



CNS PHYSIOLOGY

- Text
- **Important**
- Formulas
- Numbers
- Doctor notes
- Notes and explanation

Lecture
No.16

"Believe In Your Dreams. They
Were Given To You For A Reason"

Physiology of postural reflexes

Objectives:

- I. Postural reflexes are needed to keep the body in a proper position while standing, moving. When body posture is suddenly altered it is corrected by Sevier reflexes. These reflexes are operating at spinal cord, medulla, mid-brain and cortical levels. To make the reflex movements smooth cerebellum, basal ganglia and vestibular apparatus are needed. Students are required to know posture-regulating parts of CNS.

What is posture?

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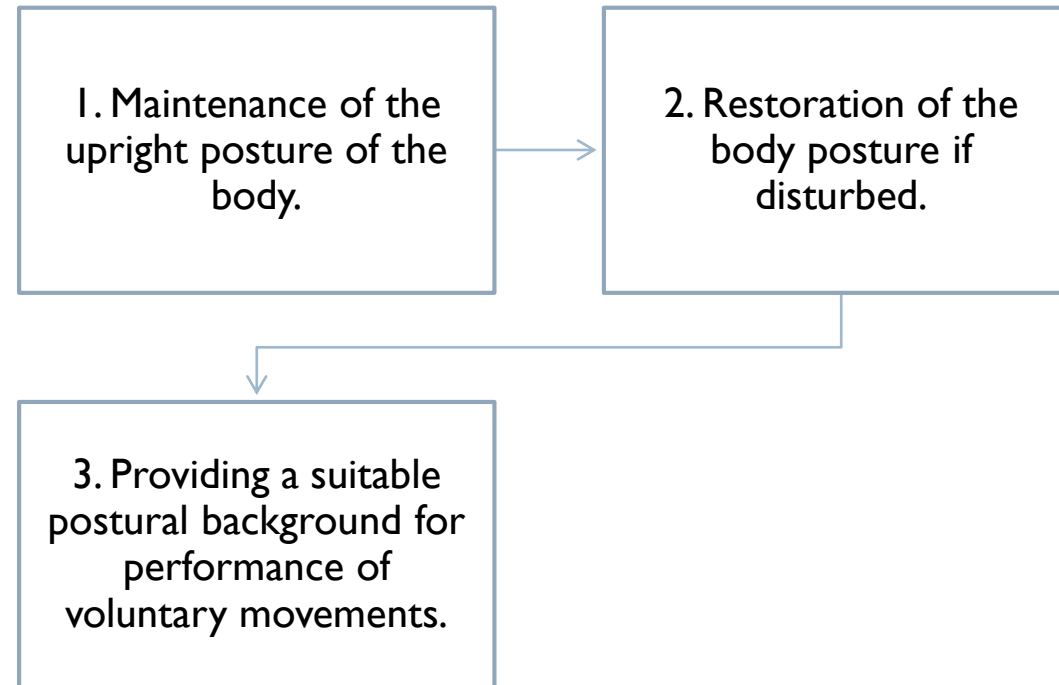
- ▶ Posture is the attitude taken by the body in any particular situation like standing posture, sitting posture, etc.. Even during movement, there is a continuously changing posture.
- ▶ The basis of posture is the ability to keep certain group of muscles in sustained contraction for long periods. Variation in the degree of contraction and tone in different groups of muscle decides the posture of the individual.

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- ▶ It is maintenance of upright position against gravity (center of body is needed to be between the legs) it needs anti-gravity muscles (**Extensor muscles**).
- ▶ Up-right posture need postural reflexes.
- ▶ Posture depends on muscle tone (stretch reflex) (basic postural reflex).
- ▶ The main pathways concerned with posture are:
 - ▶ **Medial tracts**: control proximal limbs & axial muscles for posture & gross movements.
 - ▶ **Lateral pathways**: as corticospinal-rubrospinal control distal limbs.

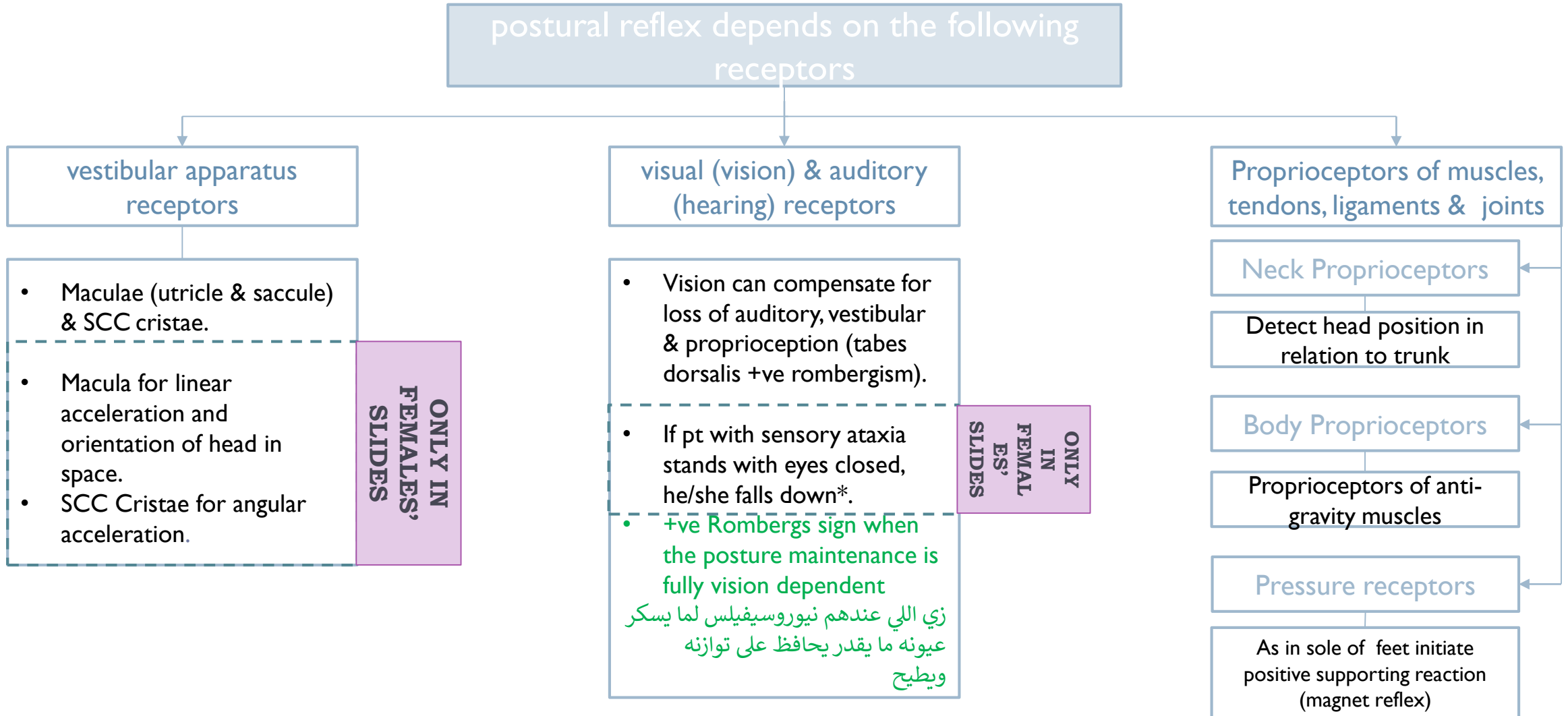
Postural reflex

- ▶ These reflexes resist displacement of the body caused by gravity or acceleratory forces, and they have the following functions:



- ▶ Studied over animals by cutting the centers above the tested area.

Cont.



▶ 5 * Loss of balance when the he standing patient close their eyes is interpreted as a positive romberg's test (sensory ataxia).

Cont.

Postural reflexes

1- Static reflexes
(at rest) (statotonic)
Maintain posture at rest

2- Phasic reflexes “center in C.C”
(with motion) (statokinetic reflex)
Maintain posture during motion

Spinal Reflexes

Medullary Reflexes

Righting Reflexes

Center: In the
midbrain

A- Hopping Reaction

(Explained in the
next slides)

(Explained in the
next slides)

(Explained in the
next slides)

- when animal is pushed laterally reflex hopping to keep limbs in position to support body.
- The receptors are in **muscle spindles**.

B- Placing Reaction

blind folded animal suspended in air & moved towards a supporting surface, the feet will be placed firmly on the supporting surface

(receptors are touch receptors & proprioceptors in soles of feet)

N.B: spinal receptors can be studied in spinal animal with cut at neck between the S.C & brain stem so all S.C is intact.

مثلاً لما شخص يرفع رجل ويوقف على رجل وهكذا، الرجل اللي واقف عليها
positive reaction or magnet reflex (local static)

والرجل المرفوعة

Negative supporting receptor (segmental)

Cont.

Spinal Reflexes “Center in Spinal Cord”

Studied in spinal animals; with cut between spinal cord and brain stem¹

I- Local Static Reflexes (in 1 limb)

i. Positive supporting reaction (magnet reflex)

Receptors are proprioceptors of flexors (contraction of both flexors & extensors) (protective reflex).

When you stand on one feet (contraction of both flexors & extensors AT THE SAME TIME .. Against reciprocal innervation.

ii. Stretch Reflexes (static):

This is the most important local static reflex which controls the tone in those extensor muscles which keep the body upright (antigravity muscles).

2- Segmental Static Reflexes (in 2 limbs)

Mediated by one segment of the spinal cord as:

i. Crossed extensor reflex.

ii. Negative supporting receptor.

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- It refers to disappearance of positive supporting reaction.
- It is initiated by stretch of the extensor muscles.

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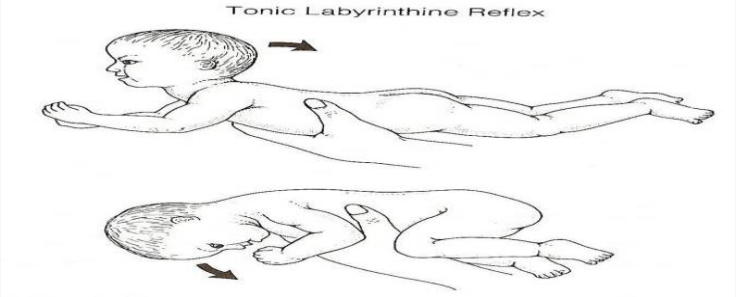
- Which release +ve supporting reaction (receptors are proprioceptors of extensors of the released limb).

In the tested animal we make sure that the reflex is done by spinal cord by cutting all the centers above

Postural Reflex



Medullary Reflexes “center in Medulla oblongata”

1- Neck Static Reflexes	2- Labyrinthine static reflex
<ul style="list-style-type: none"> Studied in: a decerebrated animal cut above medulla + labyrinth destroyed. 	<ul style="list-style-type: none"> Studied in: decerebrated animal + elimination of neck proprioceptors (labyrinth intact).
<ul style="list-style-type: none"> Stimulus is: changing head position that (+) neck proprioceptors. 	<ul style="list-style-type: none"> Stimulus is: gravity <ul style="list-style-type: none"> 1- ventroflexion of head (or prone position) 4 limbs flexion 2- dorsiflexion of head (or supine position) 4 limbs extended(as in decerebration)
<ul style="list-style-type: none"> Neck Static reflexes: (Movements that stimulate proprioceptors) <ul style="list-style-type: none"> Ventroflexion of head: Flexion of forelimb (arms) + extension of hind limb (as in decerebration). Dorsiflexion of head: Extension of forelimb (arms) + flexion of hind limb. Turning head to one side: Extension of limbs on that side + flexion of other side. 	<ul style="list-style-type: none"> Receptors are: otolith organs (maculae).  <p>The diagram, titled 'Tonic Labyrinthine Reflex', illustrates the reflex response in a decerebrate animal. The top illustration shows the animal in a prone position (ventroflexion of head), with its forelimbs flexed and hindlimbs extended. The bottom illustration shows the animal in a supine position (dorsiflexion of head), with its forelimbs extended and hindlimbs flexed. Arrows indicate the direction of head movement and the corresponding limb positions.</p>

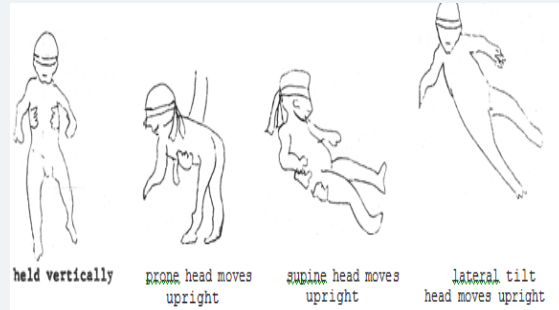
- Cancellation of the effect of neck proprioceptors is done through cutting first three cervical nerves.
- The difference between the two types is one of them depends on labyrinth with abolishing the effect of neck proprioceptors and vice versa for the other type.



when upright posture is disturbed as in falling down. (When the body goes off balance and falls down, the righting reflexes helps the body to regain the upright position)

Studied in a decerebrated animal (cut above midbrain = upper decerebration)

IA- labyrinthine righting reflexes (midbrain):



Definition:

- cover eyes & animal held in air from pelvis (the body is not in the proper position)
- As in tilting the head: (+) otolith organs → (+) neck muscles to correct the head level (when head is not in proper site)
- All static labyrinthine reflexes have macula as receptors but in statokinetic reflexes during motion macula act in linear & SCC receptors act in angular acceleration

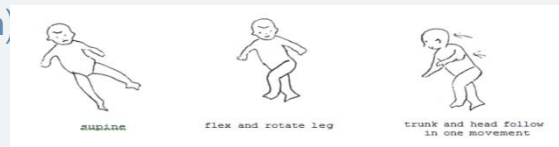
Stimulus: the body is not in the proper position

Receptors: otolith organs

Response: righting of head

IB- Body on head righting reflexes (midbrain)

studied in mid brain animal with destroyed labyrinth



Stimulus: pressure on side of body & head is free

Receptors: trunk proprioceptors (body pressure receptors)

Response: reflex correction of head

IC- Neck righting reflexes (midbrain):

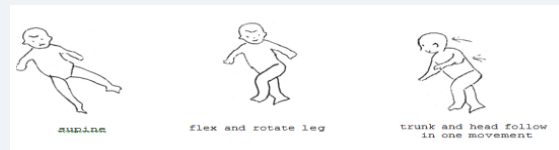


Stimulus: stretch of neck muscles (if head is corrected & body still tilted) righting of shoulders & body.

Receptors: muscle spindles of neck muscles

Response: righting of body

ID- Body on body (midbrain):



Stimulus: Pressure on side of the body and head is fixed

Receptors: trunk proprioceptors (body pressure receptors)

Response: reflex correction of body

2- visual righting reflexes (cortical/ cerebral cortex):

Studied in animals with intact brain (no decerebration), cutting upper 3 cervical nerves + destruction of the labyrinth

Stimulus: Visual stimulus (visual image can correct position of head & body if position is disturbed)

Receptors: eye receptors

Decerebrate rigidity & decorticate rigidity

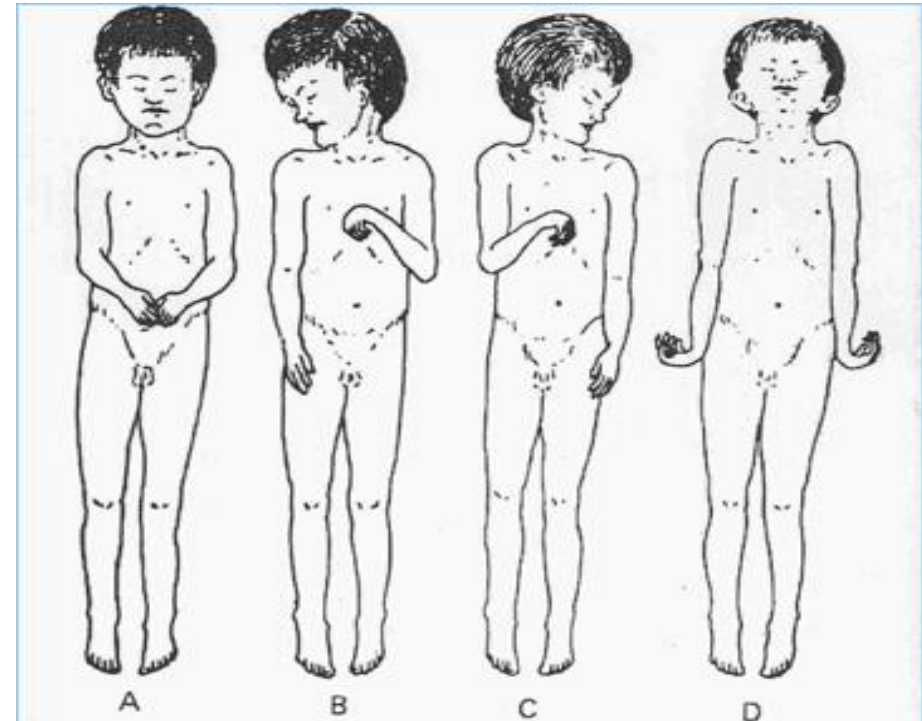
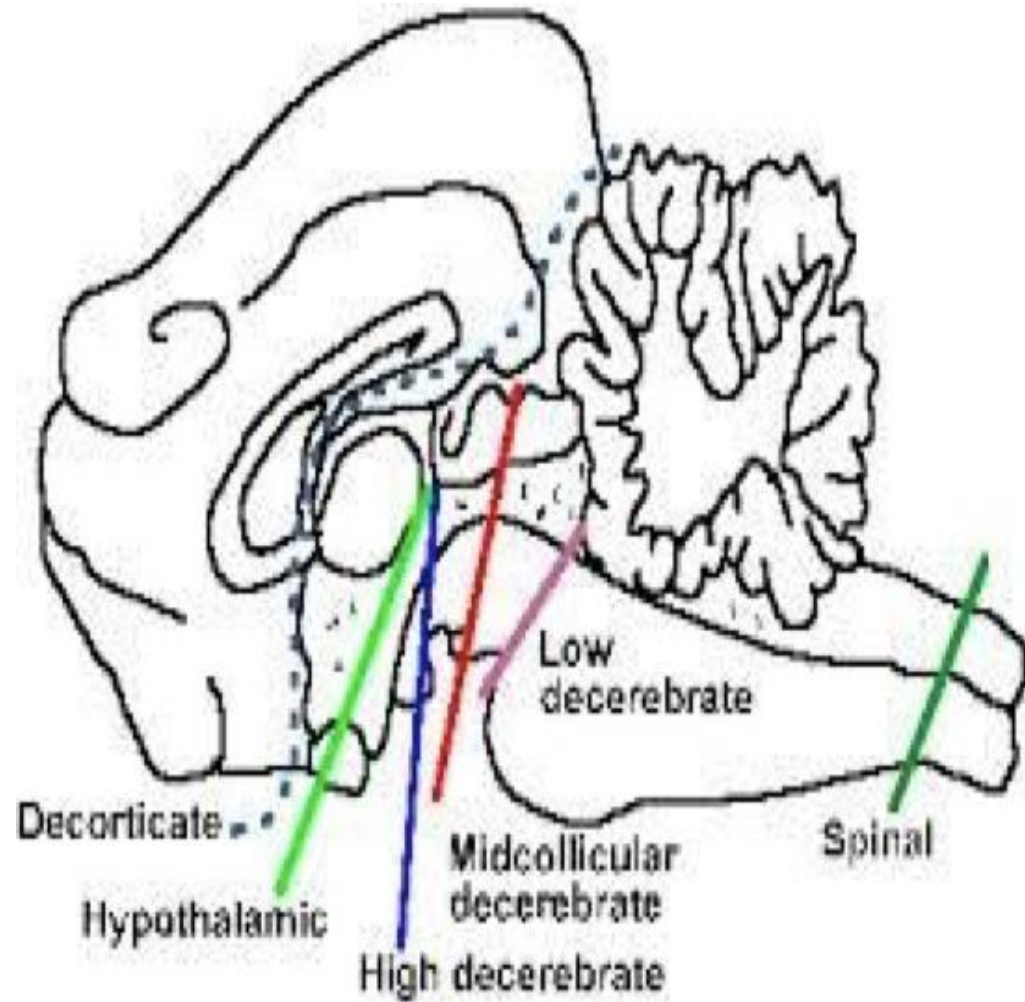


Figure 12-7. Human decorticate rigidity (**A-C**) and true decerebrate rigidity (**D**). In **A** the patient is lying supine with the head unturned. In **B** and **C**, the tonic neck reflex patterns produced by turning of the head to the right or left are shown. (Reproduced, with permission, from Fulton JF [editor]: *Textbook of Physiology*, 17th ed. Saunders, 1955.)

Decerebrate Rigidity

- ▶ **Site of lesion:** between the superior and inferior colliculi of the midbrain, lesion below Red Nucleus (e.g. mid-collicular lesion).
- ▶ block normal inhibitory signals from brain & red nucleus in midbrain to tonically active pontile R.F & Vestibular nucleus causing:

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Extensive extensor posture of all extremities → Rigidity of all 4 limbs.

- ▶ All limbs extended, arms extended by the sides & rotated internally (outward).
- ▶ Hallmark → elbows extended.
- ▶ Head may be arched to the back, it is due to:
Increased general excitability of the motor neuron pool; especially Gamma efferent discharge (due to facilitatory effects of the uninhibited Vestibulospinal Tract).

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- ▶ Maintained tonic static postural reflexes that support animal against gravity:
 - a. medullary tonic neck.
 - b. medullary labyrinthine R). 2-Absent midbrain righting R 3- Extension of head & 4 limbs extensors (as in labyrinthine static R).
- ▶ The jaw may be clenched with the neck hyperextended due to increased extensor tone from vestibulospinal & reticulospinal tracts to extensor motor neurons.
- ▶ spasticity & rigidity & extension in antigravity muscles.

Decerebrate posture results from damage to the upper brain stem. In this posture, the arms are adducted and extended, with the wrists pronated and the fingers flexed. The legs are stiffly extended, with plantar flexion of the feet.

DECEREBRATE



Cont.

▶ In a decerebrated animal:

- ▶ damage to level below red nucleus.

▶ Features of decerebrate rigidity:

1. Hyperextension of all four limbs.
2. Dorsiflexion (hyperextension) of tail and head.
3. Extreme hyperextension of the spine (opisthotonus) produces concave configuration of the back.
4. The animal can be made to stand on four limbs but is easily toppled by slight push.
5. The jaw may be clenched with the neck hyperextended due to increased extensor tone from vestibulospinal & reticulospinal tracts to extensor motor neurons.
6. Spasticity & rigidity & extension in antigravity muscles.

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FEMALES' SLIDES

▶ Reflexes that are lost/absent:

1. Optical (visual) righting Reflexes.

▶ Reflexes that are retained / still present i.e. reflexes that do not depend primarily on cerebrum:

Maintained tonic static postural reflexes that support animal against gravity (medullary tonic neck & labyrinthine R).

1. Tonic Labyrinthine reflexes.
2. Tonic Neck Reflexes.
3. Other Righting Reflexes.

Cont.

▶ Decorticate rigidity more common in human than decerebrate rigidity:

1. lesion in cerebral cortex but brain stem is intact, as what seen in hemiplegic pts after Hge of internal capsule.
2. Medullary tonic neck & tonic labyrinthine reflexes present.
3. Righting midbrain reflexes present.
4. Visual righting, placing & hopping reflexes lost.
5. it causes extensor rigidity in legs & moderate flexion of arms if head unturned , as supine position (tonic neck reflexes).

Turning the head to one side initiates tonic neck reflexes, ex:
turning head to the left = extension of limbs on left side & flexion of right side.

▶ Cause:

1. Lesions above the red nucleus so rubrospinal are intact together with pontine reticulospinal and the vestibulospinal leads to the characteristic flexion posturing of the upper extremities and extensor posturing of the lower extremities.
2. Since the corticospinal tract is interrupted, the pontine reticulospinal and the vestibulospinal extend I.L.
3. Normally suppressor area 4 strip in the anterior edge of precentral gyrus inhibit red nucleus , if this inhibition is lost by decortication ,red nucleus is disinhibited.
4. Disinhibition of the red nucleus facilitate the rubrospinal tract to flex U.L.
5. Also there is loss of inhibitory cortical signals (from suppressor area 4 strip in the anterior edge of precentral gyrus) to gamma motor neurons via reticulospinal.

Decorticate Rigidity (actions of the cerebral cortex are removed)

- ▶ In humans, where true decerebrate rigidity is rare, since the damage to the brain centers involved in it are lethal.
- ▶ Decorticate rigidity more common in human than decerebrate rigidity, due to: Lesion in cerebral cortex, but brain stem is intact. As seen in hemiplegic patients after Hge of internal capsule.
- ▶ However decorticate rigidity can be caused by bleeding in the internal capsule which causes UMNL (damage to upper motor neurons).
- ▶ **Symptoms & Signs:**
 - Flexion in the upper limbs.
 - extension in the lower limbs.

- extensor rigidity in legs & moderate flexion of arms if head unturned, as supine position (tonic neck reflexes).
- The hands are clenched into fists, and the legs extended and feet turned inward.
- Tonic neck reflexes are produced by turning the head to one side, ex: to the left extension of limbs on left side & flexion of RT.

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Decorticate Rigidity

In a decorticate animal:

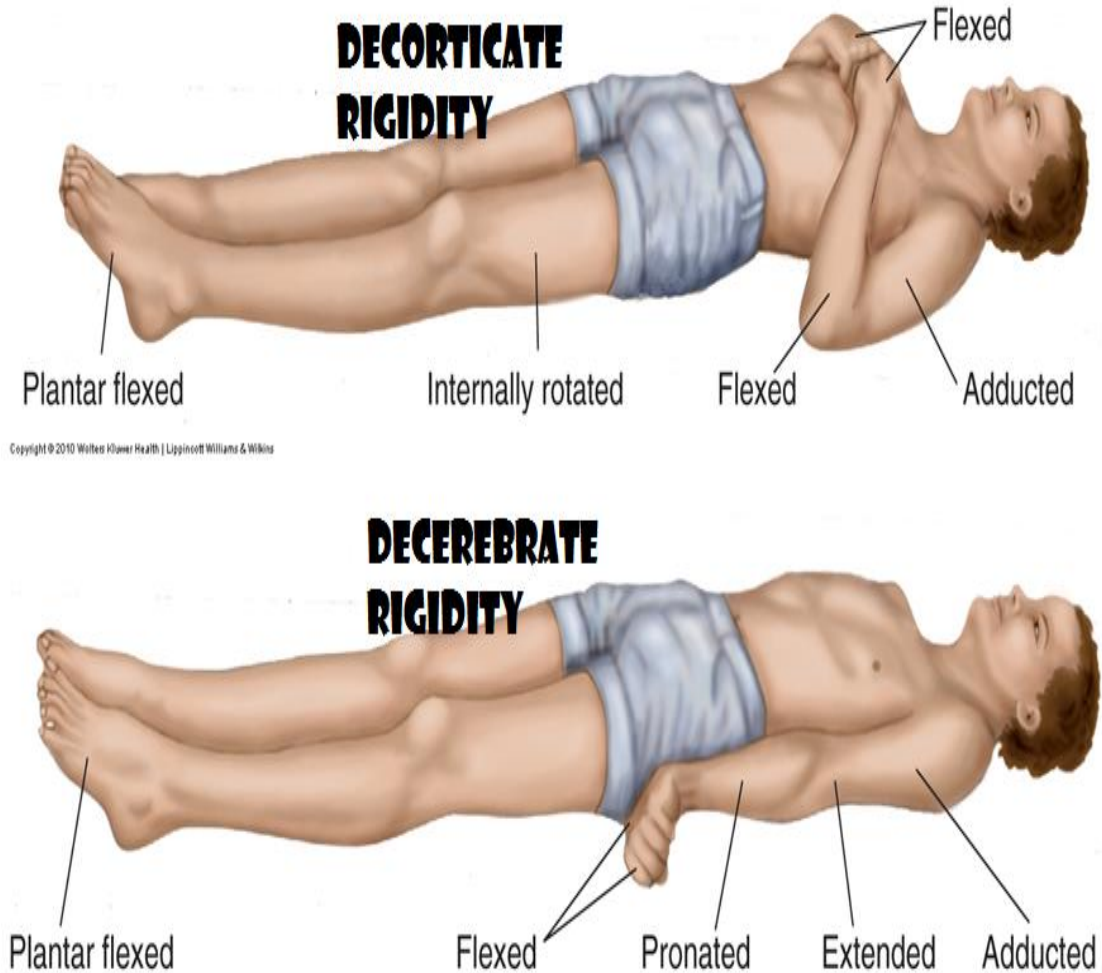
- ▶ Decorticate animal is one in whom the whole cerebral cortex is removed but the basal ganglia and brain stem are left intact.
- ▶ Characteristic features: moderate rigidity is present.
- ▶ Cortex inhibit medullary reticulospinal tract. Therefore, removal of cortex results in facilitation of γ motor neuron discharge.
- ▶ Reflexes that are lost/absent:
 1. Placing reaction, hopping reaction
 2. Visual righting reflex
- ▶ Reflexes that are retained /still present i.E. Reflexes the do not depend primarily on cerebral cortex:
 1. Tonic labyrinthine reflexes
 2. Tonic neck reflexes
 3. Other righting midbrain reflexes

Decorticate posture results from damage to one or both corticospinal tracts. In this posture, the arms are adducted and flexed, with the wrists and fingers flexed on the chest. The legs are stiffly extended and internally rotated, with plantar flexion of the feet.

DECORTICATE



Decerebrate rigidity & decorticate rigidity



POSTURING

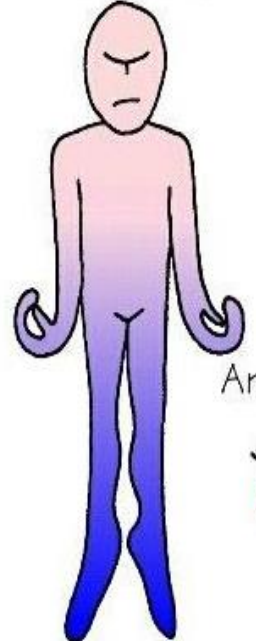
DECORTICATE
(Flexor)



Arms are like "C's"
Moves in toward the "Cord"

Problems With Cervical Spinal Tract or Cerebral Hemisphere.

DECEREBRATE
(Extensor)



Arms are like "e's"

Problems Within Midbrain or Pons.

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Summary of postural reflexes

الجدول هذا هو الي أبغاكم تعرفونه من المحاضرة

Table 12–2. Principal postural reflexes.

Reflex	Stimulus	Response	Receptor	Integrated In
Stretch reflexes	Stretch	Contraction of muscle	Muscle spindles	Spinal cord, medulla
Positive supporting (magnet) reaction	Contact with sole or palm	Foot extended to support body	Proprioceptors in distal flexors	Spinal cord
Negative supporting reaction	Stretch	Release of positive supporting reaction	Proprioceptors in extensors	Spinal cord
Tonic labyrinthine reflexes	Gravity	Contraction of limb extensor muscles	Otolithic organs	Medulla
Tonic neck reflexes	Head turned: (1) To side (2) Up (3) Down	Change in pattern of extensor contraction (1) Extension of limbs on side to which head is turned (2) Hind legs flex (3) Forelegs flex	Neck proprioceptors	Medulla
Labyrinthine righting reflexes	Gravity	Head kept level	Otolithic organs	Midbrain
Neck righting reflexes	Stretch of neck muscles	Righting of thorax and shoulders, then pelvis	Muscle spindles	Midbrain
Body on head righting reflexes	Pressure on side of body	Righting of head	Exteroceptors	Midbrain
Body on body righting reflexes	Pressure on side of body	Righting of body even when head held sideways	Exteroceptors	Midbrain
Optical righting reflexes	Visual cues	Righting of head	Eyes	Cerebral cortex
Placing reactions	Various visual, exteroceptive, and proprioceptive cues	Foot placed on supporting surface in position to support body	Various	Cerebral cortex
Hopping reactions	Lateral displacement while standing	Hops, maintaining limbs in position to support body	Muscle spindles	Cerebral cortex



Thank you!

اعمل لترسم بسمة، اعمل لتمسح دمة، اعمل و أنت تعلم أن الله لا يضيع أجر من أحسن عملا.

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QUIZ



اقتراحات وشكاوي

References:

- Females and Males slides.
- Guyton and Hall Textbook of Medical Physiology (Thirteenth Edition.)