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Mechanism of Causing Craniocerebral Injuries in Traffic Accidents

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Introduction: Traffic accidents are defined as incidents in which an automobile collides with a person, an object, or another vehicle, sometimes fatally or with minor injuries. According to the World Health Organization, traffic accidents are a concern to public health on a global scale and cause roughly 1.3 million people to die and 20 to 50 million people to suffer injuries every year (WHO). For traumatic injuries to be diagnosed correctly and effectively, it is crucial to understand the mechanism by which craniocerebral injuries result from motor vehicle collisions. [1]
Method of work: The institutional ethics committee gave its approval to this retrospective investigation for research. The research is retrospective in nature, and in order to realize it, data were collected from published books and electronic sources, with material from those books serving as examples and figures in the research. All references are mentioned in the references chapter and are cited throughout the book. The research information was gleaned from the emergency department's operating procedures at the regional hospital in Prizren.
The purpose of the paper: to present the methods for quantifying injuries and to demonstrate the mechanism of creating craniocerebral injuries in traffic accidents. To present statistics from an investigation of craniocerebral injuries sustained in car accidents at the local hospital in "Prizren" over the course of a year, from January 2020 to January 2021.
Results: 1189 traffic accident cases were recorded between January 2020 and January 2021 at the emergency room of the hospital in Prizren. 310 of them involve damage to the skull and brain. Out of 310 accidents, 73 result in isolated head injuries called "contusion capitis," and 237 involve "contusion capitis" mixed with other wounds.
Conclusion: This study explains that the primary approach to wounded patients, the quick determination of the diagnosis, and the earliest start to therapy all depend on knowledge of the mechanisms generating craniocerebral injuries. Between January 2020 and January 2021, all cases of accidents involving craniocerebral injuries were presented and treated in the outpatient setting at the regional hospital in Prizren. QKUK-Pristina has been given polytrauma cases. All instances received standard care, including craniography, as well as analgesics and physiological treatments. According to research conducted at the regional hospital in Prizren, a sizable portion of incidents resulting in craniocerebral injuries pose a major threat to life, particularly if they are also accompanied by injuries to other systems.

1. Introduction

Traffic accidents occur when a vehicle collides with a person, object, or another vehicle, causing injuries that range from minor bodily harm to fatalities. These incidents represent a significant global public health threat, leading to approximately 1.3 million fatalities and 20 to 50 million injuries annually, according to the World Health Organization (WHO).

Understanding the mechanisms behind craniocerebral injuries in traffic accidents is essential for accurate and appropriate diagnosis of traumatic injuries. [1]

Causes of Traffic Accidents

Traffic accidents are primarily caused by:

1. Substance Use by Drivers: Includes alcohol, narcotics, and sedatives (e.g., Valium, Librium).

2. Human Factors: Such as speeding, fatigue (which may cause drowsiness), and loss of consciousness.

3. Environmental Conditions: Includes fog, poor road conditions, slippery surfaces, ice, and lack of proper signage.

4. Acute Health Conditions: Sudden medical events such as heart attacks or strokes while driving. [2]

Types of Traffic Accidents

Traffic accidents can involve:

• Collisions between vehicles or with objects

• Vehicle-pedestrian accidents

• Motorcycle accidents

• Bicycle accidents

• Railway incidents [2]

Factors Influencing Accident Severity

Factors impacting the severity of traffic accidents include:

• Vehicle Size and Quality:

Larger vehicles provide better protection during side impacts, which are often associated with severe skull fractures.

• Seating Position in Vehicle:

Passengers seated in the rear are approximately 39% less likely to suffer severe injuries in accidents.

• Speed:

Roads with speed limits over 100 km/h tend to have higher accident rates.

• Brake System Condition:

Proper maintenance and functionality of brakes are critical.

• Type of Accident [3]

Understanding the injury mechanism is crucial for swift and accurate diagnosis and for effective management of traffic accidents. The injury mechanism describes how, with what force, and in which body part the patient was injured, helping responders provide appropriate care even when injuries initially appear minor but may be serious. [25]

Head Injuries in Traffic Accidents Head injuries are among the most severe consequences of traffic accidents, often resulting in high fatality rates. According to the U.S. Centers for Disease Control and Prevention (CDC),traumatic brain injuries account for 30% of all injury-related deaths. Approximately 14% of these injuries directly result from motor vehicle accidents. Craniocerebral injuries are the leading cause of death for individuals aged 5-24, while for the 15-44 age group, most cases are non-fatal but often require hospitalization. When head trauma occurs in traffic accidents, brain tissue absorbs the force of impact, potentially disrupting normal brain function. This disruption can result in:

• Closed Head Injuries: These may appear minor at first, with symptoms such as disorientation, confusion, headache, blurred vision, or short-term unconsciousness. Often, there may be bruising or mild contusion. This condition is commonly known as a concussion.

• Moderate Symptoms: Some patients experience symptoms lasting hours to days or even permanently, such as memory loss, impaired vision, or perception issues.

• Severe Symptoms: Severe symptoms can involve physical damage to the brain, including tearing of tissues, nerves, or blood vessels. This can lead to permanent changes in personality and core functions, with symptoms such as seizures, fluid leakage from the nose or ears, and unequal pupil dilation (which may indicate a skull fracture). Testing can reveal brain swelling and bleeding, potentially requiring urgent surgery to reduce swelling, repair damage, or remove blood clots. Severe trauma is often fatal. [25]

1.1 ANATOMY OF THE HEAD

Description of the head, brain, and its structures:

Scalp: The outer part of the head is the scalp, which surrounds the skull. The scalp is a highly organized, layered structure made up of three main layers: the epidermis, dermis, and hypodermis.

Anatomy of the Skull: The skull represents the skeletal structure of the head, composed of bones that join together to form a skeletal unit. Eight bones make up the braincase, and 14 other bones form the face (excluding the teeth). The skull protects the brain and several sensory organs from external impacts or trauma. The human skull, the part that contains the brain, is rounded and relatively large compared to the face.
The base of the skull is supported by the top vertebra called the Atlas, which allows movement of the head from side to side. The base of the skull has a central opening called the Foramen magnum, through which the spinal cord enters the brain. The bones of the human head are divided into two parts: the bones of the skull (cranium) and the bones of the face. Bones of the Skull:

The cranium is made up of the following bones:

• Frontal bone (frontalis): Forms the front part of the skull. This part covers the eyes and the nasal cavity. •Parietal bone (os parietale): Forms the middle part of the skull's dome.• Temporal bone (os temporale): Forms the two side parts of the skull. It protects the mastoid

sinus, which is specialized for the inner and middle ear.
• Occipital bone (occipitale): Located at the back of the skull. This is where the Foramen magnum is located, through which the spinal cord connects to the brain. • Ethmoidal bone (os ethmoidal): Located between the eyes and is easily broken.• Sphenoidal bone (os sphenoidale): Located at the base of the skull, in front of thetemporal bones.

Bones of the Face: The bones of the face include the following major bones:

• Upper jaw (maxilla) • Lower jaw (mandible) • Cheekbone (os zygoma) • Nasal bone (os nazal) • Lacrimal bone• Vomer • Nasal shell • Palatine bone • Hyoid bone

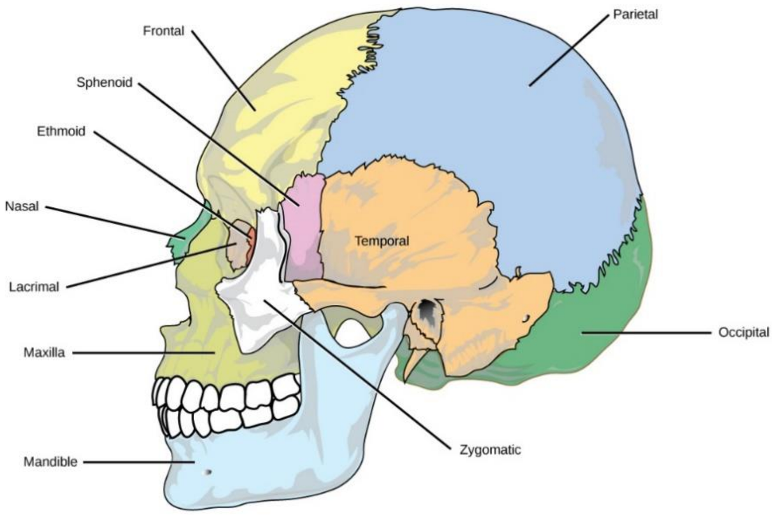


Fig. 1 The bones of the Skull Left lateral view

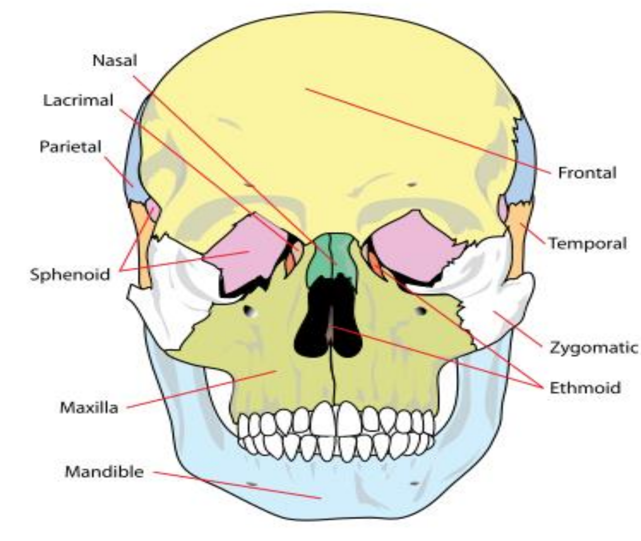


Fig. 1 The bones of the Skull anterior view

1.2 ANATOMY OF THE BRAIN (FROM A GENERAL PERSPECTIVE)

The brain is the part of the central nervous system located inside the skull. It has four main parts: the cerebrum, cerebellum, pons, and medulla oblongata.

1.2.1 The Cerebrum:

This is the largest part of the brain’s mass. In general, the function of the brain is related to thought processes and controlling actions. It is divided into two halves or hemispheres: the right hemisphere and the left hemisphere. The hemispheres are composed of a layer of gray matter called the cerebral cortex, and a central mass of white matter. Underneath the cortex, in the longitudinal fissure, lies the corpus callosum. This is a broad, flat bundle of nerve fibers about 10 cm in length that connects the left and right hemispheres. Beneath the corpus callosum is the thalamus and hypothalamus. The hypothalamus is crucial from a functional standpoint because it connects the nervous system with the endocrine system, controlling hormones and metabolism.

1.2.2 The Midbrain (Mesencephalon):

The midbrain lies between the forebrain (cerebral cortex) and hindbrain (including the cerebellum, pons, and medulla oblongata). It connects the front and back parts of the brain and serves important functions in motor movement, especially eye movements, and sensory processing, such as auditory and visual information.

1.2.3 The Cerebellum:

The cerebellum is located in the inferior occipital fossa. Its function is to coordinate voluntary movements such as posture, balance, coordination, and speech.

1.2.4 The Pons:

The pons is located at the upper part of the basilar process. It is linked to vital life functions such as controlling breathing (depth and frequency), regulating the sleep cycle, and contains the origins of several nerves, such as those for chewing, swallowing, and facial expressions.

1.2.5 The Medulla Oblongata

This part of the brain extends from the lower border of the pons to the upper part of the spinal cord. The medulla oblongata controls involuntary functions by regulating breathing, heart rate, and digestion.

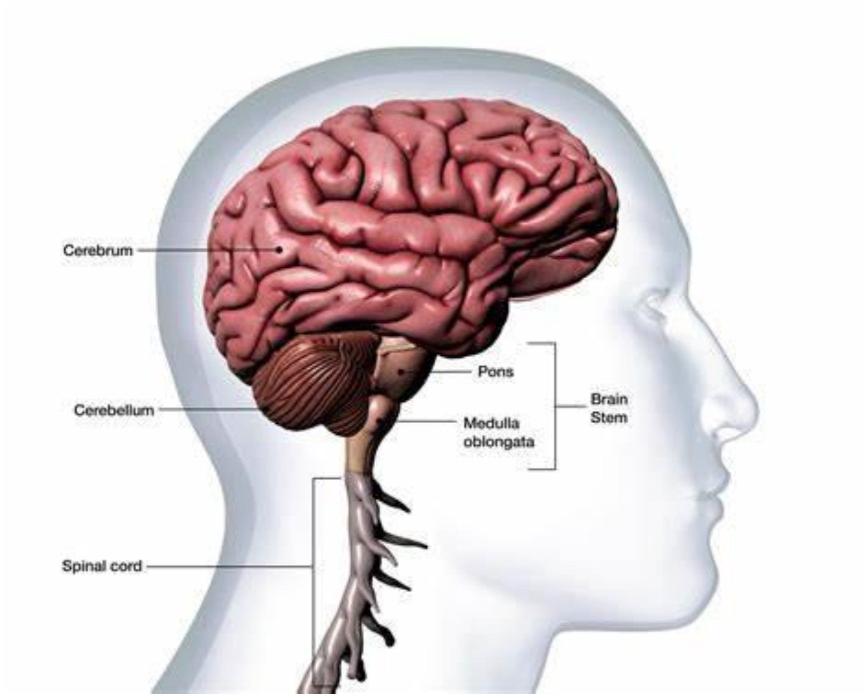


Figure. 3 Anatomy and Division of the Brain, The cerebrum (frontal, parietal, occipital, temporal lobes) and cerebellum, followed by the pons, medulla, and spinal cord. [34]

1.2.6 Meninges of the Brain

The meninges surround the brain and the central nervous system, extending from the brain down to the spine, including the sacrum. Cerebrospinal fluid circulates between the meninges. The three meninges are: dura mater, arachnoid membrane, and pia mater. [12]

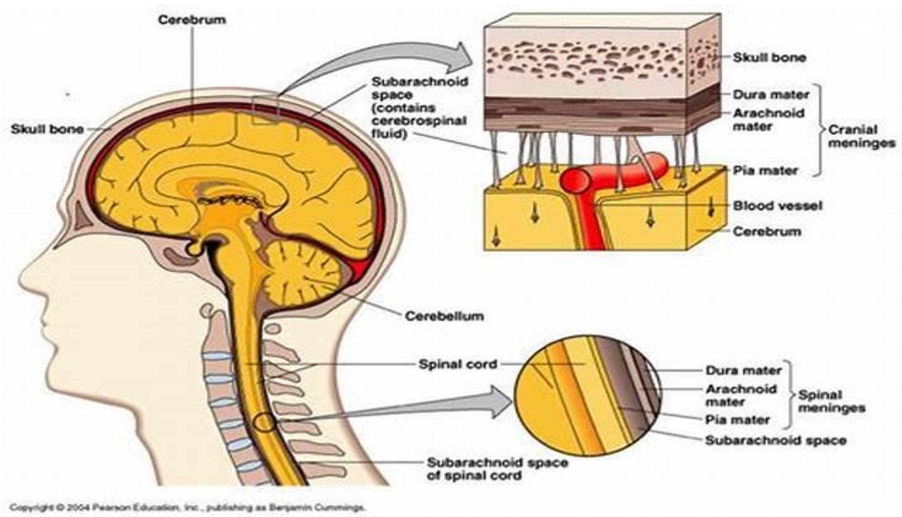


Fig. 4 Anatomical View of the Skull

The above figure shows the anatomical view of the skull, listed in order from the skull (bony part), cranial meninges (dura mater, arachnoid mater, pia mater), blood vessels, and the brain composed of gray matter and white matter. [35]

1.3 KINEMATIC THEORIES OF HEAD INJURIES

Newman (1998) provides a concise description of the principles involved, describing head movement following injury. The most well-known theories of the biomechanics of head injury describe the movement of the head or any of its parts. A skull fracture results from a mechanical action (cutting or tearing) that separates the connected parts of the head. A skull fracture occurs when the skull bone bends more than it is capable of bending. A brain contusion, for example, is a collection of blood caused by the rupture of stretched blood vessels. Separation, bending, and stretching are merely descriptions of different types of movement. Brain injury can occur if a part of the brain is distorted, stretched, compressed, or detached from the inside of the skull. [5]
A blow to the head can cause deformation of the skull, even if it is not fractured. Even if the skull does not bend but moves violently, there can still be damage within the brain. This means that injury occurs due to movement. Movement can be described by the laws of motion. The concept that brain injury is associated with acceleration/deceleration is conceptually quite accurate. However, it should be remembered that acceleration is a kinematic response to some forceful functions (either applied or generated by impact), while injury is a physiological response.

Head injury is a mechanism through which brain damage can occur. However, it has been demonstrated that even without direct impact, the inertial load of the head can lead to brain injury. [6]

1.4 GENERAL MECHANISMS OF CRANIO-CEREBRAL INJURIES IN TRAFFIC ACCIDENTS

The mechanism of cranio-cerebral injury in traffic accidents plays an important role in the accurate and quick diagnosis of traumatic cases.[15]

Below, we present the essential parameters on which conclusions about cranio-cerebral injuries in traffic accidents are based.

1.4.1 Calculation of Speed

In a collision between two objects, each has its own amount of energy. The energy can be calculated by the formula: Energy = 1/2 mass x V, where V is the speed. The speed of the collision is calculated according to the braking distance. Firstly, according to the law of conservation of energy, the kinetic energy lost by the vehicle in the braking process is equal to the work done by friction during braking.

Traffic accidents, based on the type of collision, are divided into:

• Front Collision: In traffic accidents with a frontal collision, the vehicle decelerates at the moment of impact or when it collides with another moving vehicle or an object. The collision most often damages the lower limbs of the driver and passenger if they are wearing seat belts. Meanwhile, rear passengers who are not wearing seat belts suffer greater damage to the upper part of their body. [15]

• Rear Collision: This collision also involves the acceleration of the vehicle. A rear collision (from behind) causes hyperextension of the neck and injuries.

1.4.3 Mechanisms of Injury to Pedestrians in Traffic Accidents.

Pedestrians hit by vehicles or in vehicle-pedestrian accidents suffer severe injuries with a high mortality rate. This is because pedestrians have no protection from the impact. A well-known mechanism for pedestrian

injuries is the Waddle triad, which consists of three phases:

1. Impact on the bumper: Injuries typically occur in the lower limbs.

2. Impact on the vehicle's hood or front windshield: This often results in injuries to the chest and abdomen.
3. Impact with the ground: This most commonly causes head injuries and injuries to the cervical part of the spinal column

1.4.4 Mechanisms of Head Injury

When we talk about the mechanisms of traumatic brain injury, we refer to the cause of the injury and the physiological or structural damage that occurs. There are four main mechanisms of head injury, which include: direct impact, sudden or rapid acceleration and deceleration, penetrating injury, and blast injury.
The exact mechanisms of brain injury may not be fully understood without knowing the cause. Brain injuries can be caused by external forces acting directly on the head or by internal forces transmitted through the head/neck junction. Head movements often result in severe accelerations and large speed changes, which are typically rotational. These sudden movements result in inertial forces acting on the brain tissue, causing stress and deformation throughout the brain.

The impact loading depends on:

1. The location in relation to the point of force application

2. The nature of force distribution

3. The nature of the head movement caused by the forces acting on the head.

One of the deformation mechanisms of brain tissue is the stretching of the brainstem and spinal cord caused by movements produced at the head/neck junction

Furthermore, the sudden movement of the head can also lead to relative movement of the brain or parts of the brain in relation to the skull. These movements can deform brain tissue due to irregular skull surfaces or interaction with the meninges, which link the blood vessels between the brain surface and the skull. Another deformation mechanism of brain tissue is the stretching of the brainstem and spinal cord due to movements produced at the head/neck junction. This movement can occur as a result of any head impact or movement.
Linear and rotational accelerations of the head are assumed to be the main risks for concussion. Direct and inertial loading of the head can result in linear and rotational acceleration of the head.

The acceleration of the head causes tension in the brain tissue, which may lead to injury. Melvin and Lighthall state that an injury will occur if the magnitude of the tissue deformations and strains are sufficient. Therefore, in order to develop accurate predictive criteria for injury, tissue stresses must be linked to dysfunction in physiological processes. A mouse finite element model of the brain shows that this stress correlates well with experimentally observed injuries. Unfortunately, measuring the stress during an impact is nearly impossible, especially in vivo. Later, in 1974, Ommaya and Gennarelli proposed the centripetal theory of concussion. Their hypothesis for cerebral concussion was defined as a classified group of clinical symptoms following a head injury, where the severity of the disturbance in the level and content of consciousness is caused by mechanically induced stresses that affect the brain in centripetal sequences, with destructive effects on function and structure. The effects of this sequence always begin on the brain's surface in mild cases and extend inward to affect the diencephalic- mesencephalic nuclei in more severe trauma cases. Viano proposed a "central" theory for the biomechanics of brain injury. Within this theory, he suggested that "rapid movement of the skull causes displacement of the skull's hard bone structures relative to the soft brain tissue, which lags in movement due to inertia and loose attachment to the skull." The relative displacement between the brain and skull caused by this leads to deformation of brain tissue and stretching of the connecting veins, resulting in damage at the tissue level. However, summarizing previous works, particularly that of Gurdjian, "evidence shows that concussion is caused by the involvement of a specific zone in the brain, primarily the brainstem."

To evaluate the extent of head damage, key indexes in the finite element analysis include intracranial pressure, shear stress, and strain. Additionally, observing the propagation of stress waves in the head, this approach not only helps determine head injury but also has clinical significance in developing mechanisms for intracranial damage.
Since brain tissue and the skull are separated to produce tensile forces, the entire impact process is primarily negative pressure in the early phase, while the maximum negative pressure occurs on the opposite side of the impact. According to research, when the intracranial pressure in an adult's head exceeds 235 kPa, it leads to severe brain damage, which corresponds to situations where the victim suffers serious brain injuries in clinical data.
When the head's motion is suddenly stopped, the skull stops moving, and the frontal bone in the area of impact deforms. The point of impact from the outside is concave, while the internal point is convex. The protuberance of the frontal bone then contacts and impacts the brain tissue. The speed of the brain tissue's movement slows down, and the tissue at the contact point deforms.

Gradual stress increases at the contact area between the frontal lobe and the skull, and the stress transition zone gradually increases and radiates outward. At the same time, the stress wave continues to spread across the brain and decreases in the direction of the impact. There is a wide range of phenomena where stress concentrates in the frontal lobe under the point of impact, with moderate stress increases at the frontal pole. Additionally, the relative movement of the skull and brain causes contact, friction, and impact with the irregular structures at the base of the skull, resulting in high stress in the local area of the skull base, and the stress in the posterior cranial fossa is significantly higher than in other nearby regions. When $t = 6.0$ ms, the maximum von Mises stress in the brain tissue at the impact side is 99.76 kPa. According to Baumgartner's brain injury criterion, when the von Mises stress in the brain tissue exceeds 38 kPa, it will cause severe brain damage, which manifests as the driver's death in the clinic. It can be seen that the simulation results are largely consistent with pedestrian injury in a real accident.

When the shear stress in the brain tissue exceeds 16 kPa, it will lead to moderate diffuse axonal injury (DAI) in the brain tissue, which is shown by brain hemorrhage recorded in the clinical pathological report.
Automobile trauma from a medicolegal perspective refers to the complex mechanical and thermal injuries caused by various parts of the moving vehicle to pedestrians, drivers, and passengers. Traumatic injuries can be caused to pedestrians by impacts from different parts of the vehicle, which may be followed by a fall or collision.
The mechanisms of injury in automobile accidents include: impact, falling, and collision, as well as running over and dragging. Injuries caused to pedestrians by impacts with different vehicle parts may be followed by falling or collision.

1.5 INJURIES FROM FALLING OUT OF THE VEHICLE'S CABIN

Head injuries after falling from the vehicle are accompanied by severe cranio-cerebral damage, with fractures of the skull bones, subarachnoid hemorrhages, and brain contusions, which can be localized at the point of impact or on the opposite side, due to the counter-impaction mechanism. [9]

1.5.1 Injuries Inside the Vehicle Cabin

These injuries to the driver and passengers are diverse and occur due to the following mechanisms:

1. Vehicle rollover and fall from height

2. Collision with other road objects (non-moving)

3. Impact of the moving vehicle with other vehicles from the front, side, or rear

The extent of the injuries depends on the vehicle's speed, the internal parts of the cabin, and the position of the

individuals inside the vehicle. [9]

1.6 FRONT-END VEHICLE COLLISIONS

When a vehicle collides with another vehicle or a stationary object, the phenomenon of deceleration-acceleration occurs, which is followed by inertia-driven movement inside the cabin.
The driver and passengers may hit other objects inside the cabin. Factors that influence this include:

1. The initial position of the driver

2. Body tension with fixation of the hands and legs

3. Inertial movement in the direction of the vehicle's motion

4. Head and limb impact

In the driver, common injuries include: facial, head, and nasal fractures. A hit against the front windshield can cause fractures at the base of the skull, brain contusions, fractures or dislocations of vertebrae, especially cervical vertebrae. [9]

1.7 TRAUMATIC BRAIN INJURIES

A skull fracture occurs when localized trauma breaks the bones of the skull. It may or may not penetrate the brain, as the brain is protected by a layer of tissue called the dura mater. This strong tissue acts as a barrier against traumatic forces, pathogens, and other infections. Head injuries often lead to lacerations of the scalp, which may bleed significantly but do not necessarily affect the brain.

Traumatic brain injuries may occur at deeper levels, and many signs may indicate if the force has actually damaged the brain itself. Blood or cerebrospinal fluid (CSF) leaking from the ears or nose is often a sign of a fractured dura mater.

Concussions are the most common injuries and can result from brain trauma caused by acceleration or deceleration, often due to vehicle accidents, falls, or sports injuries. If these symptoms appear after an accident, immediate medical attention should be sought for potential traumatic brain injury, such as loss of consciousness or bruising around the eyes or ears. [13]

1.7.1 FRACTURES OF THE SKULL BONES

Fractures represent disruptions in the anatomical integrity of the bones, typically as a result of the action of significant mechanical force.

Fractures can be:

1. Closed fractures: when they are not accompanied by damage to the skin and soft tissues.
2. Open fractures: when they are associated with wounds that create communication with the external environment. [9]

In the medico-legal aspect, fractures of the skull have particular importance, and according to the mechanism, they are classified as follows:

LINEAR SKULL FRACTURE: This is the most common type of skull fracture. In a linear fracture, there is a break in the bone, but it does not displace the bone. Most patients with linear skull fractures are asymptomatic and present without loss of consciousness. Swelling occurs at the site of impact, and the skin may be broken[14]

DEPRESSED SKULL FRACTURE: This type of fracture can be seen with or without a cut on the head. In this fracture, a portion of the skull is actually indented from the trauma. This type of skull fracture may require surgical intervention, depending on its severity, to help correct the deformity. Depressed skull fractures result from a direct high-force impact on a small area of the skull with a blunt object, such as a baseball bat. The fracture spreads from the point of maximum impact in a centrifugal direction. Most depressed fractures occur over the fronto- parietal region, as the bone is thinner, and this specific location is vulnerable to an assault. A loose fragment of bone needs to be compressed more than the cranial bones to be clinically significant and require elevation. A depressed fracture can be either open or closed. Open fractures, by definition, have a laceration of the skin or the fracture passes through the paranasal sinuses and the middle ear structures, resulting in communication between the external environment and the cranial cavity. [14]

BASAL SKULL FRACTURE: This is the most serious type of skull fracture and involves a break in the bones at the base of the skull. Patients with this type of fracture often have bruising around the eyes and behind the ears. They may also have clear fluid leaking from their nose or ears due to a tear in a portion of the brain's covering. [14]

TEMPORAL FRACTURE: Fractures of the temporal bones account for 75% of all basal skull fractures. The three subtypes of temporal fractures are longitudinal, transverse, and mixed. A transverse temporal bone fracture is a fracture of the bone across its length. [14]

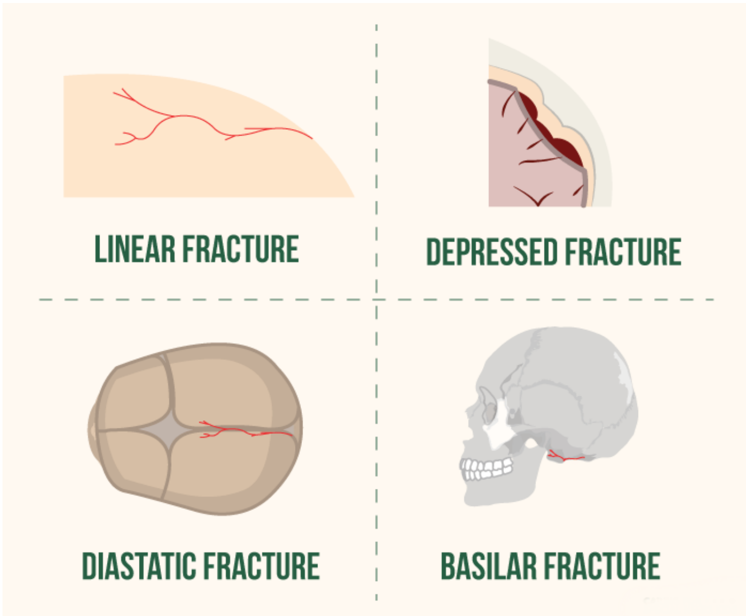


Fig. 5 Types of skull fractures

1.8 HEMORRHAGES OF THE BRAIN'S MEMBRANES

These injuries are typically combined with damage to the brain and skull bones but may also occur alone:

EPIDURAL HEMATOMA: This is a traumatic hemorrhage between the dura mater (the tough outer membrane of the brain) and the inner plate of the skull. It is caused by damage to the arteries in the outer portion of the dura mater, just below the skull. It often involves bleeding and swelling, which result from the accumulation of blood between the brain and the dural layer. This injury may be indicated by loss of consciousness, headache, bleeding, and even pupil dilation. [8]

SUBDURAL HEMATOMA: This is another layer below, which involves the rupture of veins beneath the dural layer, which extend deeper into the brain. This blood accumulation is essentially a bruise inside the brain. Symptoms of brain injury appear much more slowly and usually become apparent within 48 hours of the trauma. Indications of this type of injury include problems with consciousness that did not exist previously, headaches, and even seizures.

These symptoms develop slowly but are more severe if not controlled. [8]

SUBARACHNOID HEMORRHAGE: This occurs when there is bleeding within the actual brain tissue. It results in significant loss of consciousness, headaches, and what is referred to as intracranial pressure. Essentially, blood fills the internal brain tissue, causing pressure and damaging vital tissue necessary for brain function. [8]

INTRAVENTRICULAR HEMORRHAGE (IVH): Also known as intraventricular bleeding, it is a hemorrhage within the brain's ventricular system, where cerebrospinal fluid is produced and circulates toward the supracnoidal space. It can result from physical trauma or from a hemorrhagic stroke. However, 70% of IVH cases are secondary in nature, occurring as a result of an extension of an existing intraparenchymal or subarachnoid hemorrhage. Intraventricular hemorrhage occurs in 35% of cases with traumatic brain injury, from moderate to severe cases.

Thus, hemorrhage does not occur without significant associated damage, and the outcome is rarely favorable. Focal neurological signs are either minimal or absent, but focal and/or generalized seizures may occur. [31]

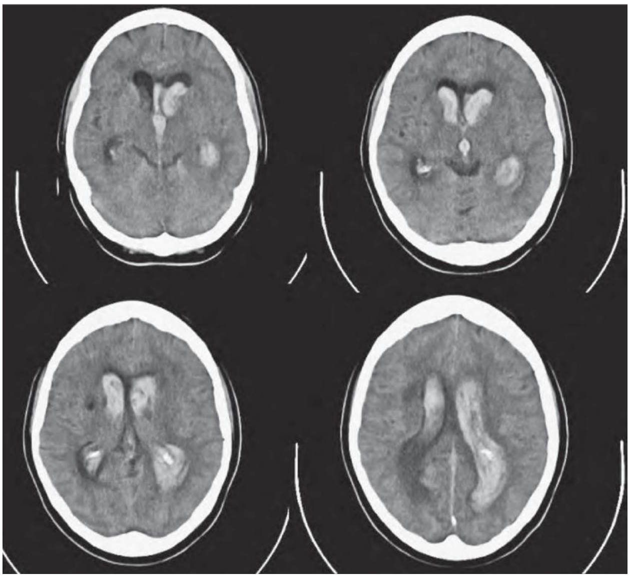


Fig. 6 Intraventricular Hematoma

1.9 TYPES OF BRAIN INJURIES.

There are three main types of injuries that can result from external forces, including:
1. Diffuse axonal injury

2. Focal contusions

3. Hematoma or hemorrhage inside or around the brain

Brain injuries are consequences of head trauma. They can be functional (concussion) or organic (brain contusion).

1.9.1 CONCUSSION (BRAIN SHAKING).

Concussion is the mildest type of cranio-cerebral injury, causing only retrograde amnesia following the injury.
Loss of consciousness at the time of impact is caused by the acceleration-deceleration movement of the head, which results in the stretching of axons by pulling forces. When the alteration in consciousness is brief, the term "concussion" is used. The mechanism by which concussion leads to loss of consciousness is believed to be the temporary functional disruption of the reticular activating system, caused by rotational forces in the upper brainstem. Most patients with consciousness have normal findings on CT scans because concussion results from physiological damage rather than structural damage to the brain. [9]

The main sign is loss of consciousness lasting from a few minutes to several hours. In severe forms, the patient may have loss of consciousness, sensitivity, dilated pupils that do not react to light, irregular breathing, and a slow pulse. The body may be covered with sweat, and sometimes death occurs on the first day. If death does not occur, post-concussion syndrome appears, characterized by headaches, dizziness, memory impairment, and attention deficits.

Concussion may present in the mild form, where the loss of consciousness lasts briefly, from a few seconds to half an hour, and the patient's condition improves quickly; in the moderate form, where the loss of consciousness lasts longer; and in the severe form, where the loss of consciousness lasts several days.

1.9.2 BRAIN CONTUSION

Contusion is a skin lesion without a wound. It is the result of a blow, fall, or trauma. It is caused by blows to the head, with or without damage to soft tissues and bones, and is characterized by hemorrhagic areas in the white matter, cerebral cortex, or subcortical nuclei. Head injuries correspond to the area of the head where the blow was delivered but are often also found in the opposite region. This mechanism also explains the hemorrhages in the central parts of the brain. [9]

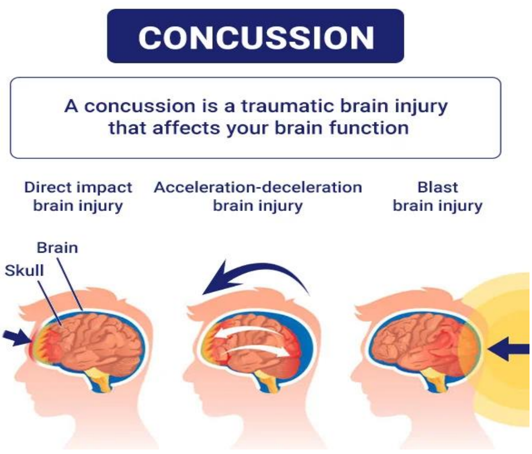


Fig. 6 Brain Contusion

1.9.3 DIFFUSE NEURONAL AND AXONAL INJURY (DAI)

Another type of brain injury is diffuse neuronal and axonal injury, which includes four types of damage: diffuse damage to blood vessels, diffuse damage to axons and brain cells, hypoxic damage to the brain, and diffuse cerebral edema. [9] The term DAI is used for traumatic comas lasting more than 6 hours. A coma lasting 6 to 24

hours is considered mild DAI, while a coma lasting more than 24 hours is referred to as moderate to severe DAI, depending on the presence or absence of signs of brainstem damage, such as decerebrate or decorticate posturing. Patients may remain unconscious for days, months, or years, and those who recover may suffer from severe cognitive and motor impairments. [20]

1.9.4 CEREBRAL EDEMA

Cerebral edema occurs for two reasons: an increase in blood volume within the blood vessels of the brain as a result of vasodilation, or the other reason is the accumulation of water in the brain tissue. In autopsy, cerebral edema is characterized by tension in the dura mater, swelling of the brain tissue, flattened and pale cerebral gyri. [9]

1.9.5 CRANIAL NERVE INJURY

Cranial nerve injury is a common complication of fractures at the base of the skull. The facial nerve is the most commonly injured in these cases, complicating 0.3% to 5% of all head injuries. In some cases, paralysis may not develop until days after the injury. Partial or complete recovery of function is the norm in traumatic cranial nerve injuries, with the exception of the first or second cranial nerves. [20]

1.10 GLASGOW COMA SCALE

The Glasgow Coma Scale (GCS) is a 15-point scale for assessing and categorizing the outcomes of brain injury. The test measures:

I. Motor response

II. Verbal response

III. Eye opening response

with the following values:

I. Motor Response

6 - Follows commands fully

5 - Localizes painful stimuli

4 - Normal flexion, withdraws from painful stimuli

3 - Abnormal flexion, indicating decerebrate posturing

2 - Extension response, indicating decerebrate posturing

1 - No response

II. Verbal Response

5 - Alert and oriented

4 - Confused speech, but coherent

3 - Incomprehensible words

2 - Sounds

1 - No sounds

III. Eye Opening

4 - Spontaneous eye opening

3 - Eye opening in response to voice

2 - Eye opening in response to pressure

1 - No eye opening

The final score is determined by adding the values from I + II + III. [22]

2. PURPOSE OF THE PAPER

The purpose of this paper is:

1. To explain the mechanisms of causing craniocephalic injuries in traffic accidents.
2. To analyze the data on methods of the progression of craniocephalic injuries.
3. To identify craniocephalic injuries resulting from traffic accidents, based on

medical reports from the “Prim Dr. Daut Mustafa” General Regional Hospital in Prizren for a one-year period and comparison between two years.

3. MATERIALS AND METHODS

This retrospective study was conducted at the Prizren Regional Hospital, specifically in the Emergency Clinic.

The subject of the research consists of traffic accident cases with craniocephalic injuries from the protocols of the Emergency Clinic for the period of January 2020 to January 2021, as well as a comparison with the years 2021-2022.

The materials are presented in tabular and graphic form.

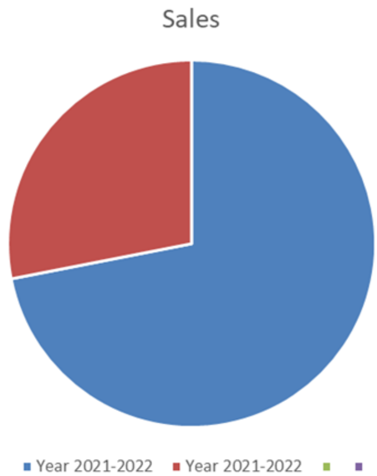
4. RESULTS

For the period from January 2020 to January 2021, a total of 1189 traffic accidents were recorded in the

Emergency Clinic of the Prizren Regional Hospital, with 310 cases of craniocephalic injuries.

During the year 2020-2021, the number of traffic accidents was 1189. During the 2021-2022 period, the number

of traffic accidents increased to 1877. Therefore, there was a lower number in comparison to the following year.

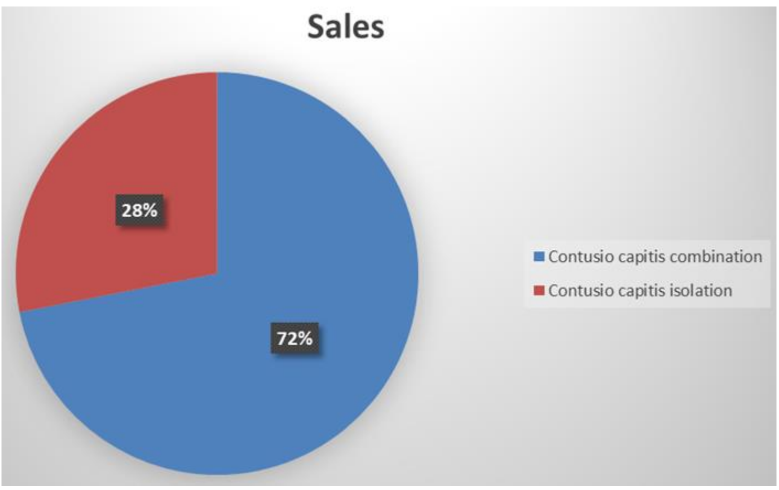


Graph 1: Graphic presentation of injuries in 2020-2021 and 2021-2022

Out of the 310 accident cases:

• 73 were isolated head injuries (“contusio capitis”)

• 237 cases were combined head injuries (“contusio capitis”) with other injuries such as contusio thoracis, distorsio colli, dislocation of the upper limbs, distorsio vertebra, etc.

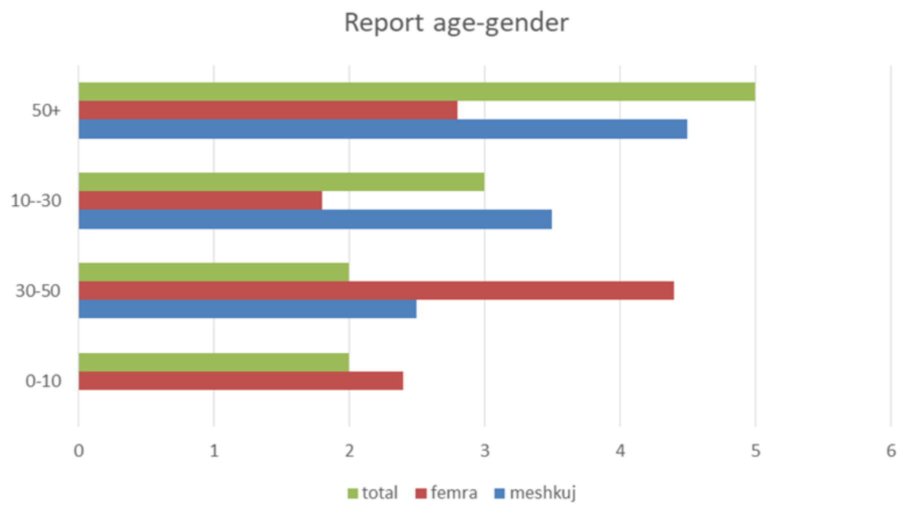


Graph 2: Graphic presentation of craniocephalic injuries sustained in traffic accidents for the period January 2020 - January 2021

The study also analyzed the age and gender of the injured individuals. Out of the 310 injured:

• 200 were male

• 110 were female



Graph 3: Craniocephalic accidents by age-gender report

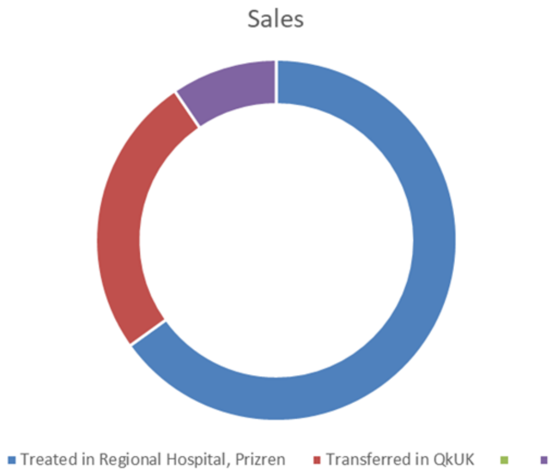
Regarding age:

- 24 cases were aged 0-10
- 121 cases were aged 10-30
- 135 cases were aged 30-50
- 30 cases were aged 50+

Out of the 310 accidents, 27 were polytrauma cases involving injuries to the chest, spinal cord, and multiple fractures. The number of cases transferred to the University Clinical Center of Kosovo (QKUK) included craniocephalic injuries along with injuries to other systems.

TABLE I ACCIDENTS BY GENDER AND AGE

Age	0-10	10-30	30-50	50+	Total
Male	10	90	70	26	196
Female	14	31	65	14	114
Total	24	121	135	40	310



Graph 4: Accidents transferred to QKUK

Out of the 310 traffic accidents with craniocephalic injuries, 10 cases ended in fatalities

5. DISCUSSION

For the period from January 2020 to January 2021, at the Prizren Regional Hospital, 257 cases of traffic accidents with craniocephalic injuries were caused by accidents between two circulating vehicles, and 57 cases

were accidents between a vehicle and a pedestrian. When discussing the seriousness of the injuries, it depended on the speed of the vehicle; 150 cases were superficial head injuries or contusions.

According to the data, the injured individuals were transported via emergency vehicles or individual means to the emergency department and then processed based on the patient's parameters. All cases underwent cranial imaging (CT scan of the head), followed by long-term treatment assignment.

According to the protocol, in traumatic patients, parameters such as consciousness (hemodynamic status), neuromuscular deficits, external examination of the injured person, radiography for suspected skeletal system injuries are evaluated. Pathognomonic signs include: periorbital hematomas resembling "sunglasses," pupil dilation, and anisocoria (a sign of bleeding on the opposite side of the dilated pupil), hemorrhages. Initially, unresponsive or very slow-reacting pupils indicate brainstem damage. The primary evaluation focuses on identifying life-threatening conditions such as loss of consciousness. Loss of consciousness can be categorized into three levels:

• First level: Loss of consciousness lasts usually 1 or 2 minutes.

• Second level: Loss of consciousness lasts slightly longer.

• Third and fourth levels: When the patient remains unconscious for 30 minutes or more.

The longer the loss of consciousness, the more irreversible the brain damage becomes. In cases of brain hemorrhage with increased intracranial pressure, emergency surgery is often required. Blood vessels may also be damaged, leading to hematomas or hemorrhages, causing increased intracranial pressure. This may cause the brain to expand, raise blood pressure, and disrupt blood and oxygen supply to other parts, leading to irreversible damage, which can result in death.

Cardiopulmonary resuscitation (CPR) in craniocephalic injuries generally aims at the early rehabilitation of the central nervous system. For this reason, CPR is also called Cerebral Cardiopulmonary Resuscitation (CPR) because all measures aim to stabilize the central nervous system, which is more sensitive to oxygen deprivation compared to other tissues.

In cases of mild hemodynamically stable injuries, patients are observed, the Glasgow Coma Scale is monitored, and examinations are conducted based on immediate evaluation. In cases of altered consciousness, patients are treated with immediate therapy, one to two venous lines are placed, airway management is secured, urinary catheterization is performed, and visible fractures (in polytrauma cases) are immobilized. The patients are then transported to the radiology department. Craniography is recommended immediately after head trauma and is included in the protocol for all head injuries or traumas. A CT scan is especially recommended when the

anamnesis indicates fatal outcomes in the involved vehicle, suggesting a severe accident. However, it is recommended after trauma and when the patient does not present physical signs suggesting severe injuries.

The evaluation continues with magnetic resonance imaging (MRI) if internal bleeding is suspected. For neck injuries, neck collars are used. For vertebral injuries, radiographs of the vertebrae are taken. Depending on other injuries, additional examinations are performed, such as nasal craniogram, nasal radiography, chest X-ray, and X-ray of the abdomen, etc.

At the Prizren Regional Hospital, 80% of cases were treated using the following medications:

0.9% NaCl solution (100 ml), Diclofenac (IM), Dexamethasone (IM), Ranitidine (IV), Mannitol (anti-edematous) for edema (IV), and Clometol (IV).

In cases with other injuries, medications like Musculoflex (capsule), Ibutop (gel), and Ketanol (amp) were also used.

In the study, 27 polytrauma cases were transferred to the University Clinical Center of Kosovo (QKUK) for further processing. 17 cases with craniocephalic injuries were sent to intensive care.

Early intensive treatment helps prevent secondary damage. In this way, all functional deficits that may remain after trauma or post-traumatic complications are properly addressed. This period can last from one week to several months, depending on the patient's condition. Head trauma is a common cause of death and disability. There have been improvements in outcomes for those with moderate and severe head injuries, but those with mild or moderate trauma still present significant diagnostic and therapeutic challenges. Traumatic brain injuries

are a leading cause of death and disability among people in their first four decades of life. The National Center for Injury Prevention and Control estimates that 53,000 people die each year from various injuries. Diagnosing trauma typically relies on clinical evaluation by a healthcare provider.

Traumatic brain injury (TBI) affects millions of Americans annually. In 2017, traumatic brain injuries contributed to 61,131 deaths in the United States, accounting for 2.2% of approximately 2.8 million deaths that year. The leading causes of TBI-related deaths included unintentional vehicle crashes, accidental falls, and homicides.

The average age of individuals who experience traumatic brain injuries is increasing, and falls have now surpassed road traffic accidents as the leading cause of these injuries. In 30% of craniocephalic injury cases involving vehicles, the majority were older individuals. Younger drivers are at higher risk due to their risky behavior and lack of experience compared to older drivers.

According to the study by Matthew Brumbelow and David S. Zuby, among injured passengers due to the braking system, the greatest disparity in injury distribution occurred in the head and chest areas. Individuals under 30 years old suffered more serious head injuries, while those 60 years and older experienced the opposite.

This translation has been formatted for use in Microsoft Word. You can copy it and make any additional adjustments or formatting changes as needed in Word.

6. CONCLUSION

This study explains that the primary approach to wounded patients, the quick determination of the diagnosis, and the earliest start to therapy all depend on knowledge of the mechanisms generating craniocerebral injuries. Between January 2020 and January 2021, all cases of accidents involving craniocerebral injuries were presented and treated in the outpatient setting at the regional hospital in Prizren. QKUK-Pristina has been given polytrauma cases. All instances received standard care, including craniography, as well as analgesics and physiological treatments. According to research conducted at the regional hospital in Prizren, a sizable portion of incidents resulting in craniocerebral injuries pose a major threat to life, particularly if they are also accompanied by injuries to other systems.

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