Traumatic Head Injury

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Introduction

- One of the most frequent neurological problems requiring medical care and rehabilitation is generalized brain injury, which can result from trauma or anoxia (e.g., from near drowning, exposure to gas, or attempted suicide). we focus on traumatic brain injury (TBI), recognizing that brain injury caused by anoxia can result in similar clinical consequences.

Head Injuries

I. Scalp wounds.
II. Skull fractures.
III. Traumatic brain injury

Head Injuries

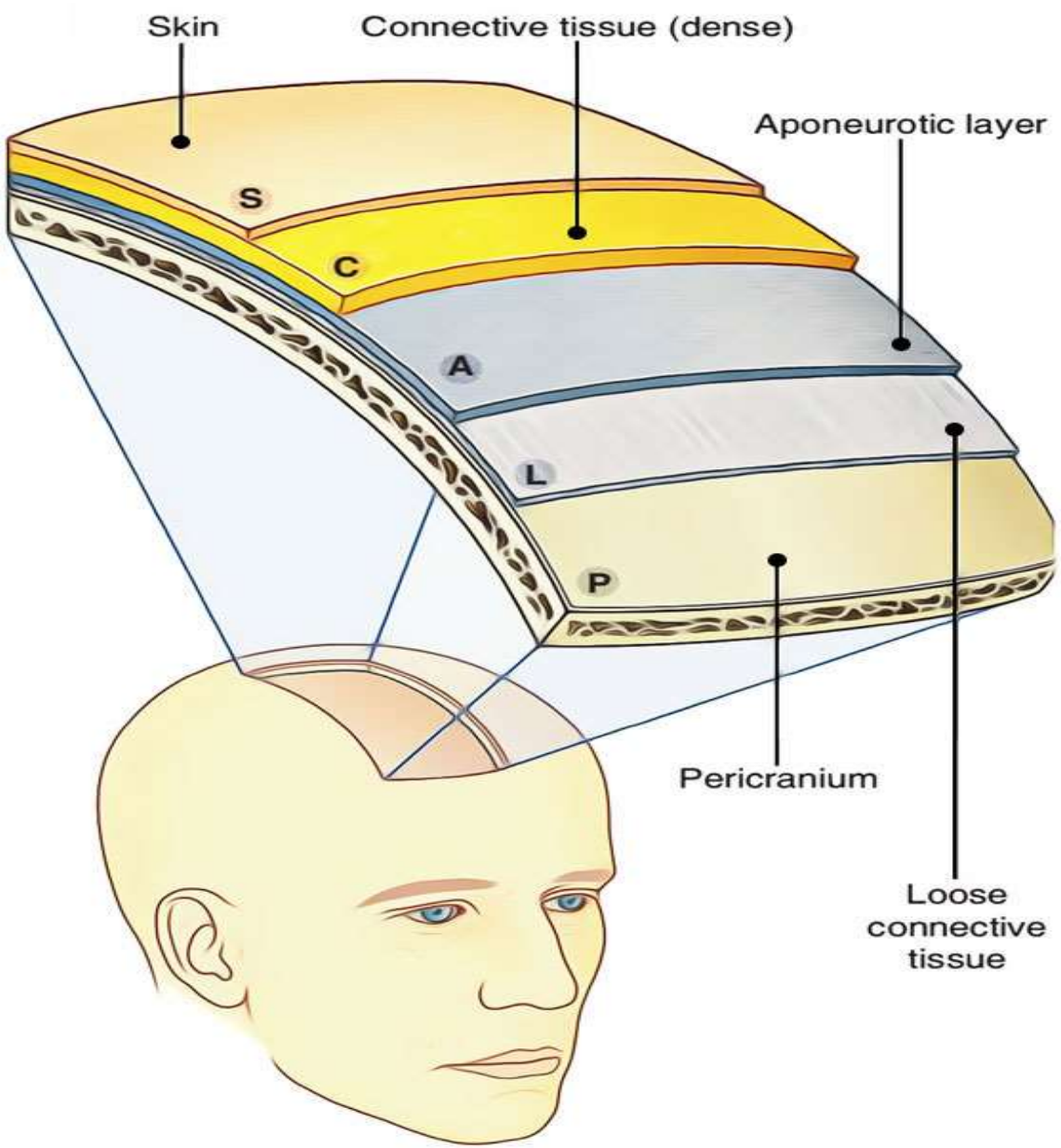
I. Closed Head injuries:

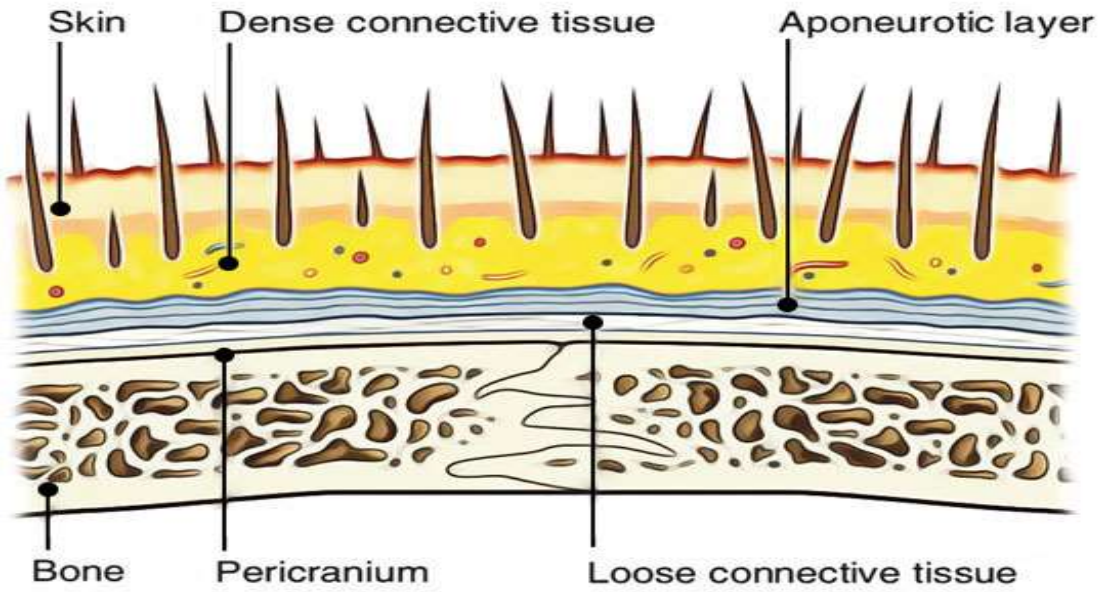
A closed head injury is where the dura mater remains intact e.g. non- missile injuries.

II. Penetrating head injuries:

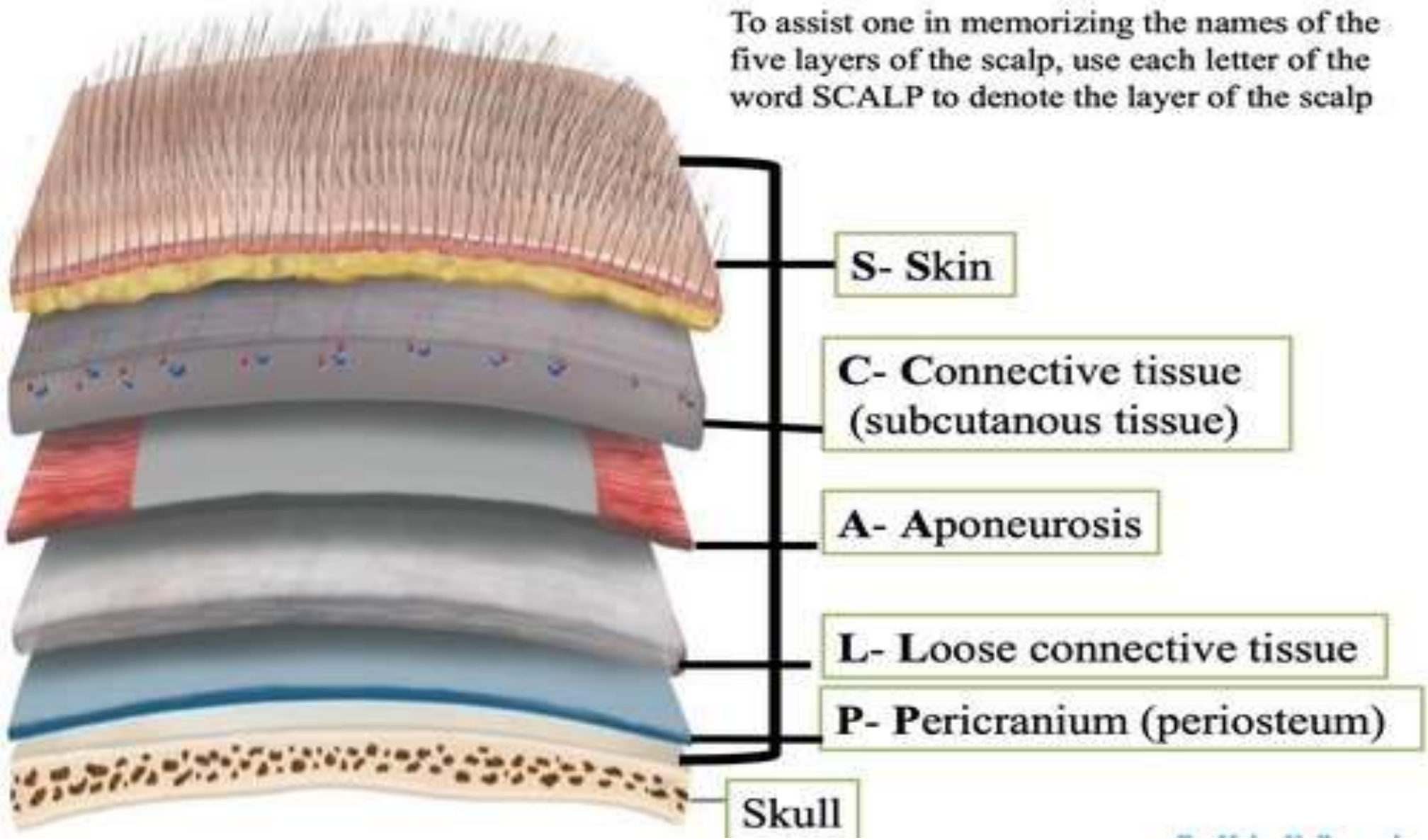
A penetrating head injury occurs when an object pierces the skull and breaches the dura mater e.g. missile injuries.

SCALP

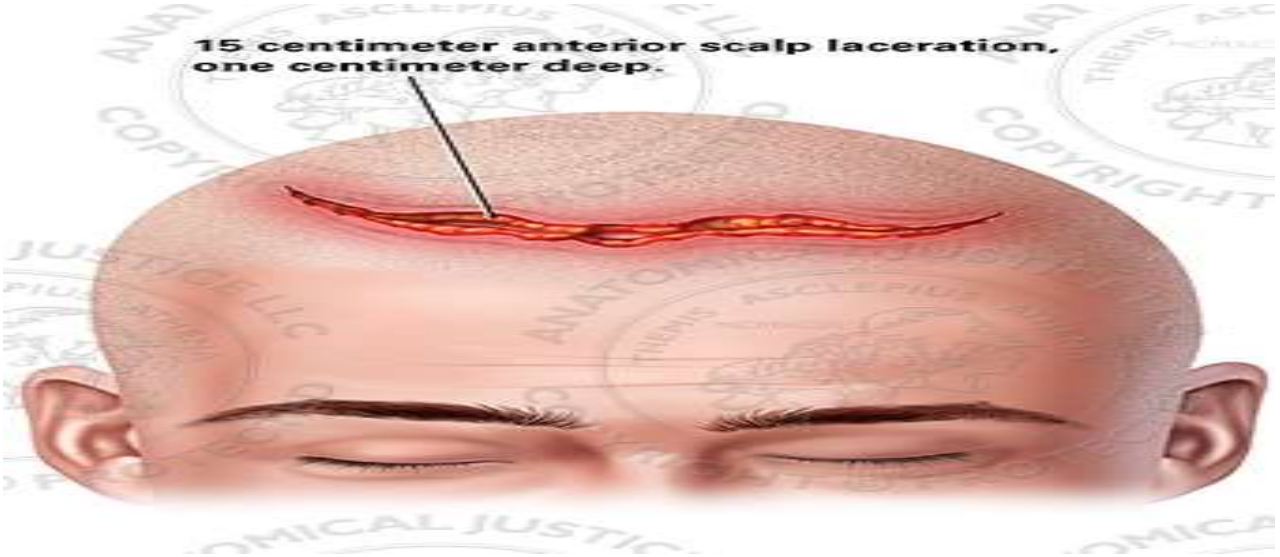

Skin
Connective tissue (dense)
Aponeurotic layer
S
C
A
L
P
Pericranium
Loose connective tissue


Skin
Dense connective tissue
Aponeurotic layer
Bone
Pericranium
Loose connective tissue

To assist one in memorizing the names of the five layers of the scalp, use each letter of the word SCALP to denote the layer of the scalp



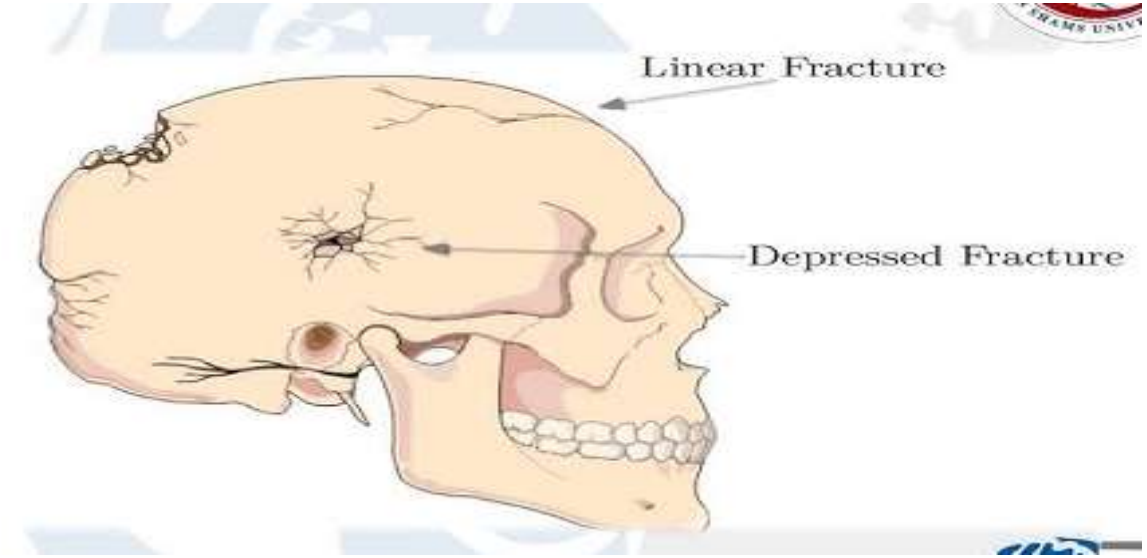
I-Scalp Wounds.

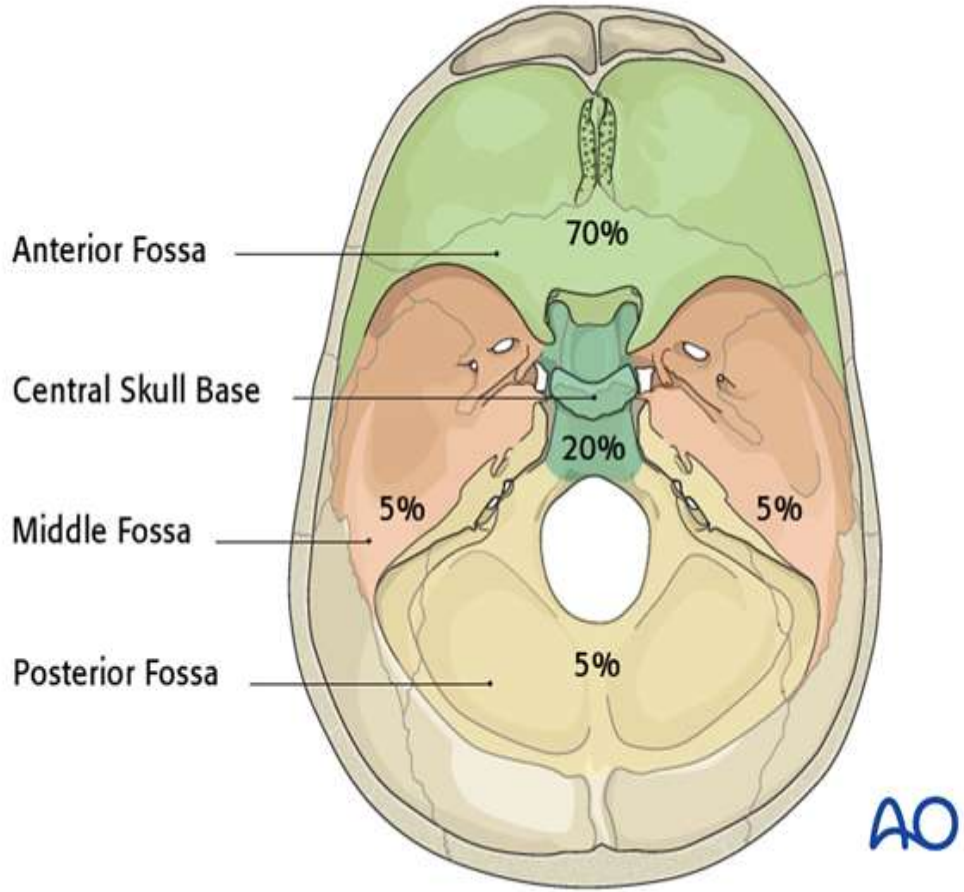


- Usually lacerated wound.
- Profuse bleeding.
- Good healing.
- Low incidence of infection.
- Excessive bleeding may lead to hypovolemic shock in pediatrics >>>CBC (anemia) .
- Tight bandage usually controls the bleeding.
- (Cephal/scalp hematoma):Maybe subcutaneous or subgaleal (moves freely under the skin) or subperiosteal (restricted by the sutures).

II-Skull fracture

- Skull vault fracture.
- Skull Base Fracture



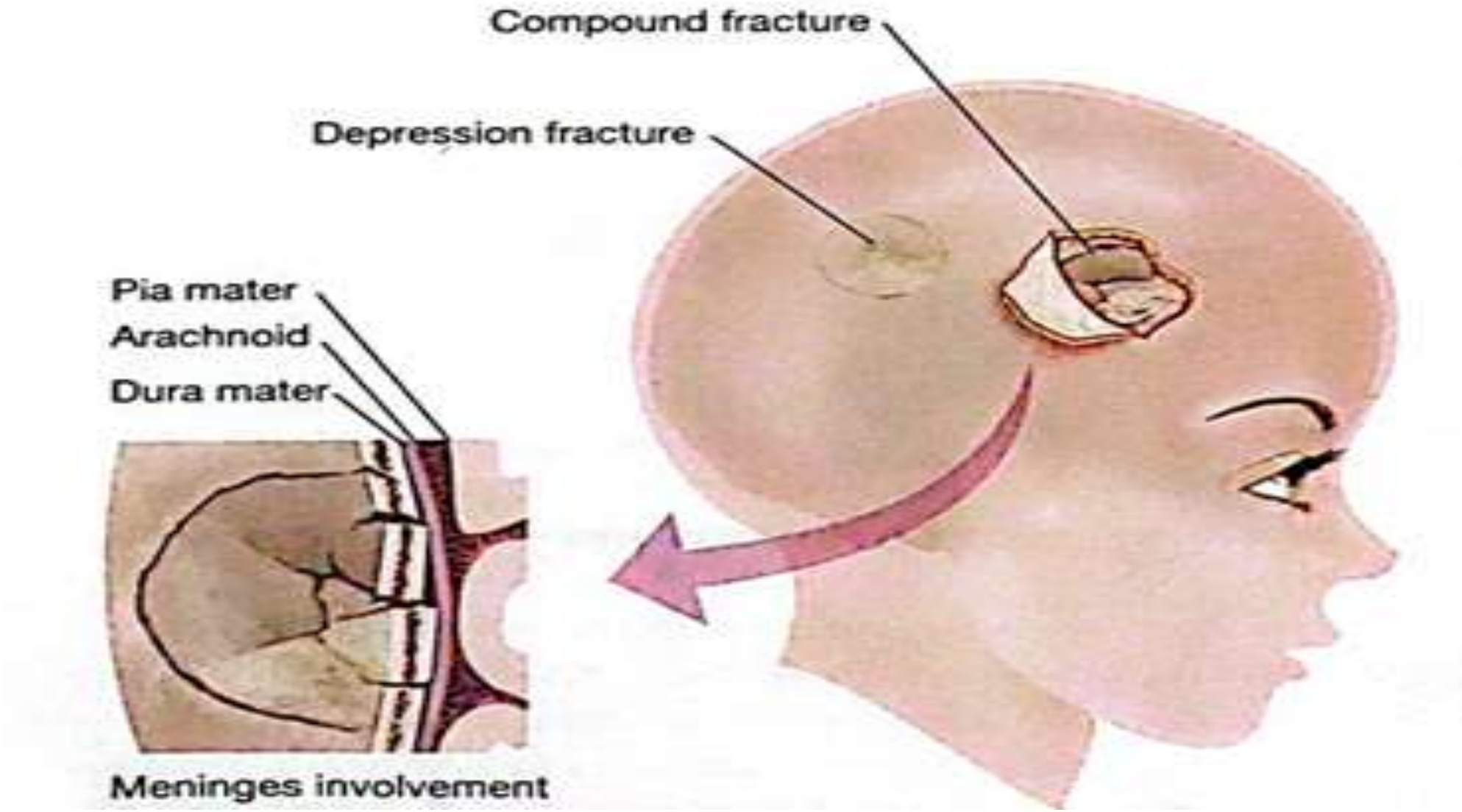


Skull vault fracture.

1. **Linear (fissure) fracture:** conservative treatment and follow up (12/24 h) as long as no underlying hematoma If level of consciousness decrease >>> CT.
2. **Depressed fracture:** includes simple and compound

a. **Simple (closed) depressed fracture:** without external wound >>> no infection. conservative Treatment unless there is severe depression and cosmetic deformity (elevation of depressed bone).

b. **Compound (open) depressed fracture:** with external wound & comminuted bone fragment >>> infection >>> surgical treatment.


Compound fracture
Depression fracture
Pia mater
Arachnoid
Dura mater
Meninges involvement

Skull Base Fracture

- Diagnosed clinically.
- Conservative TTT.

I. Anterior cranial fossa basal fracture.

II. Middle cranial fossa basal fracture.

III. Posterior cranial fossa basal fracture

I. Anterior cranial fossa basal fracture

- **Clinical features**

a) Epistaxis

b) CSF rhinorrhea CSF leak from nose

c) Raccoon's (black) eyes (subconjunctival hemorrhage and periorbital hematoma).

d) Olfactory nerve affection & may optic nerve affection.

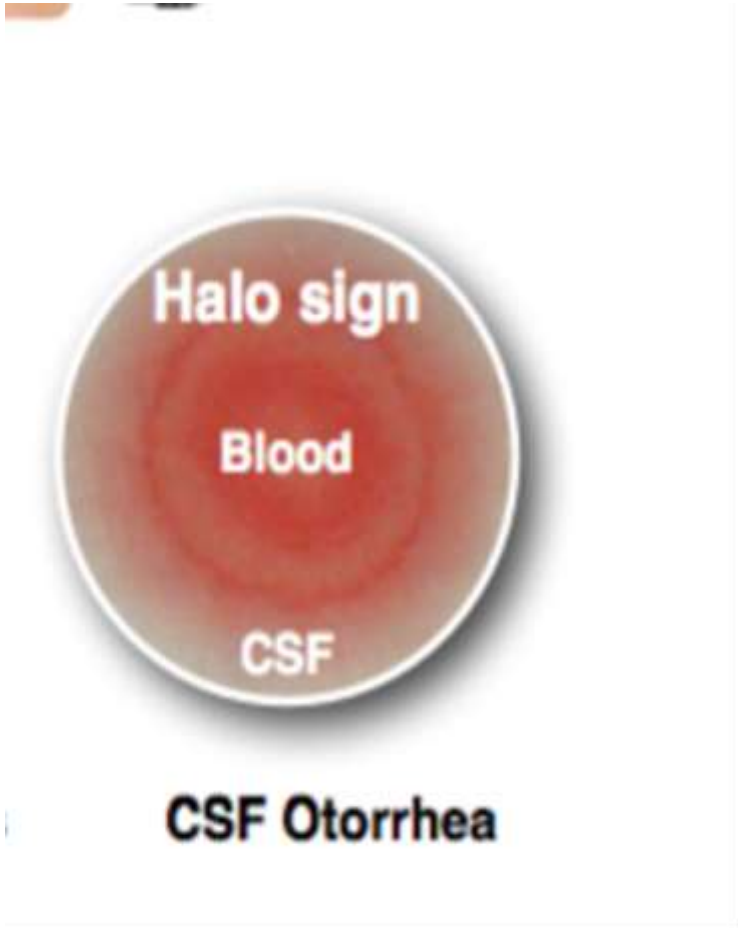
II. Middle cranial fossa basal fracture

- **<u>Clinical features</u>**

a) Bleeding per ear.

b) CSF otorrhea → CSF leak from .

c) Affection of 7th and/or 8th cranial nerves.



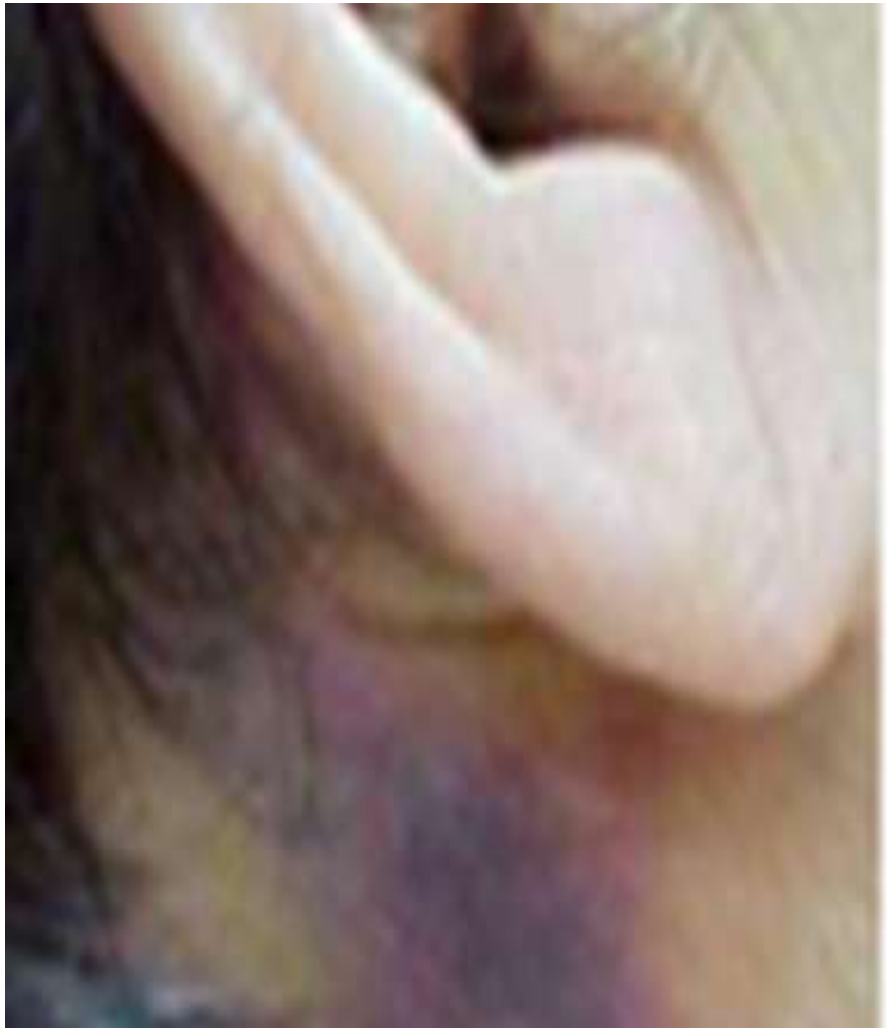
III. Posterior cranial fossa basal fracture

- **Clinical features**

a) Battle's sign (bluish color behind the ear).

b) Brain stem affection.

c) Atlanto-axial subluxation(cranio-cephalic sublaxation)



Traumatic Brain Injury(TBI)

- **Definition** :An insult to the brain, not of degenerative or congenital nature caused by an external physical force that may produce a diminished or altered state of consciousness, which results in an impairment of cognitive abilities or physical functioning. It can also result in the disturbance of behavioral or emotional functioning.
- Traumatic head injury results from a blow to the head: either a rapidly moving object striking the stationary head or the rapidly moving head being flung against a hard, immobile surface.

Causes of TBI

- the most common causes of TBI are:

✓ accidents (e.g., automobile, falls, sports related).

✓violence and abuse.

✓Blast injuries.

- **Males** are **more** likely to sustain a TBI than are **females**.
- Among young adults, common causes of TBI include car accidents, sports injuries, and violence.
- falls (resulting in subdural hematomas) are a common cause of TBI among elderly individuals.
- Child abuse is the most common cause of TBI in infants.
- Suicide attempts are among the common causes of violent injuries.

Primary traumatic brain injury: refers to brain damage from direct trauma to the brain tissue, which may result in bleeding, tearing, shearing, or neuronal damage. Primary TBIs may be diffuse or focal.

a) **Diffuse primary TBIs:**

1. Concussion
2. Diffuse axonal injury (**DAI**)

b) **Focal primary TBIs:**

1. Brain contusions
2. Intracranial hematomas
3. Brain herniation

Secondary traumatic brain injury: refers to brain damage secondary to:

1. Systemic changes e.g. hypotension, hypoxia, fever, dehydration, and electrolyte imbalances
2. Brain ischemia due to reduced cerebral blood flow and hence reduced cerebral perfusion pressure
3. Disruption of blood brain barrier (**BBB**) causing electrolyte disturbances, vasogenic edema, and cytotoxic edema
4. Excitotoxicity due to accumulation of excitatory neurotransmitters
5. Brain edema and increased intracranial pressure (**ICP**), which can lead to brain herniation
6. Increased electrical brain discharges causing seizures

7. **Secondary**: to increase ICP, hydrocephalus, reduced cerebral blood flow, ischemia of the brai brain edema, seizures

Cerebral Concussion

- One of the consequences of mild or severe head trauma.
- an immediate, reversible, trauma-induced impairment of neurologic function lasting seconds, minutes, hours, or days.
- If the patient is comatose, the duration of unconsciousness is the most reliable indicator of the severity of the concussive injury.
- Additional **symptoms** >>> headache, dizziness, confusion, disorientation, amnesia, and visual disturbances.
- **CT** and **MRI** scans do not show any obvious fracture or hematoma.

Diffuse Axonal Injury(DAI)

- Brain tissues that differ in structure or weight experience unequal acceleration, deceleration, or rotation of tissues during rapid head movement or during impact, causing diffuse axonal injury and changes in chemical processing.
- Severe >>> coma.
- mild >>> memory loss, concentration difficulties, decreased attention span, headaches, sleep disturbances, and seizures.
- Damage often involves the corpus callosum, basal ganglia, brain stem, and cerebellum.
- Diffusion tensor imaging, a new radiological technique, has been used to demonstrate axonal damage.

Cerebral Contusion

- A bruise or bleeding on the brain and lacerations can occur with or without skull fractures. Either an object hits the head, neck, or face, or the head hits an object. Damage can be to any area of the brain.

Brain Herniation

- Uncal herniation.
- Central transtentorial herniation.
- cingulate herniation.
- Upward cerebellar trans tentorial herniation.
- Tonsillar (downward cerebellar) (transforaminal) herniation.

Intracranial Hematomas

- depends on the relationship of the hematoma to the dura and brain:

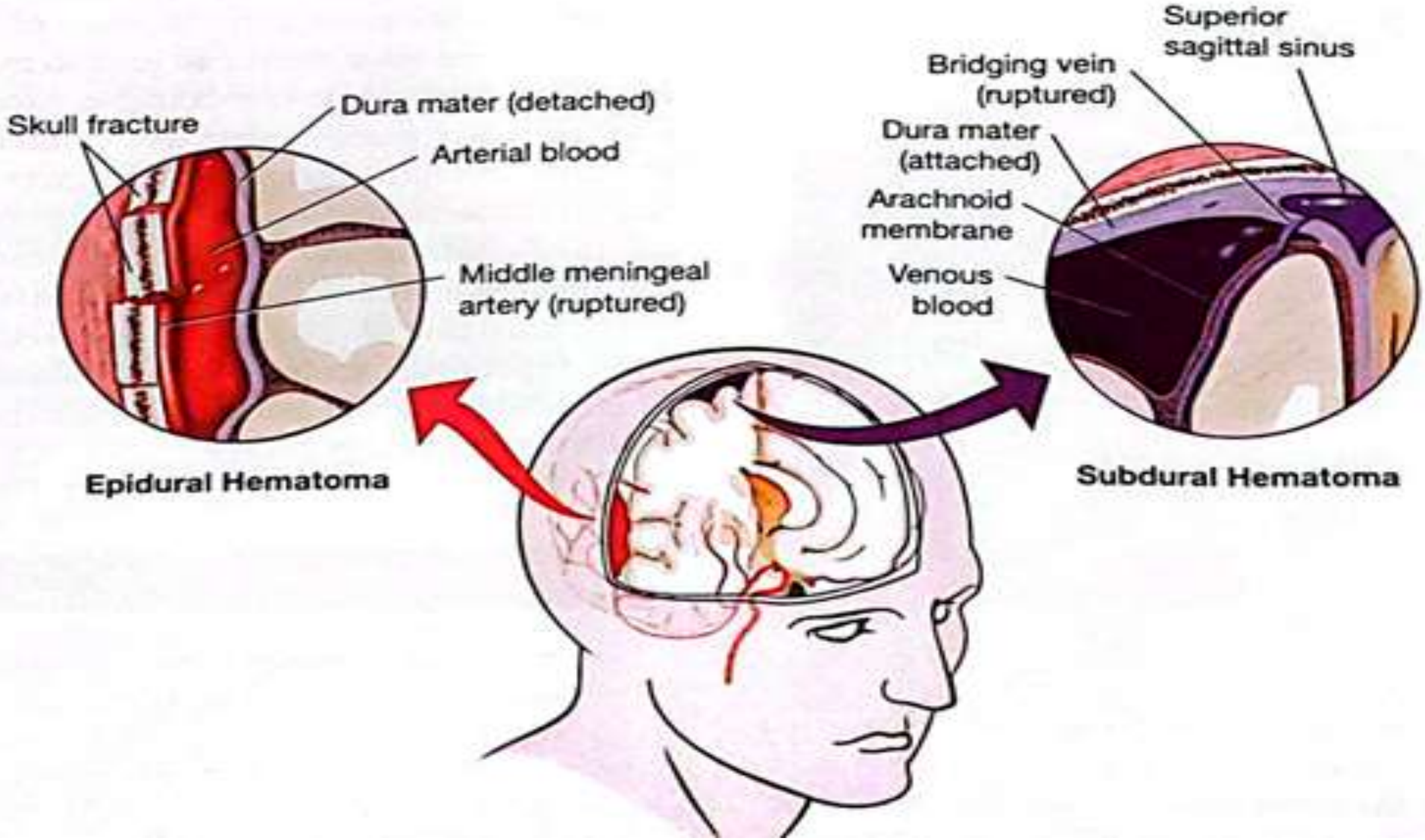
✓Extradural.

✓Subdural(acute/subacute/chronic).

✓ Intracerebral.

✓subarachnoid .

✓Intraventricular.


Skull fracture
Dura mater (detached)
Arterial blood
Middle meningeal artery (ruptured)
Epidural Hematoma
Superior sagittal sinus
Bridging vein (ruptured)
Dura mater (attached)
Arachnoid membrane
Venous blood
Subdural Hematoma

Extradural /Epidural Hematoma

- Bleeding into the extradural space (between the dura and cranium)
- Top emergency in head trauma.
- Occur due to **trauma** or spontaneous(rare).
- Extradural hematomas are more likely to occur in the younger age group as the dura is able to strip more readily off the underlying bone but in old age dura is held with inner table of bone.

- Most commonly, this results from a skull fracture of the **temporal bone** that extends across the grooves containing branches of the **middle meningeal artery**, thereby tearing the artery. The arteries that can be affected are those that lie between the dural membranes (osseous and membranous). These membranes are held very tightly together. When the fracture occurs, there are often no clinical findings (referred to as a "**lucid interval**" because the membrane sequesters the bleeding >>> **CT.**

- In these patients the most important symptoms are:

✓Headache.

✓Deteriorating conscious state.

✓Focal neurological signs (dilating pupil, hemiparesis).

✓Change in vital signs (hypertension, bradycardia).

Subdural Hematomas

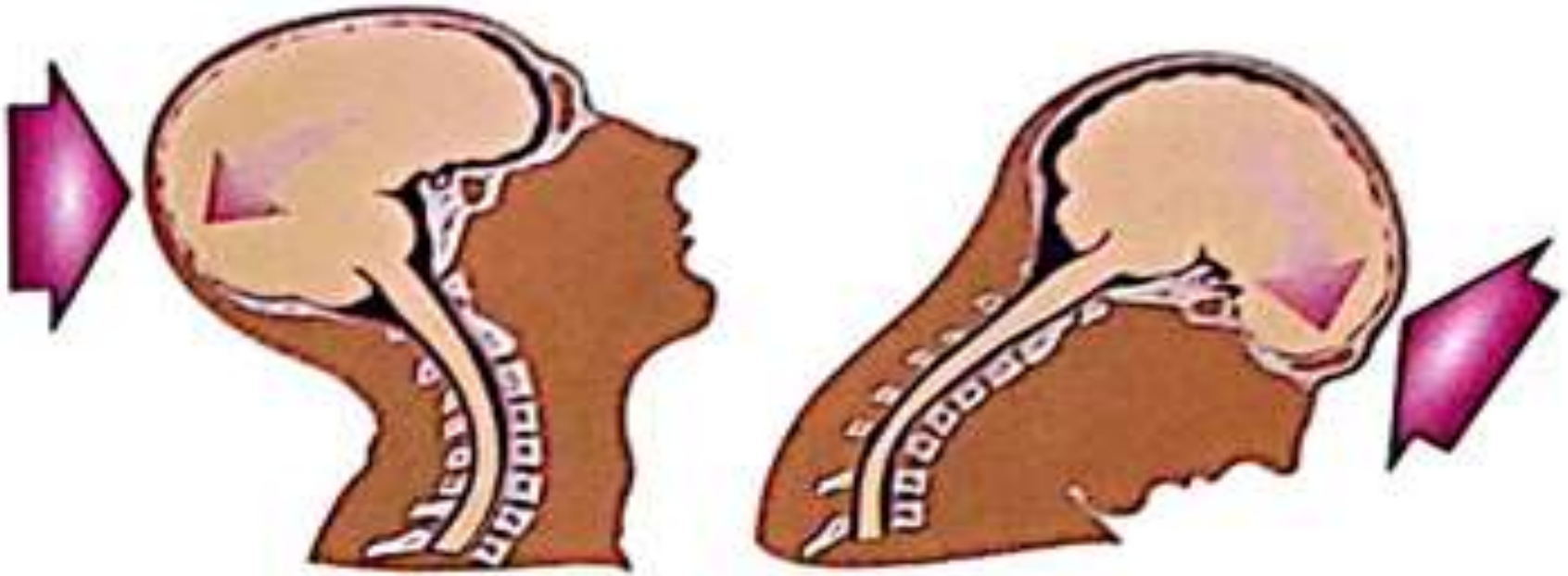
- Subdural hematoma develops between the dura and the arachnoid. It results from rupture to the cortical bridging veins.
- It classified into:

✓**Acute subdural hematoma-**less than 3 days.

✓**Subacute subdural hematoma-**4-21 days.

✓ **Chronic subdural hematoma-**more than 21 days.

- Direct blows to the head can cause coup injuries (at the site of impact) and contrecoup injuries (distant from the site of impact).



(b)

Coup–contrecoup forces.

Clinical Features of Traumatic Brain Injury

- Disorders of Consciousness.
- Autonomic Nervous System Changes.
- Motor, Sensory, Perceptual, and Functional Changes.
- Cognitive, Personality, and Behavioral Changes
- Other.

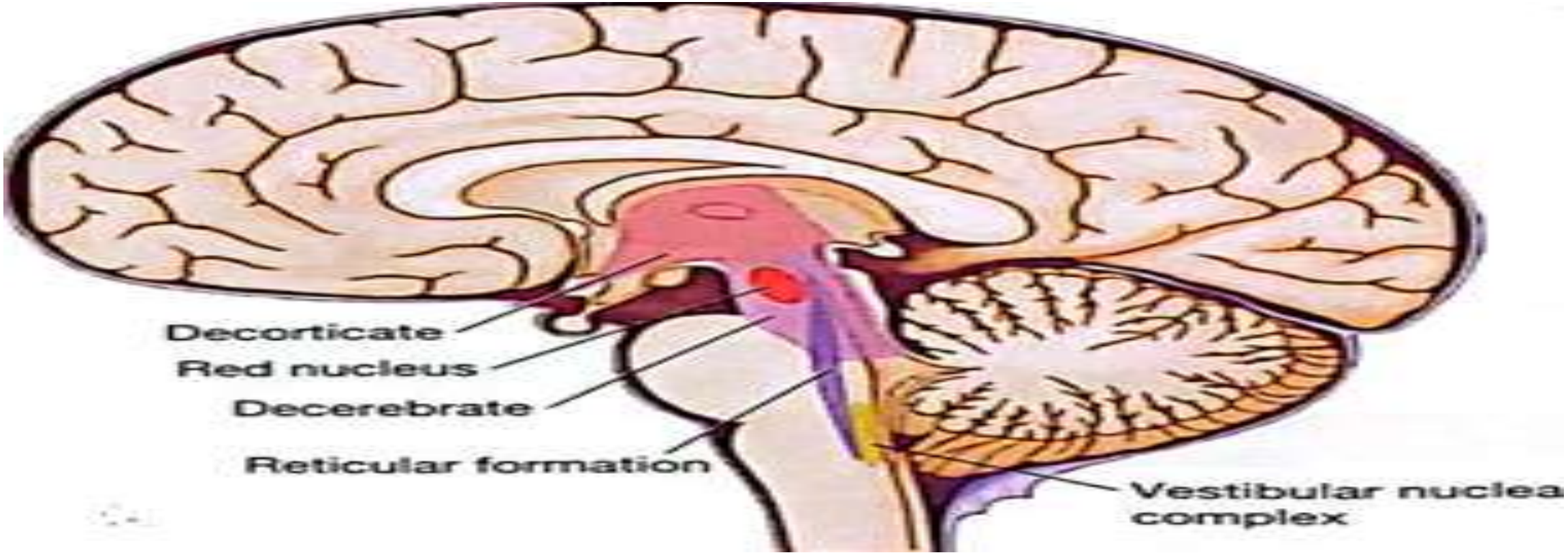
Disorders of Consciousness (DOCs)

- It is a collective term describing conditions where consciousness or arousal have been affected by brain damage.
- The damage can be of direct insult to structures and systems regulating arousal and awareness, or of indirect damage to systematic neural connections of the brain.
- The main DOCs are **coma**, **vegetative state** (VS), **minimally conscious state** (MCS) & **Posttraumatic Confusion** . Some clinicians and scientists include **locked-in syndrome** as a DOC, while some perceive it as a differential diagnosis.

Coma

- It represents a profound state of unconsciousness from which the patient cannot be aroused by external stimuli or inner need. Thus, the patient, whether with eyes open or closed, cannot be brought to a state even of partial alertness or function.
- Prolonged coma following head injury represents the accumulation of several processes affecting the brainstem and thalamic reticular activating systems.
- Cranial coma is one of the three major causes of coma(cardiac arrest/stroke).

- Abnormal posturing may occur in comatose patients. Although there are numerous exceptions, such posturing may assume one of two forms, referred to as **decerebrate** and **decorticate.**



Decerebrate posturing

- It associated with **decerebrate/extensor** rigidity >>> there is a clenching of the jaws and stiff extension of the extremities with internal rotation of the arms and plantar flexion of the feet.
- It is not a fixed steady state but is intermittent.
- occurs with **lesions at or below the level of the red nucleus** >>> there is a **loss of extensor inhibition** normally exerted on the brainstem reticular formation by the cerebral cortex >>> inhibition is lost to the reticulospinal and vestibulospinal tracts.

Decorticate rigidity

- It associated with **decorticate rigidity** >>> the arms are flexed and adducted and the legs extended.
- Such flexor posturing is thought to result from lesions at a higher level of the neuraxis in the **thalamus, internal capsule, or cerebral white matter.**
- Posturing of the upper extremities in flexion results from the intact rubrospinal tract that has been rendered free from inhibitory influences from higher centers. (The intact rubrospinal tract serves to facilitate lower motor neurons that activate upper extremity flexor muscles.)

(b)

(c)

Decorticate and decerebrate posturing.
Lesions resulting in the two types of abnormal posturing.
(b) Decorticate (upper extremity flexor) posture.
(c) Decerebrate (extensor) posture.

Vegetative State (VS)

- This state is characterized by a **wakeful, reduced responsiveness** can result from diffuse cerebral hypoxia or from severe, diffuse white matter impact damage.
- The difference between coma and VS is that there are **intermittent periods of wakefulness in VS.**
- VS The brain stem is usually relatively intact. Patients may **track with their eyes** and show **minimal spontaneous yet involuntary motor** activities, but they **do not speak**, nor do they **respond to verbal stimulation.**

Minimally Conscious State(MCS)

- consciousness **is severely changed** but **there are signs demonstrating self or environmental awareness.**
- **motor response in a reproducible manner.**
- for a **diagnosis of MCS** >>> a person must be able to follow simple one step commands and may even demonstrate some verbal responses to stimuli.
- Smooth pursuit may be present.
- MCS is often viewed as **a transitional state signifying improvement of consciousness.**

Posttraumatic Confusion or Clouding of Consciousness

- In this state the person is awake most of the time, but is confused.
- easily distractible.
- faulty memory.
- slowed but consistent responses to stimuli.
- Functional communication emerges in this state and is a clinical sign of improvement

Autonomic Nervous System Changes

- Variabilities in heart rate (e.g., tachycardia) and respiratory rates
- Irritable bowel syndrome
- Temperature elevations
- Blood pressure changes
- Excessive sweating, salivation, tearing, and sebum secretion
- Dilated pupils
- Vomiting
- Anxiety, panic disorder, and posttraumatic stress disorder

Motor, Sensory, Perceptual & Functional Changes

Motor changes may Include any or all of the following:

- Paralysis or paresis such as monoplegia or hemiplegia
- Cranial nerve injury resulting in paralysis of eye muscles, facial paralysis, vestibular and vestibuloocular reflex abnormalities, slurred speech (dysarthria), swallowing abnormalities (dysphagia), and paralysis of the tongue muscles
- Poor coordination of movement
- Abnormal reflexes
- Abnormal muscle tone: flaccidity, spasticity, or rigidity. (The terms *decorticate rigidity* and *decerebrate rigidity* are often used to denote abnormal posturing. *Decerebrate rigidity* denotes extension in all four limbs. *Decorticate posturing* includes flexion of the upper extremities and extension of the legs.)
- Combinations of asymmetrical cerebellar and pyramidal signs and of bilateral pyramidal and extrapyramidal signs have all been reported[15]
- Loss of selective motor control
- Poor balance
- Loss of bowel or bladder control

Sensory and perceptual may include any or all of the following:

- Hypersensitivity to light or noise
- Loss of hearing or sight
- Visual field changes
- Numbness and tingling (peripheral nerves are often injured)
- Loss of somatosensory functions
- Dizziness or vertigo
- Visuospatial abnormalities
- Agnosia
- Apraxia

Cognitive, Personality & Behavioral Changes

- Cognitive and behavioral sequelae can result from generalized or focal brain injuries. .
- **Amnesia** >>> Memory impairment, a very common finding after TBI.
- **Posttraumatic amnesia (PTA)** >>> is defined as “the time lapse between the accident and the point at which the functions concerned with memory are judged to have been restored.”

Cognitive changes might include any or all of the following:

- Temporary or permanent disorders of intellectual function
- Memory loss
- Shortened attention span
- Concentration problems
- Confusion
- Changes in motivation
- Difficulty sustaining attention
- Executive function loss
- Reduced problem-solving skills
- Lack of initiative
- Loss of reasoning
- Poor abstract thinking
- Shortened attention span

Behavioral changes could include the following[31]:

- Agitation
- Aggression
- Irritability
- Substance abuse
- Behavior with legal consequences
- Apathy
- Depression
- Anxiety
- Posttraumatic stress disorder
- Obsessive-compulsive disorder
- Psychosis
- Suicidal ideation and attempts
- Suicide

Other Complications

- **Locked-in syndrome** >>> In this syndrome the patient cannot move any part of the body except the eyes but cognition remains intact and the person is conscious.
- Communication disorders >>> aphasia, dysarthria, loss in reading comprehension and social communication.
- Infections, contractures, skin breakdown, thrombophlebitis, pulmonary problems, heterotopic ossification (HO), and surgical complications

Glasgow Coma Scale

EYE OPENING			VERBAL RESPONSE			MOTOR RESPONSE		
								
Spontaneous	>	4	Orientated	>	5	Obey commands	>	6
To sound	>	3	Confused	>	4	Localising	>	5
To pressure	>	2	Words	>	3	Normal flexion	>	4
None	>	1	Sounds	>	2	Abnormal flexion	>	3
			None	>	1	Extension	>	2
						None	>	1

GLASGOW COMA SCALE SCORE

Mild	Moderate	Severe
13-15	9-12	3-8

Severity of TBI

- mild TBI >>> a brief to no loss of consciousness and there may be vomiting, dizziness, lethargy, and memory loss.
- moderate TBI >>> unconsciousness can last up to 24 hours. There are signs of trauma, contusions, and/or bleeding on neuroimaging.
- severe TBI >>> coma persists for more than 24 hours, there are no obvious sleep/wake cycles, and there are signs of trauma on neuroimaging.

Measurement	Mild	Moderate	Severe
Glasgow Coma Scale	13–15	9–12	3–8
Loss of consciousness	<30 min	30 min–24 h	>24 h
Posttraumatic amnesia	0–1 day	>1 to ≤7 days	>7 days

- Damage to the anterior temporal lobes is common with TBI injuries >>> with implications for cognitive function.
- Damage to the frontal lobes frequently occurs >>> resulting in deficits of executive function.
- Right-sided hemispheric lesions >>> problems of visual-spatial processing.
- left-sided hemispheric lesions >>> deficits in verbal processing. .
- Damaged to amygdala >>> heightened arousal, which enhances sensory information processing and is linked to heightened emotional responses
- **Damage to** brainstem >>> affect vital centers associated with respiration and cardiac function and can therefore lead to death

Management of head injury

- **Initial management of head injury**
- ABC protocol : -Immediate treatment at the site of the injury involves a rapid restoration and maintenance of an adequate airway, ventilation, essential circulatory resuscitation >>> intubation
- **Neurological examination :**
- **1-** Conscious state: Glasgow Coma scale.
- 2- Pupillary size and reaction >>> dilatation of Pupil.
- 3- Focal neurological signs in the limbs (dilating pupil & hemiparesis)**.**

- **General examination**

- Careful assessment must be made of any other injuries Chest >>> hemothorax Or pneumothorax skeletal, cardiovascular or intraabdominal injury must be diagnosed and the appropriate management instituted. Hypotension or hypoxia may aggravate the brain injury, and, if severe, will cause brain damage.
- **Radiological evaluation**

The CT scan >>> loss of consciousness (history or now loss), persisting nausea or vomiting, lateralizing neurological (unequal pupil), neurological or focal deterioration, skull fracture& CSF rhinorrhea (nose &ear).

Glasgow Coma Scale

Eye Opening (E)	
Spontaneous	4
To speech	3
To pain	2
Nil	1
Best Motor Response (M)	
Obeys	6
Localizes	5
Withdraws	4
Abnormal flexion	3
Extensor response	2
Nil	1
Verbal Response (V)	
Oriented	5
Confused conversation	4
Inappropriate words	3
Incomprehensible sounds	2
Nil	1
Coma Score (E + M + V) =	3–15

Examination Strategy

- The examination strategy includes **determination of the level of coma**; **the time course of recovery from coma**; the **extent of impairments related to cognition, emotion, and memory**; and **the degree to which sensory and motor functions are impaired**. **Function is examined, not just in relation to motor performance,** but also with regard to the person's judgment and safety.

- many individuals who have sustained a TBI are **young adults** or **teenagers**. Of critical importance is an understanding of the individual's **premorbid life situation**, including the **activities preferred**, **performance in school**, **sociability level**, and **home situation**. It is important to weigh/ balance this individual's current intellectual, social, and emotional status against his or her prior status.
- For people who sustained a brain injury following an attempted suicide, clearly a **psychological evaluation** is paramount. And for infants with abuse-related injuries, consultation is required with the proper authorities.

- because emotional, cognitive, and memory deficits typically occur with TBI, these areas require extensive assessment, using both qualitative assessment and standardized tests.
- It is the necessity to assess functional ability, including tasks related to balance, gait, upper extremity function, and self-care. The tests and measures are similar to those used for people who have sustained a stroke.
- Examination Framework for TBI

- specific tests also are used to assess the motor, somatosensory, language, and perceptual systems, as well as tests of working memory, speed of response, and judgment. **When localized injury has been identified**, the **predicted impairments assist the clinician to identify tests and measures that should be applied.**
- if there is brainstem or cerebellar involvement, tests should be implemented of the vestibular system and related reflexes. If a lesion is localized to the left hemisphere, language, motor planning, and praxis can be affected and should be considered; and if the lesion involves the right temporo-parieto-occipital region, perception should be assessed.
- In situations where diffuse injury has occurred, the clinician makes judgments regarding what to measure and how to focus the intervention based on overall impressions and findings.

Interprofessional Team and Roles/Responsibilities in Care of Persons With Traumatic Brain Injury

Discipline	Roles and Responsibilities
Social Worker/Case Manager	Coordination of care and discharge planning with team, family, and insurance company
Neuropsychologist/Neuropsychiatrist	Evaluate and treat cognitive, emotional, and behavioral issues due to CNS disorders
Neuro-optometrist/Ophthalmologist	Diagnose and treat visual disorders due to CNS injury
Neurologist/Neurosurgeon	Physicians specializing in diagnosis and treatment of nervous system disorders
Physiatrist	Physicians specializing in physical medicine and rehabilitation; often coordinates care during the rehabilitation process
Pharmacist	Experts in medications and drug interactions; prepare medication as ordered by prescribers
Nurse	Maintain and/or restore health of all body systems; administer medications ordered by prescribers
Occupational Therapist	Focus on improving activities of daily living such as feeding, bathing, grooming, driving, etc.; address cognitive, visual, and social skill impairments
Physical Therapist	Movement specialists; focus on improving functional mobility by addressing the movement system and movement dysfunction
Speech and Language Pathologist	Focus on improving ability to speak, swallow, and communicate orally, through writing or augmented communication devices
Recreational Therapist	Focus on improving self-esteem, social skills, motor skills, coordination, endurance, cognitive skills, and leisure skills

I. History: injury, age, PTA, GCS score, job, home environment, educational level, previous injuries, etc.
II. Patient and family data: patient and family perception of the limitations, goals, personal factors, socioeconomic factors relating to participation limitations
III. Other health care team member evaluations
IV. Screens
    A. Systems review to emphasize precautions during intervention and to identify any "red flags" that will require referrals.
        1. Circulatory and respiratory
        2. Integumentary
        3. Musculoskeletal
        4. Autonomic nervous system—bowel, bladder
        5. Cognitive
        6. Language
        7. Emotional
V. Assess activity limitations (perform task analyses) of patient-identified problems
VI. Formation of underlying impairments (hypotheses) from the task analyses
VII. Choose specific tests and measures and recommended outcome measures to test underlying impairments or confirm the hypotheses; these might include:
    A. Sensory
        1. Somatosensory
        2. Vestibular
        3. Visual
        4. Hearing
    B. Integrated, perceptual
    C. Motor
        1. Muscle strength
        2. Muscle flexibility
        3. Response speed
        4. Tone
        5. Movement speed
        6. Endurance and fatigue
        7. Complex impairments
            - Basic motor patterns available
            - Modification of motor patterns possible
            - Anticipatory and adaptive responses
            - Variability of performance
    D. Autonomic nervous system
    E. Cognitive
    F. Language
    G. Emotional

Physical Therapy Interventions Through the Care Continuum

- The focus of rehabilitation will vary depending upon **severity of the brain injury, the person's level of consciousness, physical functioning, the practice setting**, **and personal goals.**
- physical therapists should work with the inter-professional team to **prevent secondary complications**, including pneumonia, pressure sores, adaptive shortening of soft tissue, disuse atrophy, heterotropic ossification (HO), joint contractures, and deep vein thrombosis (DVT) through aggressive bronchopulmonary hygiene, positioning schedules, tone management techniques, pressure relieving mattresses, cushions and splints, and daily ROM and stretching programs.

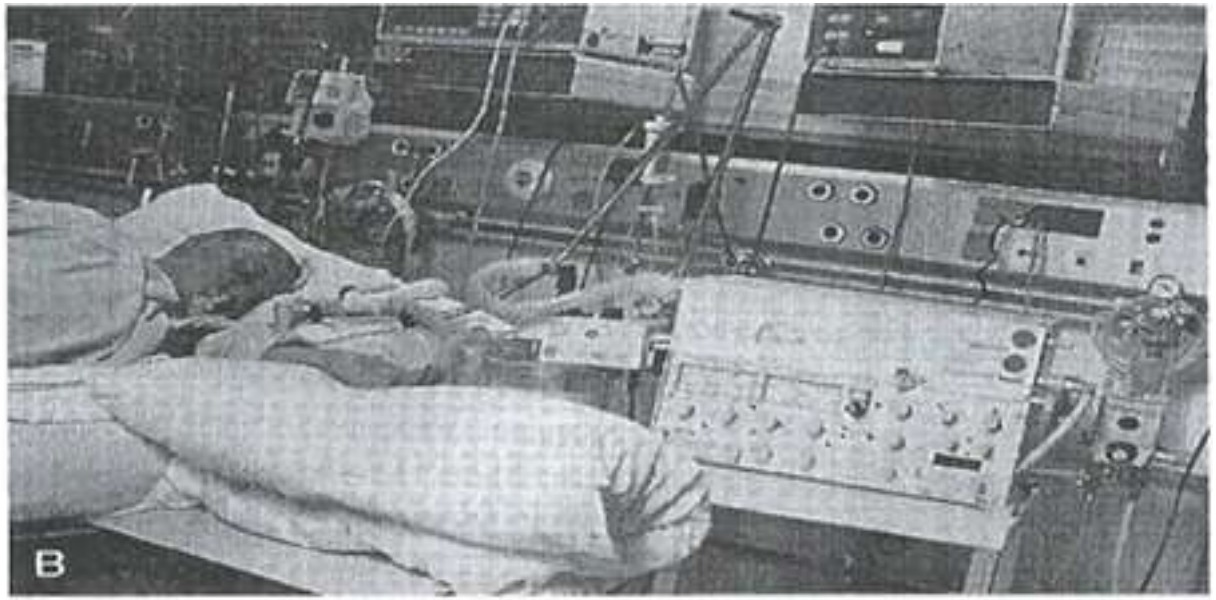
- Physical therapists also receive competency training on the medical monitoring and treatment devices commonly used in the neurological intensive care unit (ICU) and acute care settings. Precautions for all of the **devices must be observed**, and therapists should closely **monitor all lab values and vital signs** throughout physical therapy sessions to **maintain patient safety** and **prevent complications.**
- Within neurological ICU, and/or trauma center, the primary focus of all care is on **preservation of life** and **neural tissue**, and **prevention of secondary complications.**

- physical therapy interventions **In acute stages** of a moderate to severe in the ICU or trauma center >>> **early mobility**, and **improving level of arousal and awareness for people with DOC**.
- Once the person is transferred to a **step-down unit or is in a neurological acute care unit** and level of arousal is improved, **the priorities** shift towards increasing **mobility** and **improving meaningful interactions with the environment.**
- In acute or subacute rehabilitation, priorities are on **maximizing safety and independence with functional mobility, performance of ADLs, and appropriate interactions with others and the environment.**
- The post-rehab goals for a person with moderate to severe TBI will depend on **residual deficits** and **level of function;** however, the focus is typically on **participation in society and community reintegration**, **including return to school/work/family responsibilities and independent function.**

Positioning.

- It is one of the most important early treatment interventions.
- Side-lying and **semi-prone** positions are more desirable positions.
- Patients can be positioned in **prone** by placement of a pillow under the chest and forehead. This position maintains the patient’s airway.
- Positioning upper extremity in slight abduction and external rotation while the patient in a prone or supine position also exerts an inhibitory influence on abnormal muscle tone.

- Firm towels or half-rolls should be used to assist the patient in maintaining the optimal position to reduce contractures.
- Proper positioning can be accompanied by range of motion exercises and static splinting.
- Reflex inhibiting postures: It is used to inhibit abnormal muscle tone.



A. One end of the footboard is beneath the mattress.
B. A rolled pillow supports the extended arm.
C. The arm is well-supported in the corrected position.

From Davies PM. *Starting Again: Early Rehabilitation after Traumatic Brain Injury or Other Severe Brain Lesion*. New York, Springer-Verlag, 1994.

- prolonged stretch.
- prolonged positioning with splints and/or serial casts.
- modalities such as heat and cold, and weight bearing have all been shown to reduce spasticity.
- If conservative measures fail to address the hypertonicity, communication with team members, including the neurologists and physiatrist >>> phenol or Botox injections, oral medications, or intrathecal pump delivery of Baclofen.

Increasing Level Of Arousal

- scope of practice include **increasing level of arousal** to promote normal sleep-wake cycles.
- There are two primary types of interventions used in neuro rehabilitation to increase arousal level:

✓ upright positioning.

✓ sensory stimulation.

Upright Positioning

- careful consideration of factors such as **medical stability** and comorbidities, level of consciousness, activity orders, precautions (spine, weight bearing, craniectomy, aspiration, behavior, seizure, etc.), and availability of equipment and personnel should be used to determine the safest method of mobilizing a person and achieving upright positioning.
- persons who are in a coma and/or medically unstable, a hospital bed that moves into a reverse Trendelenburg position (patients are placed in a supine position, which is inclined at 30 degree angle, so that the head is higher than the pelvis and the leg is lower than hip) or converts to a chair may be most appropriate to initiate upright positioning if available.

Hospital bed converts to chair for upright positioning to improve level of arousal.

a tilt table

- gradually increase upright posture >>> safety can be maintained even when the patient is unable to follow commands or actively participate in the treatment.
- The person can be transferred via a **slide board** or with **bed sheets** from hospital bed to the tilt table, then **safely strapped to the table** with harnesses and belts before moving the person to an upright position, which limits risk of a fall.

Benefits of tilt table

- early weight bearing to promote circulation and prevent DVT
- redistribution of pressure points on skin,
- improve renal function,
- improve ankle ROM,
- decrease spasticity in the LE,
- improve respiration,
- preserve bone density,
- reduce orthostasis, and
- improve cardiovascular response to position changes after prolonged bedrest.

- Rolling and transferring the person to sitting position on the edge of the bed is another option >>> this method requires participation of several clinicians to prevent a fall for a person with DOC as total assist will be required for maintaining sitting balance.
- Transfer of a person from bed to a recliner or wheelchair via active, dependent transfers or using a mechanical lift.
- Abdominal binders and compression stockings may be beneficial for improving venous return, limiting orthostasis, and improving tolerance to upright position during early mobilization procedures.

- This chair allows the trunk to **recline while maintaining 90- degree angles at the hips, knees and ankles**. Standard wheelchairs may be satisfactory for the individual with **fair trunk and head control**. Lap trays securely fastened to the chair support the patient's upper extremities and help to maintain proper sitting alignment.

- Many people with **TBI** have concomitant internal injuries, **orthopedic injuries**, including fractures and subluxations, as well as soft tissue damage such as skin tears, lacerations, and muscle contusions. Therefore with mobilization and other interventions, therapists should observe persons for signs and symptoms of pain such as grimacing, agitation, withdrawal responses, and/or increased heart rate, blood pressure, and ICP.
- If any of these symptoms are noted during physical therapy, the therapist should discontinue the treatment and try to return the person to a comfortable state. The findings should be documented and reported to the inter-professional team, and a plan of care should be implemented to premedicate the person before treatment for comfort and safety.
- Additionally, therapists must carefully observe patients for sign and symptoms of seizure activity at all times as this is a common complication following TBI.

Sensorimotor stimulation

- a rigorous program of olfactory, visual, tactile, auditory, and gustatory stimuli provided by trained family members for **1 to 2 hours per day for 7 to 12 days shortened the time** it took to follow commands and execute purposeful movements among people with severe TBI.
- start with **one type of stimulation at a time**, then gradually add additional **forms** and/or increase the **intensity of the stimuli**, until arousal is achieved.
- Therapists should carefully consider environmental factors such as **temperature, lighting, and ambient noise** and attempt to control these factors to keep the person as alert as possible for as long as possible but without overstimulating them.
- Treatment may need to be performed in a closed environment free of external distractions to promote participation.

Mode	Examples
Auditory	• Conversation, voice of family members • Reading books, magazines • Sounds, e.g., ringing bell, hand clapping • Play music
Tactile	• Light touch, massage • Temperature (hot/cold) • Brushing or stroking • Pressure, e.g., inflate a sphygmomanometer cuff or air sleeve • Noxious: sternal rub, deep nail bed pressure, pin prick
Visual	• Colored papers • Pen light, room lights • Daylight • Faces of the patient's family, friends, pet, etc. • Pictures of the patient's family, friends, pet, etc.
Olfactory	• Perfume • Vinegar • Orange • Lemon • Coffee
Gustatory	• Oral swabs • Lollipop • Popsicle • Providing oral hygiene care
Kinesthetic	• Any change of position, e.g., rolling, supine to sit • Vestibular, head turns if not contraindicated, rolling • Passive range of motion

N.B

- The voice of a therapist can be used as a tool to influence the patient's response. For patients who are in **a heightened state** of awareness, the **use of a soft tone of voice may calm the patient**. On the contrary, for patients who are **lethargic**, the **use of the patient's name** followed by a **brief concise command in a loud voice** may be utilized to arouse the patient.

Motor learning strategies

- It specific to the TBI population and those with impaired awareness include use of **implicit memory tasks** in therapy. Several studies have demonstrated impairments in explicit memory tasks with preservation of implicit tasks, including **priming and procedural learning following TBI.**
- rehabilitation professionals utilize implicit memory tasks, including priming and procedural learning, for interventions as this type of learning does **not** rely up on **conscious awareness** >>> exposure to the stimuli, and procedural tasks, such as riding a bike. **These tasks are more automatic, and automaticity may be augmented by use of familiar and desirable items and objects.**

Behaviors changes &interventions

Behaviors	Interventions
Agitation • Removing restraints/tubes • Crawling/getting out of bed • Mood swings • Screaming, crying, restlessness • Pacing, wandering	• One-to-one supervision • Remove restraints if order in place to do so • Redirection to tasks • Reduce stimulation (turn off TV, dim lights, check needs for bathroom or pain, limit visitors, keep door closed, etc.) • Education on importance of tubes, IVs, lines, etc. • Do not argue or yell, and stay calm • Consistent response by all team members to undesired behaviors
Aggression • Verbal (increase in voice volume and tone, swearing, name calling) • Physical (hitting, kicking, biting, choking, hair pulling, object throwing, etc.) • Demanding unreasonable requests (e.g., demanding to leave or go home)	• Remove breakable or sharp objects from reach • Keep safe distance from patient • Do not respond with physical force or restrain person unless for their safety • Reduce stimulation (turn off TV, dim lights, check needs for bathroom or pain, limit visitors, keep door closed, etc.) • Minimize safety risks: lower bed, lock brakes • Do not argue or yell, stay calm • Give patient breaks from activity/stimulation
Noncompliance • Refuse to take meds • Refuse to participate in therapy	• Identify motivators and use positive reinforcement • Education regarding purpose of interventions • Give patient some control and/or choices • Involve family who induce cooperation • Set goals with person • Behavioral contract-avoid punitive measures

Impulsivity • Quick verbal response without awareness of consequences • Quick physical action without safety awareness	• Verbalize or rehearse steps prior to starting a task or activity • Provide verbal cues for safety throughout task performance • Safe environment (use of assistive device, grab-bars, handrails, etc.) • Review consequences of unsafe movements or behaviors • Utilize bed alarm or door alarm if ordered • Restraints if ordered and all other interventions have failed
Confusion/Disorientation • Where am I? • What time is it? • Not recognizing staff members • Hallucinations or delusions	• Provide frequent orientation • Utilize same staff members (nurses and therapists) • Utilize consistent therapy schedule • Use bed alarm or door alarm if ordered • Give simple explanations prior to activity • Limit change and be consistent
Inappropriate Sexual Behavior • Inappropriate comments • Masturbation • Grabbing or groping staff	• Provide education that inappropriate sexual behavior is not allowed • Keep distance from patient • Utilize same sex staff if effective and able to do so • Involve family members to minimize inappropriate behavior if effective • Consistent verbal cues among the interprofessional team, e.g. "that is not appropriate"
Fatigue • Poor endurance or tolerance for therapy/activity • Frequent rests or desires to go back to bed • Always sleeping or requesting to skip treatment	• Identify cause of fatigue if possible (medication, depression, poor sleep/wake cycle, restlessness at night, etc.) • Use frequent rest breaks during and between therapy sessions • Minimize time in bed during the day to promote sleep at night • Education regarding need for breaks and cause of fatigue
Denial • Low insight into deficits • Unrealistic about abilities and outcomes	• Set up experiences with patient that bring out the deficit for patient's own observation (within safe limits) • Review deficit areas/outcomes with patient • Gradually prepare patient for outcomes and highlight progress • Provide support for acceptance of deficits/outcomes, social worker involvement

Interventions to Improve Motor Performance and Physical Function After Traumatic Brain Injury

- Traditional approaches such as Bobath, neurodevelopmental treatment (NDT), and proprioceptive neuromuscular facilitation (PNF) are often blended by contemporary therapists into general neuromuscular reeducation and functional task-oriented retraining approaches.
- Therapists should therefore engage persons post-TBI in intense, repetitive, task-oriented training to promote recovery of function and optimal motor performance with all functional mobility tasks, including rolling, transferring supine to/from sitting, sit to/from stand, bed to/from wheelchair, wheelchair mobility, ambulation, and stair mobility.
- Constraint-induced movement therapy (CIMT) is used to improve UE function and ADL performance for people.

Functional mobility training

- It requires **inhibiting abnormal muscle tone** and **developing postural control.** Selection of common daily activities such as **washing face**, **brushing the teeth** and **combing the hair** is often successful as they are meaningful to the patient. Hand over hand or therapeutic guiding techniques in which the therapist guides the patient's own extremity or body movements are effective.

INTERVENTION 11-4 Hand-over-Hand Guiding (Face Washing)

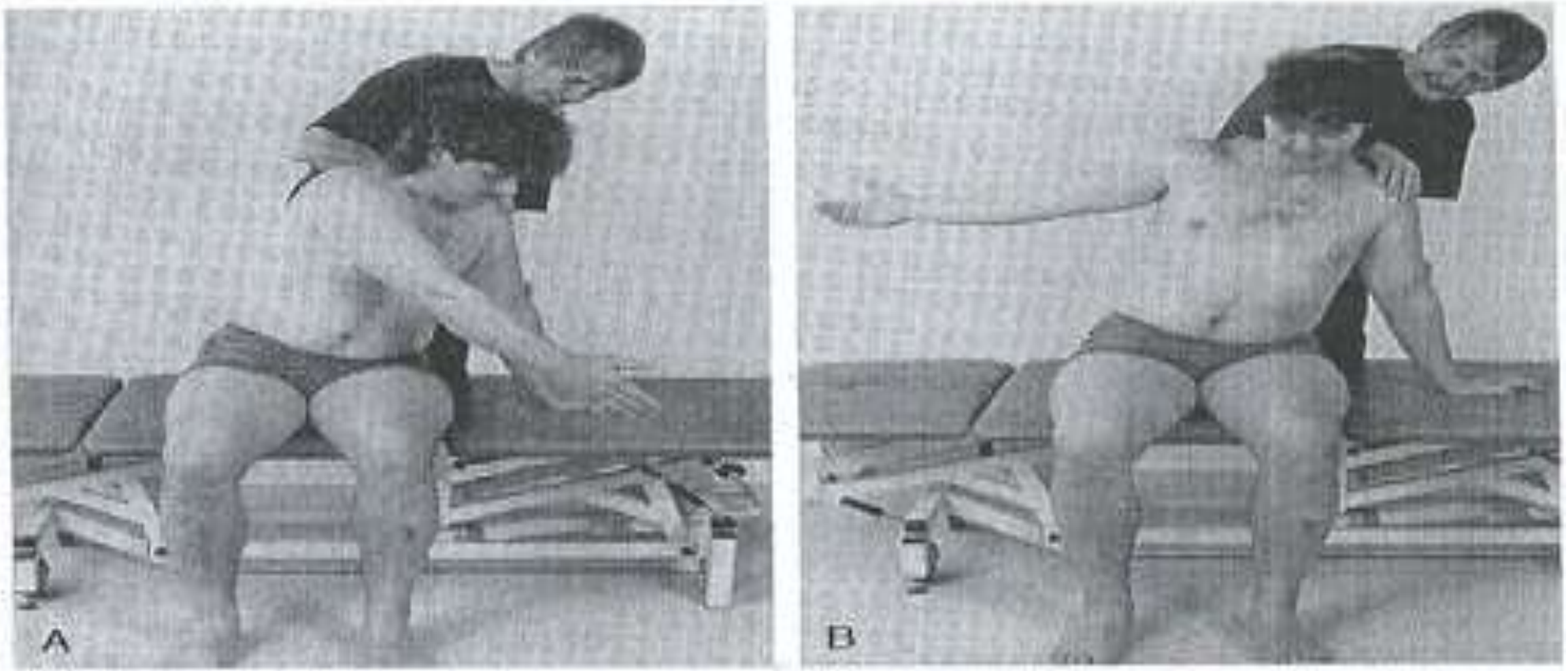
A. A task is presented as the patient's wife watches.
B. During hand-over-hand guiding, the patient lifts his head.
C. Active neck and trunk extension are achieved as he washes his face.

From Davies PM. *Starting Again: Early Rehabilitation after Traumatic Brain Injury or Other Severe Brain Lesion*. New York, Springer-Verlag, 1994.

Sitting activities

- Sitting can increase arousal and also provides a challenge to the patient's **postural alignment and righting and equilibrium response**. Activities such as gentle anterior and posterior weight shift, trunk flexion, rotating trunk forward and back while weight bearing on upper extremities, reaching, throwing and catching tasks and donning socks and shoes while sitting

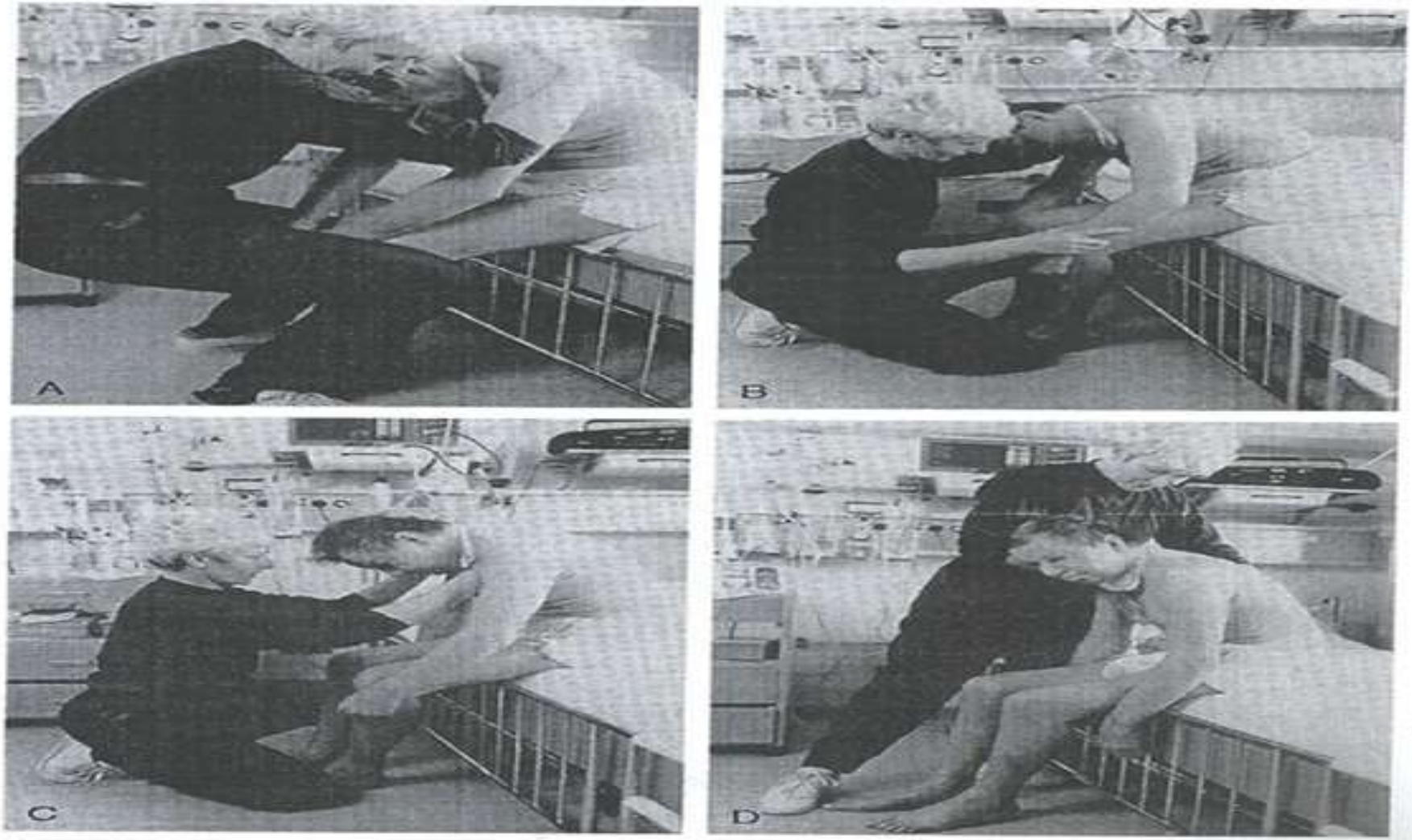
INTERVENTION 11-7 **Sitting Activities**



A. Rotating the trunk forward with the arm supported sideways.
B. Trunk rotated back with the contralateral arm abducted.

From Davies PM. *Starting Again: Early Rehabilitation after Traumatic Brain Injury or Other Severe B*

INTERVENTION 11-6 Trunk Flexion in Sitting

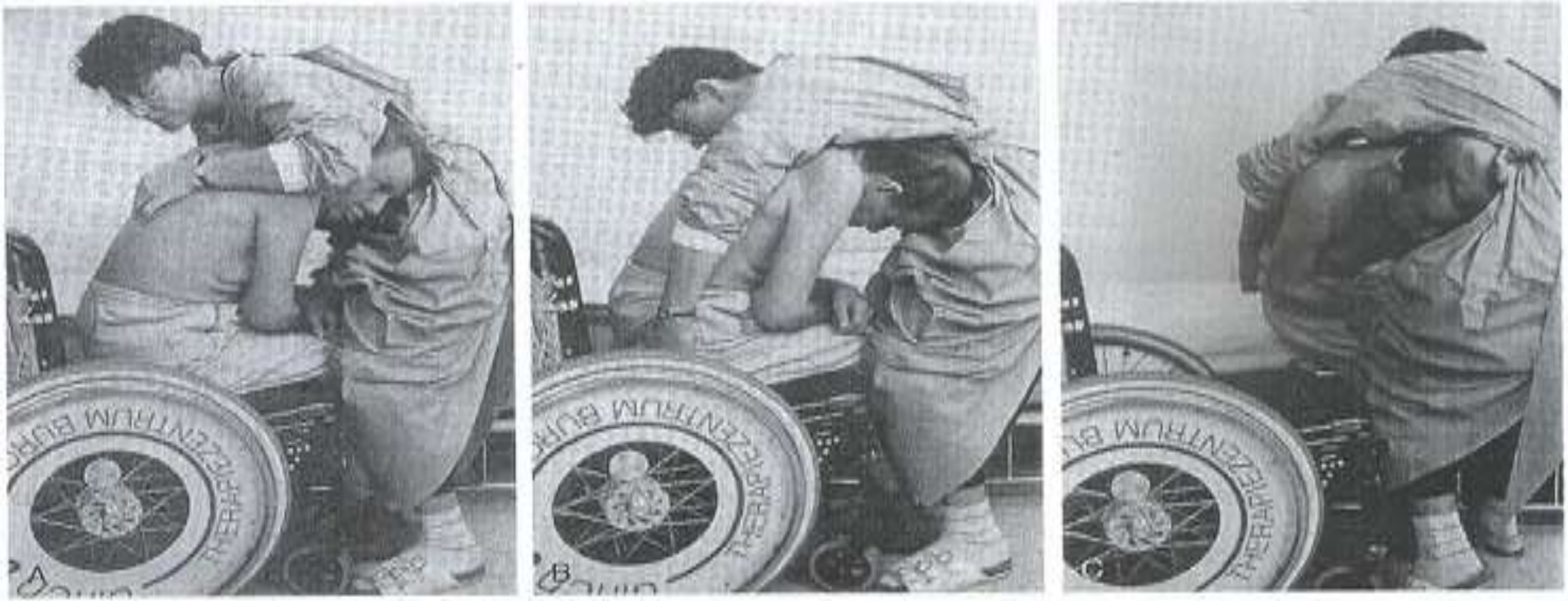


A. Bending the trunk forward with the therapist blocking the patient's knees.
B. Hands reaching toward the feet.
C. Assisting return to an upright position.
D. Assisting extension of the thoracic spine.

Transfers

- A sit-pivot transfer is recommended for patients who are low functioning and lack trunk control. As the patient progresses, stand-pivot transfer can be attempted

INTERVENTION 11-8 **Sit-Pivot Transfer**



Transferring the patient with his trunk flexed forward.
A. The therapist flexes the patient's trunk and supports his head against her side.
B. She puts one hand under each trochanter.
C. Pressing her knees against his, she lifts and turns his buttocks onto the bed.

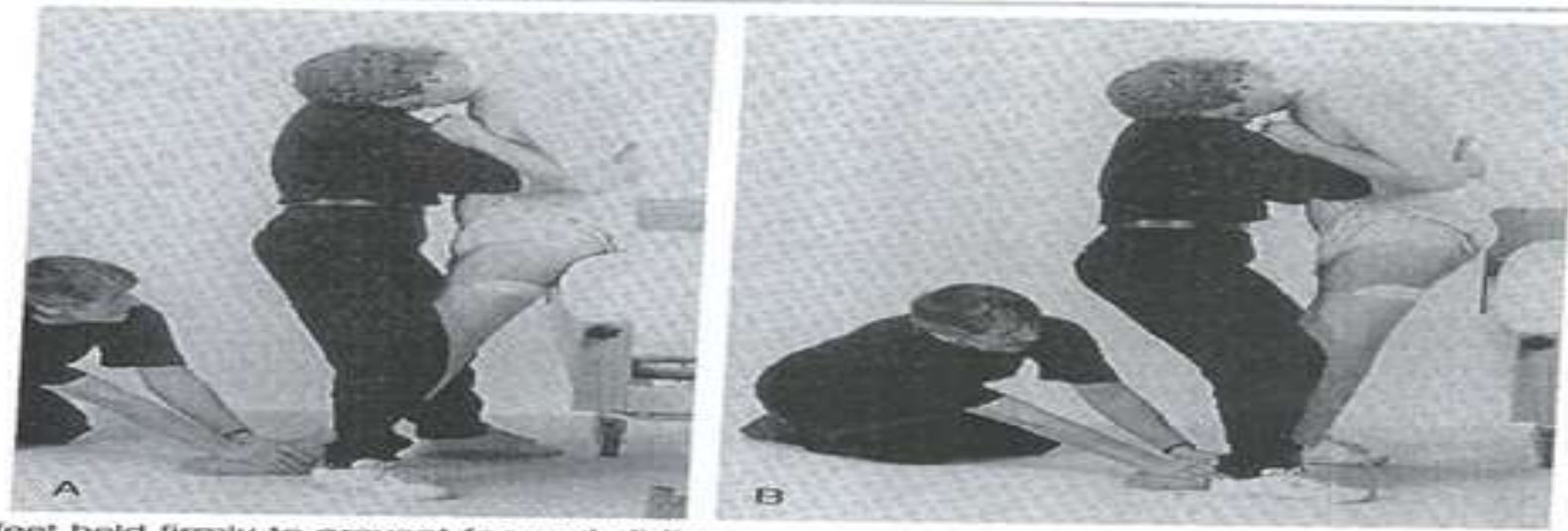
From Davies PM. *Starting Again: Early Rehabilitation after Traumatic Brain Injury or Other Severe Brain Lesion*. New York, Springer-Verlag, 1994.

Standing activities

- If the patient has low functional capabilities, the tilt table may need to be used initially to provide necessary stabilization to maintain a standing posture. Activities that increase awareness and cognition can be performed while the patient is standing on the tilt table. Administering different sensory modalities. Performance of simple activities of daily living such as face washing or teeth brushing

INTERVENTION 11-9

Standing the Patient Who Is Unconscious



A. Starting position, feet held firmly to prevent forward sliding.
B. Therapist uses key points of control to support the patient.

From *Davies PM. Starting Again: Early Rehabilitation after Traumatic Brain Injury or Other Severe Brain Lesion.* New York, Springer-Verlag, 1994.

INTERVENTION 11-10

Supporting the Patient in Standing

A. Weight is brought forward over his feet.
B. Therapist moves around behind him.
C. Therapist uses tactile cues on the pelvis and trunk to achieve extension.

From *Davies PM. Starting Again: Early Rehabilitation after Traumatic Brain Injury or Other Severe Brain Lesion.* New York, Springer-Verlag, 1994.

- Treadmill training >>> The use of treadmill training, with or without body-weight support and robotic assist, has be come common practice in rehabilitation of gait.

Body Weight Support Treadmill Training. **(A)** Front view. **(B)** Back view.

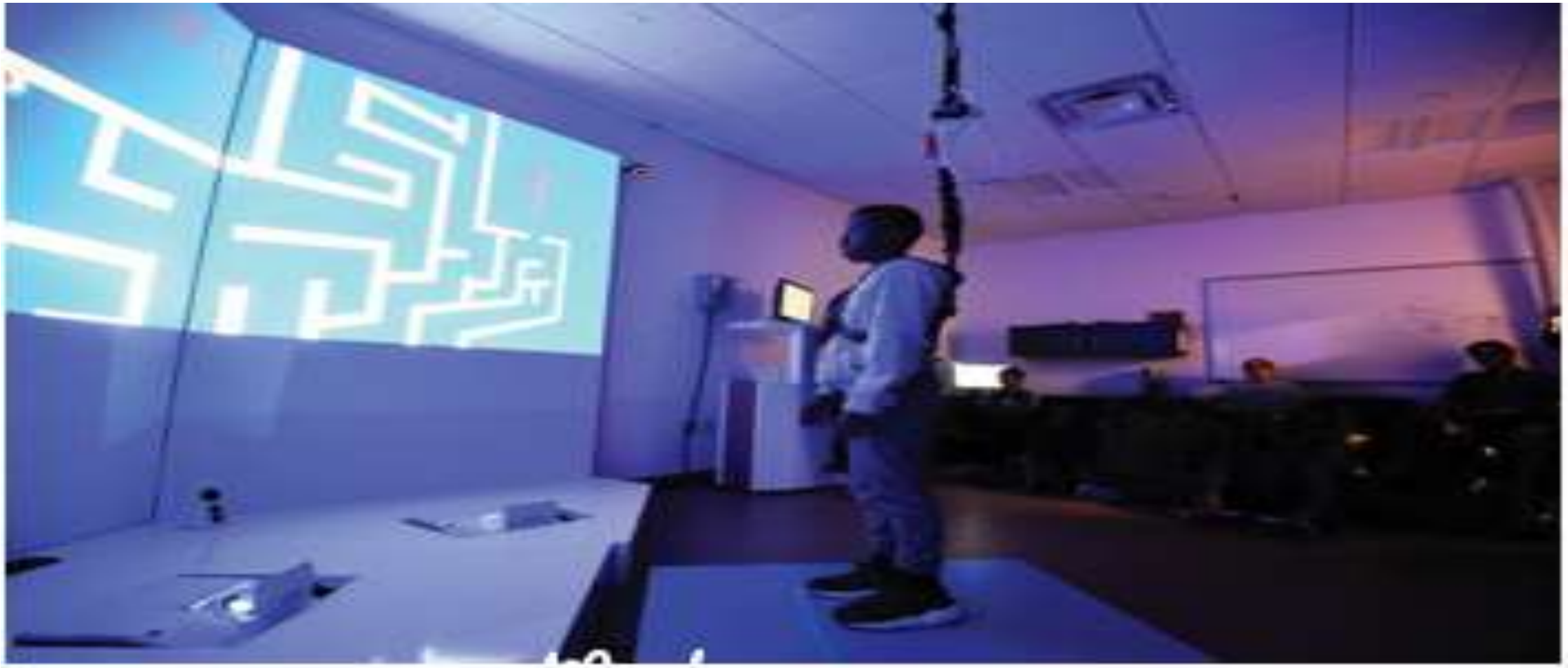
Interventions to improve endurance and benefits of aerobic exercise.

Physical activity following TBI:

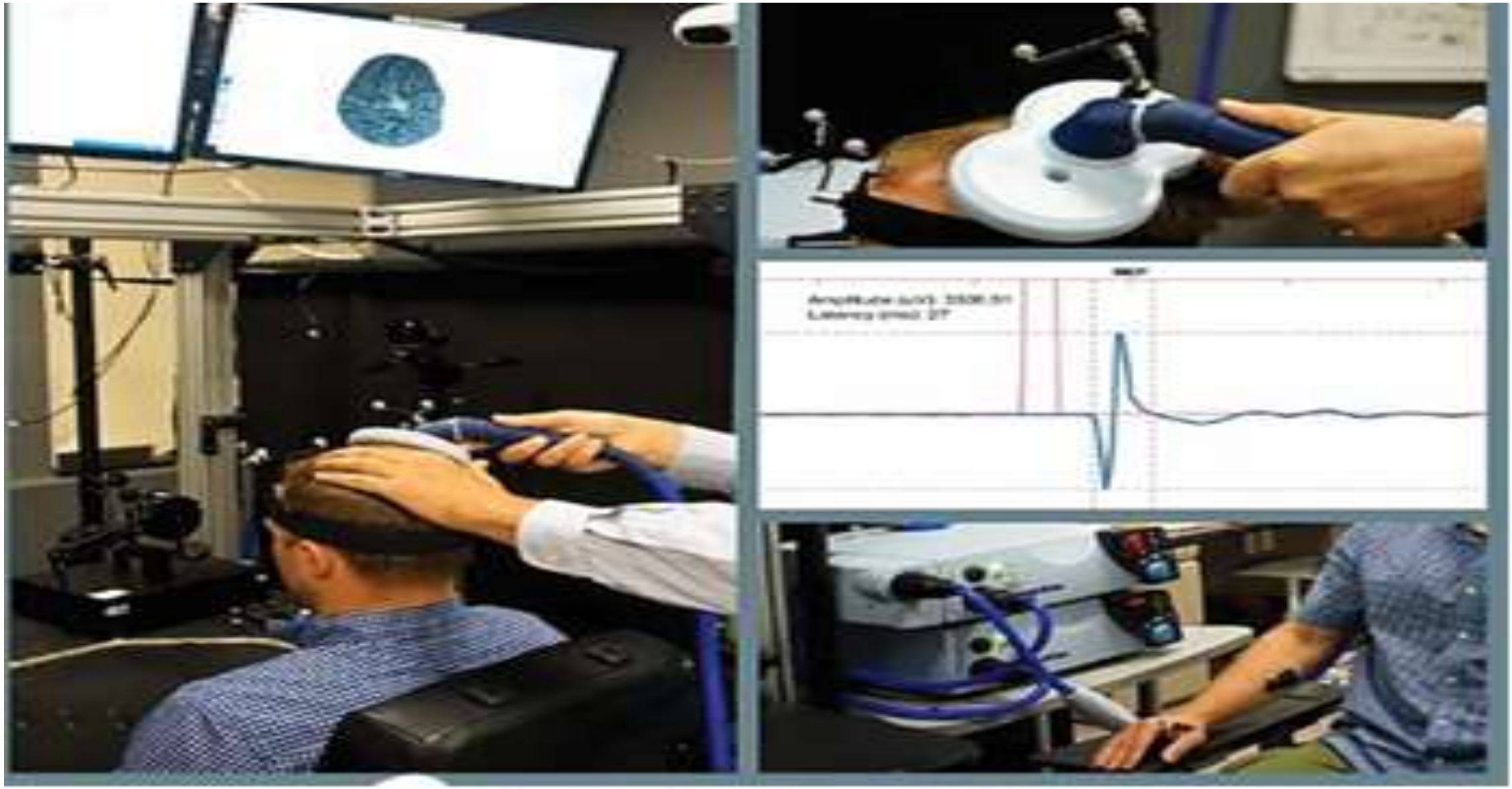
- improve neuroplasticity & promote recovery.
- lower risk of secondary health complications associated with inactivity.
- have a positive impact on sleep, mood, and cognition, which are also frequently impaired after TBI.
- Exercise also increases the production of molecules such as brain-derived neurotrophic factor (BDNF), a protein vital to neuro plasticity and essential to cognition, as well as insulin-like growth factor-1 (IGF-1), a growth factor that mediates exercise-induced neurogenesis and angiogenesis and upregulates BDNF during exercise.

- aerobic conditioning such as stationary bicycle, recumbent bicycle, walking on a treadmill or over ground at a faster speed, jogging, upper body ergometry, and swimming.
- dual-task performance.
- Emerging technology for the rehabilitation of moderate to severe traumatic brain injury >>> including robotics, VR, and noninvasive brain stimulation (NBS) techniques, including transcranial direct current stimulation (tDCS) and TMS.

Virtual Reality (VR)



Virtual Reality.



Transcranial Magnetic Stimulation.

Range of motion

- These exercises are also important to **decrease** the likelihood of **contracture formation**. As stretching of individual joints is time-intensive, different developmental positions can be used to increase patient flexibility such as positioning a patient in prone or tall kneeling can be used to stretch the hip flexors, quadruped and sitting can be utilized to stretch the gluteal and quadriceps and standing on a tilt table or approximation directed down through the knee when the foot is in weight bearing can assist with stretching the gastrocnemius and soleus.

- Patients who have developed **deformities or contractures** require more intensive **stretching such as static splinting or serial casting. A plaster cast** is applied to the joint with the range of motion limitation and contracture and is **left on for seven to ten day**s. Thus a prolonged stretch is applied to the joint and soft tissues. **Three to four casts** may need to be applied to achieve desired results

Family education

- Educating the patient's family about ways in which they can assist the patient with **orientation and awareness** is important. **Encouraging the family to bring in favourite pictures, music or other items can of assistance**. However family members should be cautioned against over stimulating the patient. In an effort to arouse the patient, families often play music or leave the patient's television on for extended periods. Family members should be instructed in and encouraged to assist with patient positioning and passive range of motion exercises.

Physical environment

- Too much sensory stimuli can overstimulate the patient and call lead to confusion or an adverse behavioural response. Patients may become more agitated , aggressive or distracted in this type of environment (lighting, noise level and number of individuals present.
- **Discharge planning** >>> It is an important component of treatment for the patient with traumatic head injuries. **Environmental modifications required at patient's home and home health care services** should be arranged prior to the patient's discharge from the facility. Some patients may require additional outpatient services following their discharge. Outpatient physical therapy may continue to be needed to improve the patient's physical limitations.

Prognosis

- depends on the severity and location of the lesion, and access to immediate, specialized acute management.
- Most **mild TBI** is completely resolved within **three weeks**, and almost all people with mild TBI are able to live **independently and return to the jobs they had before the injury**.
- **Subarachnoid haemorrhage** approximately doubles mortality.
- **Subdural hematoma** is associated with worse outcome and increased mortality.
- People with **epidural hematoma** are expected to have a good outcome if they receive surgery quickly.

Indications for hospital admission:

- GCS score < 15
- GCS score 15, but with:
  - Continuing amnesia
  - Continuing nausea/vomiting
  - Severe headache
  - Any seizure
  - Focal neurological signs
  - Skull fracture
  - Abnormal brain CT scan
- Significant medical problems
- Social problems/no supervision at home

➢ Indications for hospital Discharge:

- None of the above indications for hospital admission
- Patient must be given head injury advice
- Responsible adult to supervise the patient
- Easy access to a telephone
- Reasonable access to a hospital
- Easy access to transport