19 Cerebellum

CNS

Sources:
female slids

OBJECTVIES

✓At the end of this lecture you will be able to:-

✓Describe the functional divisions of the cerebellum vestibulocerebellum, spinocerebellum and cerebrocerebellum

✓Define the physiological roles of the cerebellum in regulation of movement.

✓ Explain the abnormalities associated with cerebellar disease: Cerebellar nystagmus, changes in muscle tone, ataxia, drunken gait, scanning speech , dysmetria (past-pointing), intention tremor,rebound phenomenon and adiadochokinesia.

Location of cerebllum

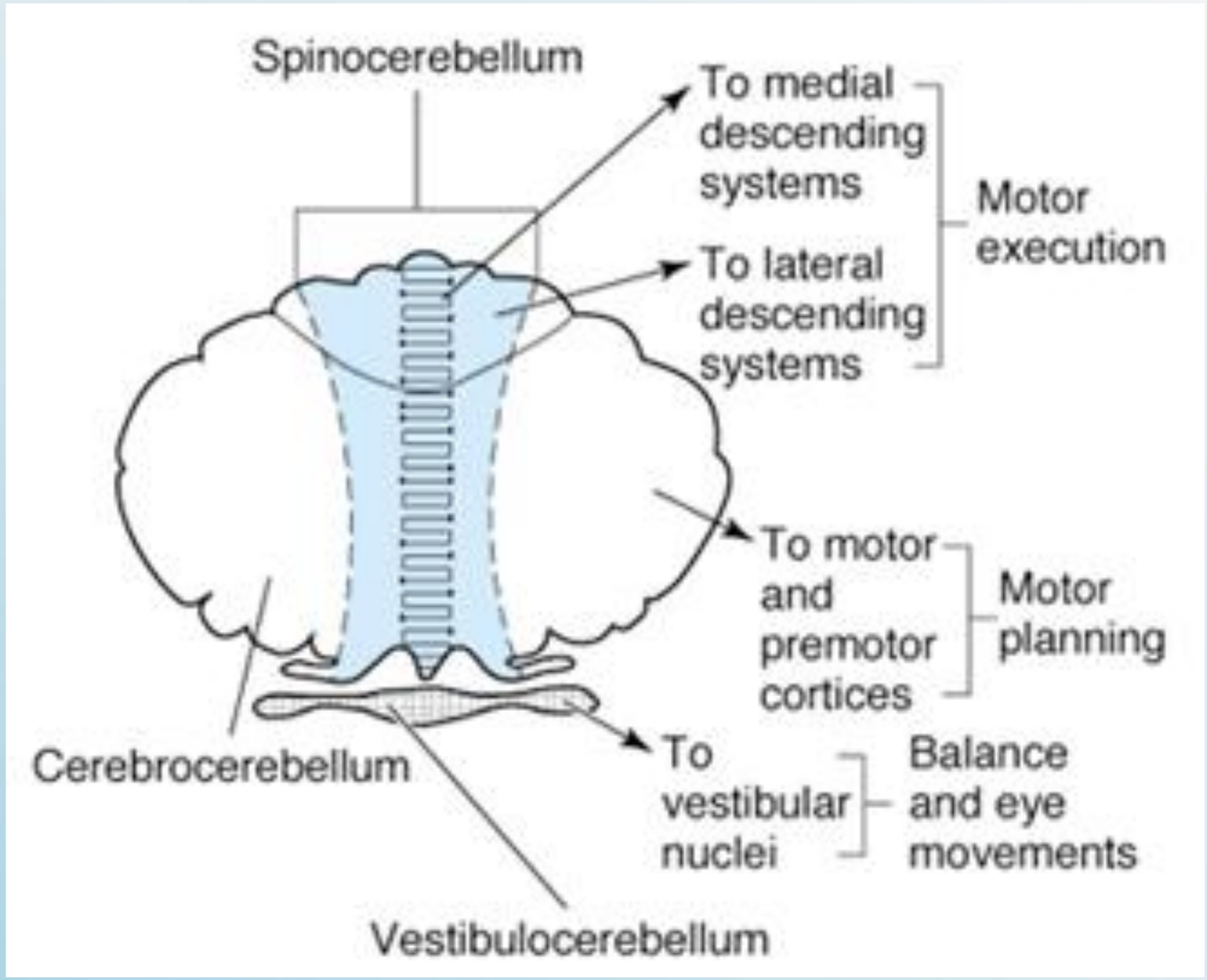
- ✓Occupies a prominent position beside the main sensory and motor systems in the brain stem.
- ✓It is connected to the brain stem by three cerebellar peduncles: superior, middle and inferior.
- ✓Various fibers inter and leave the cerebellum through these peduncles

Functions of cerebellum

- ✓**Maintenance of equilibrium :** balance, posture, eye movement
- ✓**Coordination of half-autonomic movement of walking and posture maintenance**
- ✓**Adjustment of muscle tone**
- ✓**Motor Learning – Motor Skills**

functional divisions of the cerebellum

The anterior & posterior lobes on each side constitute 2 large cerebella hemispheres, which are separated by a narrow band called the vermis



✓**Spinocerebellum**

Motor execution

✓**Vestibulocerebellum**

Balance and eye movement

✓**Cerebrocerebellum**

Motor planning

STRUCTURE AND CONNECTION OF CEREBELLUM

Cerebellum has an external layer of gray matter (cerebellarcortex) is deeply infolded, giving a large surface area , and it contains five different cell types :

1-Golgi, 2-basket, 3-stellate are inhibitory interneurons

4-granule cells, which are excitatory

5-purkinje cells which are the output cells inhibit the deep nuclear cells (DNCs)

an inner white matter continue 3 deep nuclei

1- Dentate

2- Fastigial

3- Interpositous (formed of globose and emboliform nuclei)

The inhibitory neurons in the CB release GABA (e.g stellate, basket, Golgi, PC)

The excitatory neurons release glutamate (e.g. granule cells, that also has GABA A receptors)

AFFERENT FIBERS (INPUT)

All afferent fibers relay first at the deep nuclei and the cerebellar cortex, then the latter discharges to the deep nuclei, from which the efferent fibers originate and leave the CB (efferent arieses from deep nuclie)

✓The CB receives both sensory and motor information through a rich afferent nerve supply This arises from :

1-Other areas of the brain

2-Peripheral receptors

✓And enters the CB via the 3 cerebellar peduncles

AFFERENT FIBERS

Climbing fibers :

- ✓ From the inferior olivary nucleus
- ✓ It learns the cerebellum to perform new patterns of movements precisely

Mossy fibers:

- ✓ All other afferent fibers that enter the cerebellum + some fibers coming from the inferior olivary nucleus (**greater than the climbing fibers**)
- ✓ Help the precise execution of the voluntary movements *(concerning their initiation, duration and termination), which occurs by controlling the turn on and turn off output signals from the cerebellum to the muscles*.

EFFERENT FIBERS

- ✓ There are 3 main efferent pathways from the 3 parts of the CB
- ✓ Are the axons of the 3 deep nuclei
- ✓ Leave the CB through the superior and inferior peduncles

FUNCTION OF THE CEREBELLUM

✓The CB is called the silent area, because its stimulation does not give rise to any sensation and cause almost no motor movements

✓It is important in the **precise execution of rapid muscular movements**

✓Damage to the CB cause almost **total in coordination of muscular movements**, although the muscles are not Paralyzed

✓The cerebellum is concerned only with **subconscious control of motor activity**

1-Control of equilibrium & postural movements

The function of the Vestibulocerebellum It receives information from the vestibular apparatus then through the fastigal nucleus,it discharges to the brain stem, and through the vestibulospinal and reticulospinal tracts. It controls equilibrium & postural movements by **affecting the activity of the axial muscles (trunk & girdle muscles)**

vestibular apparatus

Vestibulocerebellum

fastigal nucleus

brain stem

the vestibulospinal and reticulospinal tracts

Spinal cord

equilibrium & of the axial muscles postura

LESION IN THE VESTIBULOCEREBELLUM

Due to a tumor called medulloblastoma

Lead to trunk ataxia which is characterized by:

Equilibrium disturbances:

- ✓the patient sways on standing,
- ✓cannot maintain the erect posture,needs support,
- ✓ walks by a staggering or drunken gait
- ✓have nystagmus

B) Control of the Stretch Reflex

✓The **cerebrocerebellum** exerts a facilitatory effect on the stretch reflex & increases the muscle tone

✓The spinocerebellum probably exerts an inhibitory effect

normally the facilitatory effect predominates so cerebellar disease often results in hypotonia

C) Control of voulantary movement by cerebellum

Each cerebellar hemisphere is connected by efferent and afferent pathways to the contra lateral cerebral cortex *(the cortico –ponto-crebello-dentato- thalamo- cortical circuit)*

the cerebellum exerts its **effects on the same side of the body**.
The vermis controls muscle movements of the axial body neck, shoulders and hips.

The intermediate zones controls muscle contractions in the distal portions of both the upper and lower limbs (especially the hands, fingers, feet and toes).

The lateral zones help in the planning of sequential movements.

Other function of cerebellum

The CB co-ordinates involuntary postural movements initiated by extra-pyramidal system by acting as comparator (in the same way as intvoluntary movement) and correcting errors so movements do not over shoot

Cerebellar Lesion

1. The neocerebellar syndrome :

Due to **damage of the deep cerebellar nuclei as well as the cerebellar cortex**

The **manifestations** occur **on the same side of the lesion (ipsilatteral)**

i.e a lesion of the left cerebellar hemisphere produce sits effects on the left side of the body ,etc.

Bilateral dysfunction of the cerebellum is caused by :

1. Alcoholic intoxication
2. Hypothyroidism
3. inherited cerebellar degeneration (ataxia)
4. multiple sclerosis
5. non metastatic disease.

Manifestations of neocerebellar syndrome :

a) Hypotonia: Due to loss of the facilitatory effect of the CB on the stretch reflex, and it is associated with ***pendular knee jerk*.**

b) Athenia*:* (muscle weakness): This is due to difficulty in initiation and maintenance of muscle contraction secondary to loss of the potentiating signals by the mossy fiber circuit.

c) Motor ataxia: In coordination of the voluntary movements, specially the rapid movements (becoming abnormal in rate, range, force and direction).

http://www.dailymotion.com/video/x1j0an_cerebellar-disease_family

Cerebellar Lesion

2. Ataxia :

This is incoordination of voluntary movements. It is either **sensory** or **motor** **(or mixed).**

Motor ataxia:

Is due to defect in the coordination of the voluntary movements.

It commonly occur in lesions of either

a- **the cerebellum** or spinocerebellar tracts

b-the labyrinth (vestibular apparatus)

c-the cortical motor areas.

Cerebellar Ataxia :

Left cerebellar tumor

Ataxic gait and position:

a. Sways to the **right** in standing position

b. Steady on the **right** leg

c. Unsteady on the **left** leg

d. ataxic gait

Manifestations of Motor ataxia

1-Dysmetria

2-Kinetic (intension, action or terminal) tremors

3. Rebound phenomenon

4-Asynergia

5-Dysartheria

It will explain in the next slides

6-Failure of progression of movements: manifested by: a-Adidokokinesia

b-Decomposition (fragmentation of movements)

7-Nystagmus

8-Staggering (drunken) gait

Manifestations of Motor ataxia

1-Dysmetria:

Inability to control the distance of the motor act, which may either overshoot the intended point (= hypermetria or past pointing) or stop before it.

2-Kinetic (intension, action or terminal) tremors:

This an oscillatory movement that appears on performing a voluntary movement (especially at its end) but is absent at rest.

It can be demonstrated by the finger nose test.

It occurs **secondary to dysmetria** and is due to a series of subconscious correction of the overshoot followed by over shoot of the correcting movements

3. Rebound phenomenon:

This is over shooting of a limb when a resistance to its movement is suddenly removed. (loss of the braking function of the CB),(the arm pulling or flexion) test

4-Asynergia:

This is loss of the harmony between the three groups of muscles involved in performance of voluntary movement the agonists, protagonists, and antagonists).

Manifestations of Motor ataxia

5-Failure of progression of movements: manifested by:
a-Adidokokinesia(=dysdiadokokinesia)
Inability to perform alternate (opposite) movements successively at a rapid rate
e.G pronation and supination of the forearm or upward and downward movement the hand.

It is usually caused by multiple sclerosis in adults and cerebellar tumors in children.
Patients with other movement disorders (e.g. Parkinson's disease) may have abnormal rapid alternating movement testing secondary to akinesia or rigidity, thus creating a false impression of dysdiadochokinesia.

b-Decomposition (fragmentation of movements):
Inability to perform actions involving simultaneous movements at more than one joint.

Manifestations of Motor ataxia

6-Dysartheria:

This is difficulty in producing clear speech. It is due to incoordination of the speech muscles secondary to loss of the predictive functions of the CB. The syllables may be too long or too short, loud or weak and speech may be also **staccatoor scanning** i.e cut off into separate syllables.

7-Nystagmus:

This is tremor of the eyeballs that occurs on looking to an object placed at one side of the head. (mainly in vestibulocerebellar damage). Nystagmus is a very common feature of multiple sclerosis).

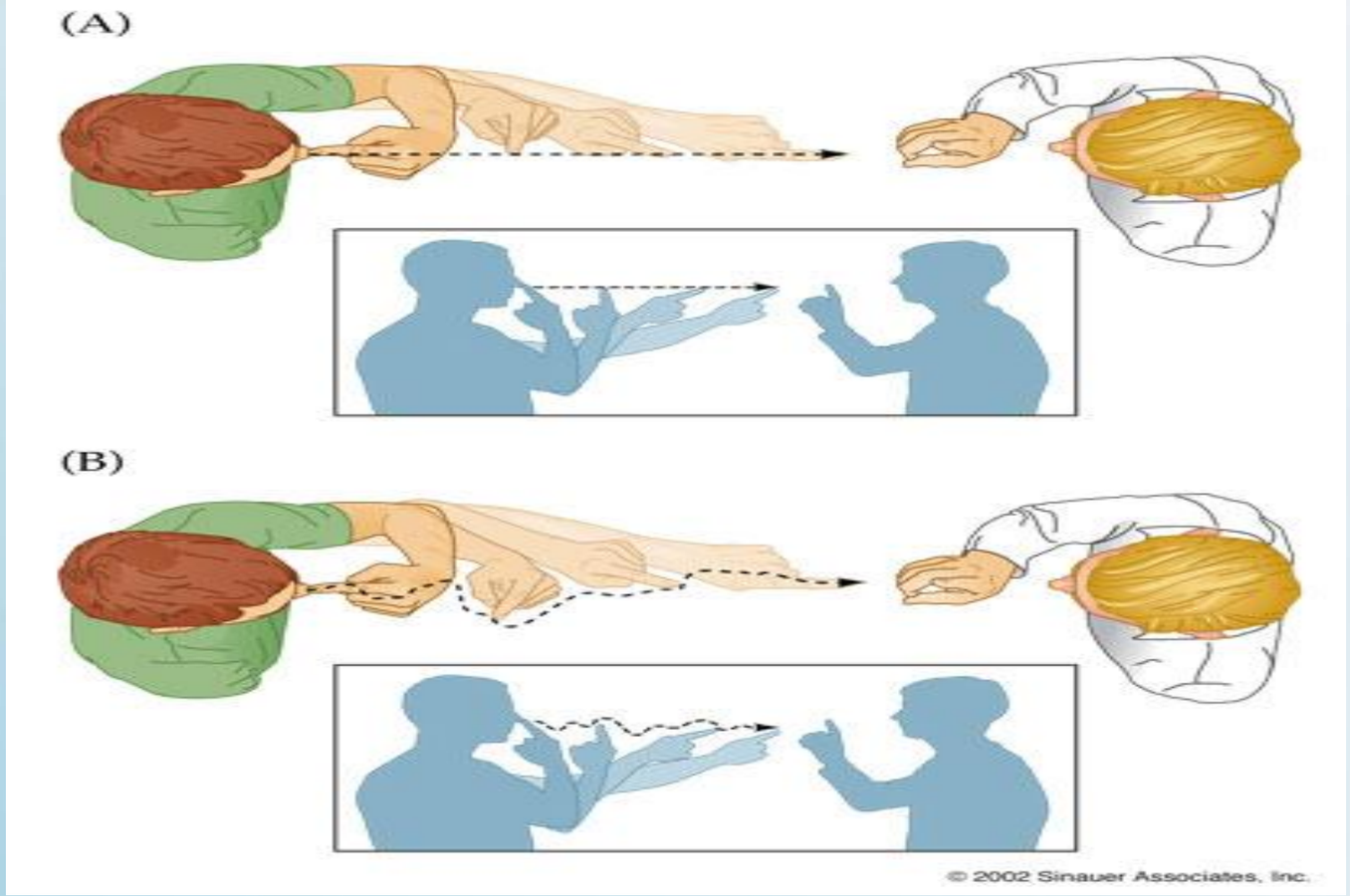
8-Staggering (drunken) gait:

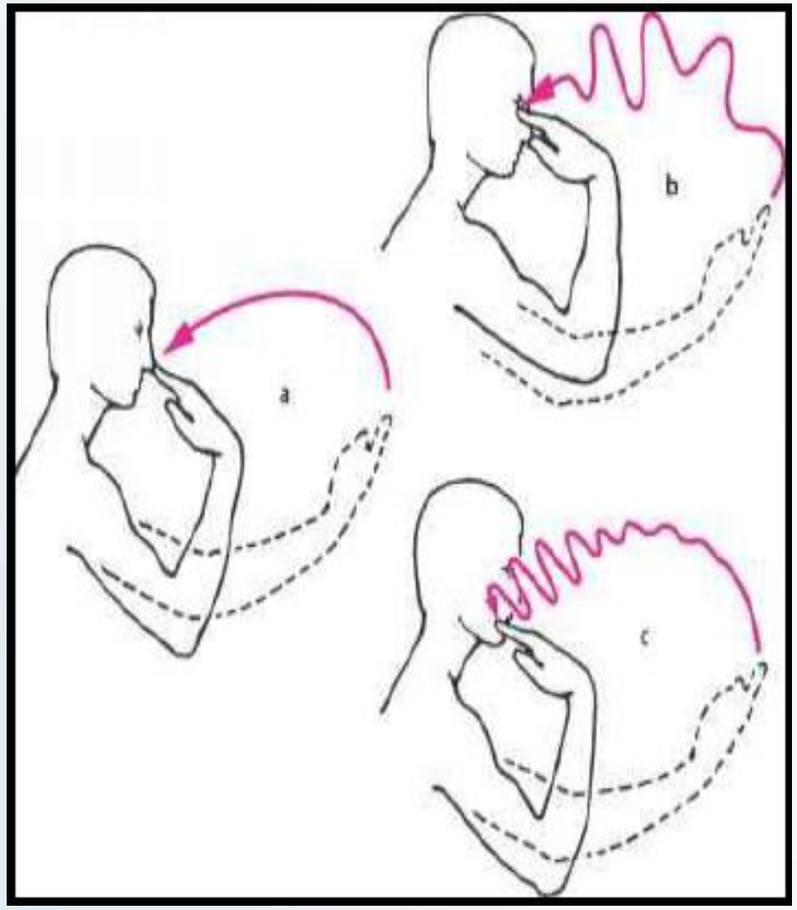
The patient walks unsteady –on a wide base (zigzag-like gait) in a drunken(swaying) manner, and tends to fall on the diseased side. Such gait is more apparent with archicerebellar Damage

FINGER NOSE TEST

While the examiner holds his finger at arm's length from the patient. Patient touches her nose and then touches the examiner's finger. After several sequences, the patient is asked to repeat the exercise with her closed eyes.

A patient with a cerebellar disorder tends to miss the target.





HEEL TO SHIN TEST

The heel to shin test is a **measure of coordination and may be abnormal if there is loss of motor strength, proprioception or a cerebellar lesion.**

If motor and sensory systems are intact, an abnormal, asymmetric heel to shin test is highly suggestive of an ipsilateral cerebellar lesion.

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CNS Block