the face mask may be quickly removed, although the technique for its removal will vary by helmet design. Accordingly, potential and serious difference in practice should be avoided by good communication between athletic training staff and first responders prior to the start of the event. Certified athletic training staff are familiar with the helmet model currently in use by their athletes, are expert in its removal, and carry the equipment needed to do so, and there is no substitute for familiarity and practice. At the same time, investigation and development of improved, face mask release systems is ongoing.

The 22nd edition of the NCAA Sports Medicine Handbook states: "ordinarily, it is not necessary to remove the helmet on the field to evaluate the scalp. Also, the helmet can be left in place when evaluating an unconscious student-athlete, an individual who demonstrates transient or persistent neurological findings in his/her extremities, or the student-athlete who complains of continuous or transient neck pain......once the ABCs (airway, breathing, circulation) are stabilized, transportation to an emergency facility should be conducted with the head secure in the helmet and the neck immobilize by strapping, taping and/or using light weight bolsters on a spine.
When moving an athlete to the spine board, the head and trunk should be moved as a unit, using the lift/slide maneuver or a log-roll technique.”

**Face mask removal**

With agreement on the importance in maintaining cervical spine alignment, and by implication, the most common strategy of leaving the helmet and shoulder pads in place, the immediate task falls into two parts:

1. the coordinated, synchronized log roll of an injured athlete who happens to be lying in the face down or prone position;
2. removal of the face mask to allow care and protection of the airway.

Currently, face masks fall into two broad categories, the 'traditional', secured by screws and plastic loops or thin wire ties and a combination of screws and T-nuts, and the 'innovative' using some additional type of proprietary 'quick release' hardware. However, it should be recognized that helmet and face mask design is an area of active development and change.

Whichever, removal customarily involves cutting/releasing the loop straps and various tools have been advocated including cutting tools and cordless screwdrivers. In some studies, the cordless screwdriver has been shown to be the most efficient and quickest.

However, concern has been raised concerning the use of a single technique when helmet fittings have been degraded by poor maintenance. In those circumstances, a screw seized with rust, or in which the threads have been stripped, may be encountered. Accordingly, there has been advocacy for a reliable, combined, tool technique such as a cordless screwdriver with backup cutting tool. Moreover, in some innovative designs, a cutting tool is essential.

In general, 'quick release' face-mask attachments appear to make face-mask removal quicker and cause less unwanted movement of the athlete's head or neck. The opposite is the case in cutting loop straps.

**Helmet removal**

At some stage, the helmet and protective equipment will need to be removed. How this may be done with minimum risk remains a question of importance.

First, there are three possible athlete/equipment configurations:

- no helmet and no shoulder pads;
- both helmet and shoulder pads;
- helmet only without shoulder pads.

Of the three options, the least desirable appears to be helmet removal with shoulder pads retained (third choice), that combination potentially allowing the head to drop back in relation to the shoulders inducing the greatest amount of movement (extension) of the cervical spine.
It was also previously held that X-ray of the neck should be carried out before movement of the neck was permitted. Since retention of helmet and shoulder pads would be the least disruptive to the neck as previously observed, the second question to arise became the reliability of what is referred to as cross-table lateral X-ray of the neck, the routine radiologic procedure in such cases. Although previously regarded as standard procedure, at least one study has found that football equipment is an impediment to accurate X-ray interpretation. Further, it has transpired on review that most patients with significant neck symptoms undergo X-ray computed tomography or 'CT' examination of the neck even when X-ray is normal, rendering the X-ray somewhat pointless. Additionally, it has become apparent that when compared to emerging 'gold standards', cervical spinal x-ray simply lacks the required sensitivity in important trauma situations.

Current opinion now suggests that X-ray of the cervical spine adds little to what can be obtained by clinical examination and two clinical assessment strategies have been validated, the first being the National Emergency X-Radiography Utilization Study (NEXUS) and the second, the Canadian C-Spine Rule (CCR). The first has a reported sensitivity for detecting cervical spine injury of 99% and the second, if anything, higher.

Accordingly, a practice has arisen that "clears" the patient from cervical spinal injury if the following criteria are met:

1. the subject is alert and oriented;
2. has a normal neurological examination;
3. has no concurrent injury that would distract him/her from full cooperation;
4. is free from pain when the cervical spine is carefully palpated;
5. is free from pain on flexing and extension of the cervical spine.

Since the last part of the exam requires removal of cervical restraints such as collars and attachments to spinal boards etc., the implication is that it is 'safe' to remove such restraints if the first four criteria are satisfied.

In the event that application of the above criteria fails to indicate a 'normal cervical spine', the next step currently is CT examination, which has a reported 98-99% sensitivity for cervical spinal injury. A separate imaging technique, magnetic resonance imaging, has been found to be too prone to artifacts from parts of the protective equipment to be clinically useful.

It should be understood that, apart from the clinical examination rules and CT, the majority of sports or athletic information has been derived from studies involving football, ice hockey and motorcycle accidents. This induces an age (late adolescence and young adult) and gender (mainly male) bias. Consequently, caution should be used in applying the conclusions to injuries involving the use of helmets of other design such as those used in lacrosse, horseback riding, baseball/softball, or cycling. They also cannot necessarily be applied to a younger or female population without caution.
Lisfranc injury

The **Lisfranc injury** (also known as the Lisfranc fracture, Lisfranc dislocation, Lisfranc fracture dislocation, tarsometatarsal injury, or simply midfoot injury) is an injury of the foot in which one or more of the metatarsal bones are displaced from the tarsus. This type of injury is named after Jacques Lisfranc de St. Martin (2 April 1790–13 May 1847), a French surgeon and gynecologist who first described the injury in 1815, after the War of the Sixth Coalition.

**Causes**

In humans, the midfoot consists of five bones that form the arches of the foot (the cuboid, navicular, and three cuneiform bones) and their articulations with the bases of the five metatarsal bones. Lisfranc injuries are caused when excessive kinetic energy is applied either directly or indirectly to the midfoot and are often seen in traffic collisions or industrial accidents.

Direct Lisfranc injuries are usually caused by a crush injury, such as a heavy object falling onto the midfoot, or the foot being run over by a car or truck, or someone landing on the foot after a fall from a significant height. Indirect Lisfranc injuries are caused by a sudden rotational force on a plantar flexed (downward pointing) forefoot. Examples of this type of trauma include a rider falling from a horse but the foot remaining trapped in the stirrup, or a person falling forward after stepping into a storm drain.

In athletic trauma, Lisfranc injuries occur commonly in activities such as windsurfing, kitesurfing, wakeboarding, or snowboarding (where appliance bindings pass directly over the metatarsals). American football players occasionally acquire this injury, and it most often occurs when the athlete's foot is plantar flexed and another player lands on the heel. This can also be seen in pivoting athletic positions such as a baseball catcher or a ballerina spinning.
Diagnosis

In a high energy injury to the midfoot, such as a fall from a height or a motor vehicle accident, the diagnosis of a Lisfranc injury should, in theory at least, pose less of a challenge. There will be deformity of the midfoot and X-ray abnormalities should be obvious. Further, the nature of the injury will create heightened clinical suspicion and there may even be disruption of the overlying skin and compromise of the blood supply. Typical X-ray findings would include a gap between the base of the first and second toes. The diagnosis becomes more challenging in the case of low energy incidents, such as might occur with a twisting injury on the racquetball court, or when an American Football lineman is forced back upon a foot that is already in a fully plantar flexed position. Then, there may only be complaint of inability to bear weight and some mild swelling of the forefoot or midfoot. Bruising of the arch has been described as diagnostic in these circumstances but may well be absent. Typically, conventional radiography of the foot is utilized with standard non-weight bearing views, supplemented by weight bearing views which may demonstrate widening of the interval between the first and second toes, if the initial views fail to show abnormality. Unfortunately, radiographs in such circumstances have a sensitivity of 50% when non-weight bearing and 85% when weight bearing, meaning that they will appear normal in 15% of cases where a Lisfranc injury actually exists. In the case of apparently normal x-rays, if clinical suspicion remains high, some form of advanced imaging such as magnetic resonance imaging (MRI) or X-ray computed tomography (CT) is a logical next step.

Classification

There are three classifications for the fracture:

1. Homolateral: All five metatarsals are displaced in the same direction. Lateral displacement may also suggest cuboidal fracture.
2. Isolated: one or two metatarsals are displaced from the others.
3. Divergent: metatarsals are displaced in a sagittal or coronal plane and may also involve the intercuneiform area and include a navicular fracture.

Treatment

Treatment options include operative or non-operative treatment. If the dislocation is less than 2 mm, the fracture can be managed with casting for six weeks. The patient's injured limb cannot bear weight during this period. For severe Lisfranc injuries, open reduction with internal fixation (ORIF) and temporary screw or Kirschner wire (K-wire) fixation is the treatment of choice. The foot cannot be allowed to bear weight for a minimum of six weeks. Partial weight-bearing may then begin, with full weight bearing after an additional several weeks, depending on the specific injury. K-wires are typically removed after six weeks, before weight bearing, while screws are often removed after 12 weeks.

When a Lisfranc injury is characterized by significant displacement of the tarsometatarsal joint(s), nonoperative treatment often leads to severe loss of function and long-term disability secondary to chronic pain and sometimes to a planovalgus deformity. In cases with severe pain, loss of function, or progressive deformity that has failed to respond to nonoperative treatment, mid-tarsal and tarsometatarsal arthrodesis (operative fusion of the bones) may be indicated.

History

During the Napoleonic Wars, Jacques Lisfranc de St. Martin encountered a soldier who suffered from vascular compromise and secondary gangrene of the foot after a fall from a horse. Subsequently, Lisfranc performed an amputation at the level of the tarsometatarsal joints, and that area of the foot has since been eponymously referred to as the "Lisfranc joint". Although Lisfranc did not describe a specific mechanism of injury or classification scheme, a Lisfranc injury has come to mean a dislocation or fracture-dislocation injury at the tarsometatarsal joints.
References

External links
• Lisfranc Fracture Club - Mutual Help and Support group (https://www.facebook.com/LisfrancFractureClub)
• http://www.footeducation.com/lisfranc-fracture-orif
• Diagnosis of joint (http://www.aafp.org/afp/980700ap/burrough.html)