



SPASTICITY AND INCREASED MUSCLE TONE

Objectives:

- ❖ Define spasticity rigidity & hypertonia
- ❖ Know main causes of spasticity & rigidity
- ❖ Appreciate that spasticity is an important conditions that is encountered in a broad spectrum of medical specialties such as neuropsychiatrics, adult neurology, orthopedics, rehabilitation medicine and others.
- ❖ Be able to define the term spasticity and understand that it occurs in medical conditions frequently encountered in the Kingdom such as stroke, multiple sclerosis, cerebral palsy, traumatic spinal cord and brain injury, cerebral and spinal tumors, spinal cord disc lesions; and in less common but important & preventable conditions such as tetanus and spinal cord infections such as tuberculosis of the spine.
- ❖ Explain the neurophysiological basis of clinical features associated with multiple sclerosis, cerebral palsy, traumatic spinal cord injury tuberculosis of the spine and tetanus.

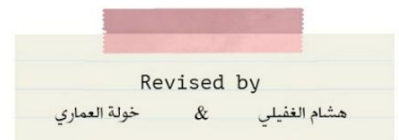
Girls Slides Version

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★ References:

- 435 girls slides and notes.



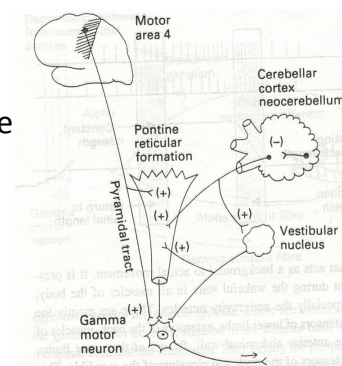
Color index: Important - Further explanation - Doctors Notes - Numbers.

*Please check out [this link](#) before viewing the file to know if there are any additions or changes.

Gamma efferent and the muscle tone

Q: Increased gamma efferent discharge is the main cause of increased muscle tone. How?

- It controls the muscle spindle by enervating the contractile part of the intrafusal muscles, so the muscles will be tense and sensitive all the time to receive any impulse or input.
- So, ↑ impulses to gamma motor neurons by (motor area 4 and pontine reticular formation) → ↑ impulses to muscle spindle → it'll keep the muscles stretched all the time → keep the extrafusal muscles contracted all the time → spasticity and hypertonia



(Anxiety, stress and jendrassik maneuver are also facilitatory)

❖ So What will happen in hypertonia?

When there is a **loss of descending inhibition** from the brain Higher Motor-inhibitory centers (**medullary RF & basal ganglia**) resulting in **un-antagonized** excitatory input from brainstem excitatory centers As (**pontine RF + vestibular N**) through Vestibulospinal & reticulospinal excitatory tracts to gamma motor neurons causing hypertonia & spasticity of muscles

Hypertonia:

• What is it ?

Refers to **increased resistance** to passive lengthening (passive stretch) of a muscle or muscle group. This means increased stiffness of the muscle and reduced ability of a muscle to stretch.

يعني لما اسوي للمريض Flexion راح الاقي مقاومة من العضلة

→ Hypertonicity could be due to a neural drive problem such as **spasticity** or **rigidity**

It is caused by injury to motor pathways in the CNS which carry information from the central nervous system to the muscles and control posture, muscle tone and reflexes.

	Spasticity	Rigidity
Definition	Involuntary velocity dependent increased resistance to passive movement of the muscle due to : Abnormally high muscle tone (hypertonia) which varies with the speed of displacement of a joint	Involuntary increased resistance to the passive movement of a muscle which is constant throughout the movement and not related to the speed of movement
Velocity	"The faster you stretch the muscle the greater the resistance" very important	Is not velocity dependent

Association	neural in nature and is associated with the UMNL	Rigidity is usually Is often associated with basal ganglia disease such as Parkinson's disease
Involvement	Involves the corticospinal tract is often associated with UMNL and spasticity.	Extrapyramidal in origin and includes that and other features of increased muscle tone but tends to be used more often when describing extrapyramidal conditions
Directional	Uni-directional (only in flexors or extensors)	Resistance is present in both agonist and antagonist (bi-directional) الفرق المهم بين السباستيسيتي والريجيديتي ان قلنا بالسباستيسيتي يكون المقاومة بحركة وحده مثل بس flexion اما بالريجيديتي سيكون flexion and extension كلها فيها مقاومة .
Test	Fast flexion or extension of selected joint.	passively move the joint in both direction.
Types	Clasp-knife spasticity in UMNL describe a sudden release of tone after an initial hypertonia of selected joint movement معناها بالعربي الفصيح هو كساراة البندق، لأنها بالبداية تقاوم الحركة اللي بسويها مثل flexion وبعدها تصير زي مافيه مقاومه.	1. Uniform rigidity in both agonist and antagonist muscle group is known as lead pipe rigidity 2. If there is tremor superimposed with background increase of tone is cogwheel rigidity . (These rigidity is commonly seen in Parkinson's disease) زي حركة عجلة الثرس، يفك وبعدين يمस्क ويفك ويمسك وهكذا، ليش الحركة مو ثابتة؟ بسبب وجود ال tremors.
Causes	UMNS syndrome include: 1- Cerebral palsy 2- Stroke 3- Spinal cord injury 4- Multiple Sclerosis 5- Acquired brain injury (trauma , etc)	1-Parkinsonism 2-Decerebrate & decorticate rigidity

❖ Summary

- **Spasticity** is resistance to passive stretch + an involuntary + velocity-dependent + unidirectional ---> resistance to movement
- **Rigidity** is resistance to passive movement+an involuntary + not velocity-dependent + bidirectional ---> resistance to movement

Spasticity

- **There are a number of clinical features that are spasticity associated reactions :-**

1- Hyperflexia

2- Flexor spasticity in the upper limb and extensor in the lower limb.

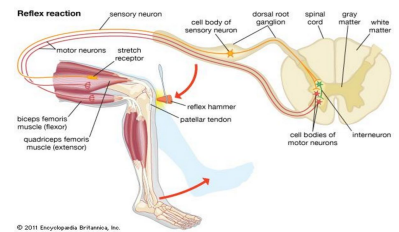
عشان نتذكر هذا كمان كان يصير عندنا بال decorticate

- ◀ **Spasticity and hypertonia** is a feature of altered muscle performance
 - Usually in Upper Motor Neuron Syndrome (UMNS).
 - Patients complain of stiffness and inability to relax
 - Muscles become permanently "tight" or spastic.
 - The condition can interfere with walking, movement, or speech.
- ◀ **Spasticity with the increased muscle tone** together cause a contraction and **deformity of a limb**. It is what we try to avoid with physiotherapy.

يعني يصير عنده زي الإعاقة لأنه مو قادر يتحرك بسهولة The person will be handicapped

- **Spasticity** is a motor disorder characterised by hyperexcitability of both types of stretch reflex:

1. Increase in tonic **static stretch reflexes** (muscle tone) as one component of the upper motor neurone (UMN) syndrome
2. Exaggerated tendon jerks resulting from **hyperexcitability** of the **dynamic stretch reflex** as one component of the upper motor neurone (UMN) syndrome.



Rigidity

- **What is the difference between rigidity and stiffness ?**

Stiffness is different from rigidity. Stiffness is a principal symptom due to continuous motor unit activity within muscles itself.

يعني لما يجيني مريض مراح يقول لي ان عندي rigidity لراح يقول انا عندي stiffness

Features of UMN Syndrome

1. **Weakness and decreased muscle control .**
2. **No remarkable muscle wasting** , but disuse atrophy
3. Spasticity & hypertonia , frequently called “ **clasp-knife spasticity** ”= increased resistance **at the beginning** of muscle stretch due to increased extensor muscle tone then a sudden collapse in resistance due to inhibition of extensor motor neurons by **GTOs (golgi tendon organs)**
4. **Clonus Repetitive jerky motions** (clonus), especially when limb moved & stretched suddenly
5. Exaggerated tendon jerks
6. Extensor plantar reflex = **Babinski sign** (dorsiflexion of the big toe and fanning out of the other toes)
7. Absent abdominal reflexes

● Causes of Spasticity: 1. UMN syndrome 2. Causes of Rigidity

UMNS syndrome include:

1. Acquired brain injury (trauma..etc)

2. Cerebral palsy

- Caused by brain damage due to **lack of oxygen**, as (near drowning or near suffocation) that cause damage to the motor control centres of the developing brain

لما الأم الحامل تصاب ب hypoxia - الاوكسجين ما راح يوصل للبيبي خلال 5 دقائق وظائف المخ راح تتعطل , راح يولد طبيعي لكن مع مرور السنوات الام راح تلاحظ neural abnormalities

- it can occur during pregnancy , during stressed childbirth (or after birth up to about age three by meningitis)

3. Multiple Sclerosis :

❖ What is it ?

is an **autoimmune demyelinating disease** , in which the body's own immune system attacks and damages the myelin sheath of myelinated nerves mainly of **brain, spinal cord ,and optic nerve** .

- Loss of myelin sheath (demyelination) prevents axons from saltatory conduction of action potentials causing muscle weakness & wasting.
- Disease onset usually occurs in young adults, and it is **more common in females** .
- The disease can attack any part of the CNS , and when it causes **demyelination of descending motor tracts in the brainstem & spinal cord** , the subject develops **spasticity** and other signs of UMNS .
- The disease frequently remits and relapses because of remyelination & restore of function - during acute attacks **intravenous corticosteroids can improve symptoms** .

4. STROKE:

❖ Caused by :

1. **Haemorrhagic stroke** as in cerebral hemorrhage
2. **Ischaemic stroke** as in thrombosis or embolism in brain bl.v

Both cause **death of brain tissues results in paralysis in the opposite half of the body** .

- A lesion in area 4 will cause monoplegia
- A lesion in **Corona Radiata** on one side can cause Monoplegia in a contralateral limb (UL or LL , according to site).
- A lesion in the **Internal Capsule** on one side may cause Hemiplegia or Hemiparesis on the contralateral side .

(hemiparesis = ضعف)

(hemiplegia = شلل)

5. Complete transection of spinal cord:

- e.g. following tumor or trauma

The **higher** the level of the section, the **more** serious are the consequences.

- If the transection is in the **upper cervical region** immediate **death** follows, due to paralysis of all respiratory muscles .**phrenic nerve is affected**
- In the **lower cervical region** below the **5th** cervical segment **diaphragmatic respiration** is still possible, but the patient suffers complete paralysis of all four limbs (**quadriplegia**).
- Transection **lower down in the thoracic region** allows normal respiration but the patient ends up with paralysis of both lower limbs (**paraplegia**) .

❖ **Stages :**

1. **Spinal shock** (2-6 weeks)
2. **Recovery of reflex activity**
3. **Paraplegia in extension**

These stages don't happen at the same time (after each other)

● **Spinal shock**

In the immediate period following transection there is :

- ◀ Loss of all sensations (anaesthesia) and voluntary movement (paralysis) below the level of the lesion , **due to interruption of all sensory and motor tracts**
- ◀ Loss of tendon reflexes and superficial reflexes (abdominal , plantar & withdrawal reflexes)
=complete loss of spinal reflex activity below the level of the lesion .
- ◀ The **loss of muscle tone** (flaccidity) and absence of any muscle activity (muscle pump) lead to **decreased venous return causing** the lower limbs to become cold and blue in cold weather

الفكره انه **venous return in the lower limb** تحتاج لعضلات عشان تضخها وتوصل للقلب فاذا العضلات صارت ضعيفه معاناتها راح يقل الدم اللي يوصل القلب وراح يتجمع في **lower limb** وبيصير لونها ازرق .

- **The wall of the urinary bladder becomes paralysed** and urine is retained until the pressure in the bladder overcomes the resistance offered by the tone of the sphincters and dribbling occurs. This is known as (**retention with overflow**).
- **Loss of vasomotor tone** (**autonomic supply to the blood vessels**) occurs, due to interruption of fibres that connect the vasomotor centres in the medulla oblongata with the lateral horn cells of the spinal cord, which project **sympathetic vasoconstrictor** impulses to blood vessels.
vasodilatation causes a fall in blood pressure

This stage varies in duration but usually lasts a maximum of **2-6 weeks**, after which some reflex activity recovers.

● **Stages of return of reflex activity:**

As the spinal shock ends, spinal reflex activity appears again, this partial recovery may be due to:

Only flexor reflex comes back normally. Increase in the natural degree of excitability of the spinal cord neurons below the level of the section, Due to:

1. **Disinhibition of motoneurons** as a result of absence of inhibitory impulses from higher motor centres. في هذه الحالة تفقد السيالات المثبطة فتبدأ تعمل مع نفسها.
2. **Sprouting of fibres** from remaining neurons. عن طريق زيادة التفرعات.
3. **Denervation supersensitivity** to excitatory neurotransmitters

● **Features of the stage of recovery of reflex activity:**

1. Gradual rise of arterial blood pressure:

- due to return of spinal vasomotor activity in the lateral horn cells. But, since **vasomotor control from the medulla is absent, the blood pressure is not stable.**
- vasoconstrictor tone in arterioles and venules improve the circulation through the limbs.

2. Return of spinal reflexes:

- **Flexor** reflexes return **earlier** than **extensor** ones. Example: Biceps, withdrawal reflex.
- **Babinski sign** (extensor plantar reflex) is one of **the earliest** signs of this stage.
- Tendon reflexes also recover earlier in flexors.
- As a result, **flexor spastic tone** causes the lower limbs to take a position of slight flexion, a state referred to as **paraplegia in flexion**. Paralysis in lower limb.
- The return of the stretch reflex (& consequently muscle tone)

3. Recovery of visceral reflexes:

return of micturition, defecation & erection reflexes.

However , **voluntary control over micturition and defecation , and the sensation of bladder and rectal fullness are permanently lost.**

يصير كأنه يببى اول ما يجمع كمية صغيرة يسوي urination لان ما عنده inhibition من higher centres .

- ◆ Remember : In spinal shock (retention with overflow)

In stage of recovery of reflex activity = automatic micturition

4. Sexual reflexes: consisting of erection or ejaculation on genital manipulation , recover.

5. Mass reflex: appears in this stage (very important)

- A minor painful stimulus to the skin of the lower limbs will not only cause withdrawal of that limb but will evoke many other reflexes **through spread of excitation (by irradiation)** to many **autonomic centers**.

So the **bladder and rectum will also empty, the skin will sweat, the blood pressure will rise.**

في هذا النوع نحضر sharp needle on the upper medial aspect of the thigh و النتيجة تكون سحب الرجلين إلى البطن.

- **Voluntary movements and sensations are permanently lost**, however, patients who are rehabilitated and properly managed may enter into a more advanced stage of recovery
- Since effective regeneration never occurs in the human central nervous system, patients with complete transection never recover fully.

● Stages of extensor paraplegia:

1. **The tone in extensor muscles returns gradually to exceed that in the flexors.** بمعنى أنها ترجع الاكستنسورز . ابعده الفلكسورز و لكن أقوى منها

The lower limbs become spastically extended.

- Extensor reflexes become exaggerated, as shown by tendon jerks and by the appearance of clonus. Example: Triceps, Crossed extensors
- The positive supportive reaction becomes well developed and the patient can stand on his feet with appropriate support.

2. **The flexor withdrawal reflex which appeared in the earlier stage is associated during this stage with the crossed extensor reflex.**

Hemisection of the Spinal Cord (Brown-Sequard syndrome)

Occurs as a result of unilateral lesion or hemisection of the spinal cord due to stab injury, Bullet , car accident and tumor

The manifestations of the Brown-Sequard syndrome depend on the level of the lesion.

(Let us take an example of such injury involving the thoracic spinal cord)

- **On the same side at the level of lesion**
 - ◆ **Paralysis of the lower motor neuron type**, involving **only** the **muscle** supplied by the damaged segments.
 - ◆ **Loss of all sensations in the areas** supplied by the **afferent fibres** that **enter the spinal cord in the damaged segments** +/- band of **hyperesthesia** (abnormally increased sensitivity to stimuli)
 - **Below the level of lesion**

Ipsilaterally	Contralaterally
1. UMNL/spastic lower limb (spasticity) & CLONUS 2. Fine touch, two-point discrimination, position and vibration sense are lost.	Pain and temperature sensations are lost
Why ?	
Because the lost functions are carried by dorsal column tracts that decussate at mid medulla level	Because these functions are carried by spinothalamic tract which decussate after it synapse with 2 nd order neuron contralateral in spinal cord

Causes of Rigidity

- **Parkinsonism rigidity is of two types:-**

1. **Cogwheel rigidity**

In cogwheel rigidity one feels the resistance in rhythms when applying a passive movement. It is thought to be the product of an underlying resting tremor which is masked by the rigidity but can be felt on passive movement .

2. **Lead-pipe rigidity**

Lead pipe rigidity describes a constant resistance when moving a joint

- **Decerebrate rigidity**

extension of head & 4 limbs extensors

- **Decorticate rigidity**

extensor rigidity in legs & moderate flexion of arms if head unturned