Year 2 MBChB

Clinical Skills Session

Examination of the Motor System

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Motor Examination

Objectives

- To know the basic anatomy and function of the motor system
- To be able to understand and carry out a bed side assessment of the motor system and assess a patient’s co-ordination
- To be able to elicit monosynaptic tendon reflexes on a patient
- To adhere to waste disposal policies including sharps and clinical waste

Motor examination;

Both passive and active movement of the limbs are performed in this examination.

Passive is moved by the examiner, active is moved by the patient. You may see different variations in practice, some movements may be done entirely passively. You may wish the patient to perform the movements actively to assess the range of movement, and then assess passive movement. If there is a restricted range of active movement, or problems with active movement, you will need to assess the movement passively.

Please note that images in this study guide are done with right handed examiners, please adjust appropriately, if you are left handed.

Theory and background

Muscle groups (myotomes) are innervated by spinal nerves, these nerves are numbered in relation to the spinal column:

There are 8 Cervical nerves

As you can see in the diagram C1 the spinal nerve sits above the cervical bone so as there are 8 nerves and only 7 vertebrae C8 sits above T1. T1 Nerve is below T1 vertebrae - and so on....

There are;

- 12 Thoracic nerves
- 5 Lumbar nerves
- 5 Sacral nerves
Spinal cord section

**Posterior column**
- Ipsilateral (crosses at medulla)
  - proprioception
  - vibration

**Spinothalamic tract**
- Contralateral (crosses at spinal level)
  - pain
  - light touch
  - temperature

**The motor system**

Messages travel from the motor cortex via subcortical nuclei and brainstem to spinal cord, then to nerve roots, peripheral nerves and finally to muscles

**Upper Motor Neurone (UMN)**
- From the motor cortex to anterior horn cell (relay station) of the spinal cord

**Lower Motor Neurone (LMN)**
- From anterior horn cell to neuromuscular junction

**Patient safety**

- Introduce yourself
- Check the patient’s identity
- (including allergies)
- Explain what you want to do
- Gain informed consent from the patient
- Consider an appropriate chaperone
- Adequate exposure maintaining dignity
- Position the patient appropriately
- Wear Personal Protective Equipment as required.
- Wash your hands before and after you touch the patient
- (as per the WHO guidelines WHO (2018) [link](http://www.who.int/infection-prevention-tools/hand-hygiene/en/))
**Inspection**

As always inspection starts as soon as you see your patient.
General inspection should be followed by specific inspection.
Consider;
- Limb posture and gait
- Hand muscles, specifically 1st Dorsal interosseous and thenar eminence for wasting (atrophy).
- Observe for asymmetry of
- Muscle bulk in all 4 limbs.

The image above is showing atrophy of the muscle to the patient’s left hand below the thumb and the hand on the left has normal muscle bulk, following surgery for carpal tunnel syndrome. There are however a wide variety of causes for example, Multiple Sclerosis, Cerebrovascular Accident (CVA) trauma etc. (Image attributed to Henry K Gerlach)

The image below is demonstrating loss of muscle bulk to the right leg following trauma.
**Assessing muscle and postural tone**

Normal tone; on passive movement of the limbs, tone should be neither floppy nor stiff. *Increased tone could be due to;*
- lesions of pyramidal tract (Upper Motor Neurone), this is called SPASTICITY
- lesions of the extrapyramidal tract, this is called RIGIDITY

*Reduced tone could be due to;*
- lower Motor Neurone lesions, this is called FLACCIDITY

Abnormal tone will be accompanied by other signs which help to localise the lesion

**Testing for tone/spasticity in the arms**

Support the patient’s elbow with one hand, and take control of the patient’s hand as if shaking hands.

Supinate and pronate the arm, then place the wrist in supination and sharply pronate the wrist.

Use the same technique on each arm.

Always use the same hand to assess movement for the patients’ right and left.

If spasticity is present, resistance to movement will be evident and will be velocity dependent, therefore when performing an assessment for “supinator catch”, the sharp movement of forearm will result in a sharp “catch” followed by increased resistance to movement.

While still supporting the elbow passively flex and extend the elbow.

Use same technique on both arms.

If tone is normal there will be no resistance to these movements.
Testing for tone/spasticity in the legs

Encourage the patient to relax their leg muscles, place your hands on the patient’s thigh and roll the whole leg, observing the movement of the foot.

If the tone is normal the range of movement of the foot is similar to the rotation of the leg.

In addition flex and extend the knee, if tone is normal there should be no resistance to this movement.

Testing for Clonus

Position the patient with the knee flexed and the hip externally rotated

Sharply dorsiflex the foot and maintain this.

In most people with normal tone the foot will not move but 2-3 beats of clonus (plantar flexion followed by dorsiflexion of the foot) can be within normal limits.

Sustained clonus is a sign of an upper motor neurone problem. If clonus is found in both limbs the cause is spinal in nature. If clonus is found in one limb it could be either spinal or brain in origin.

Pyramidal tract (UMN) lesion:

SPASTICITY

There is initial resistance to movement which gives way as the movement continues

Arm; PRONATOR or SPASTIC CATCH - As the passive movement becomes quicker at a certain point the muscle may sharply resist the movement. This is referred to as a “pronator” or “spastic catch”.

Leg; CLASP KNIFE phenomenon – sometimes the resistance becomes so great that the autogenic inhibition reflex is initiated, causing a sudden drop in the resistance; this is referred to as the clasp-knife phenomenon.
**Testing Power**

Ask the patient to make the required movement and sustain it against gravity
Attempt to overcome the movement remembering that this is not a test of relative strength
Compare right and left for each movement but avoid mechanical advantage to the examiner.

**The grading of muscle power** *(Used with the permission of the Medical Research Council 1943)*

<table>
<thead>
<tr>
<th>Grade</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No Contraction</td>
</tr>
<tr>
<td>1</td>
<td>Flicker or trace of contraction</td>
</tr>
<tr>
<td>2</td>
<td>Active movement, with gravity eliminated</td>
</tr>
<tr>
<td>3</td>
<td>Active movement against gravity</td>
</tr>
<tr>
<td>4</td>
<td>Active movement against gravity and resistance</td>
</tr>
<tr>
<td>5</td>
<td>Normal Power</td>
</tr>
</tbody>
</table>

**Documentation of power**

Here is an example of how to write up the findings from a power examination, all movements were graded as normal.

<table>
<thead>
<tr>
<th>Movement</th>
<th>Right</th>
<th>Left</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shoulder abduction</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Shoulder adduction</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Elbow flexion</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Elbow extension</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Finger flexion</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Finger extension</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Hip flexion</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Hip extension</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Knee flexion</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Knee extension</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Ankle dorsiflexion</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Ankle plantar-flexion</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>
Summary of motor nerve supply to the upper limb

Movements of the upper limb

Shoulder abduction (C5/6) and adduction (C6/7/8)

1. Position the patient with the shoulders abducted to 90°. (This gives the patient what is known as the mechanical advantage and they will not be in a weaker position than the examiner)

   “Stop me from pushing your arm down”

2. Ask the patient to maintain position whilst you attempt to overcome by pressing down on upper arm.
3. Ask the patient to bring elbows towards side against resistance.

**Elbow flexion 2 (C5/6) and extension (C7/8)**

1. Position the patient with their elbow fixed, ask them to resist your attempt to straighten their arm.

   "Stop me from pushing your arm up"

2. Position the patient with their elbow extended beyond 90°. Ask them to resist your attempt to flex the elbow.

   "Pull me towards you"

   "Push me away"
Finger flexion

Ask the patient to curl fingers towards palm and to keep fingers flexed while you attempt to straighten them.

Alternatively ask the patient to squeeze two of your fingers placed in either of the patient’s palms.

Finger extension (C7, C8)

Position patient with fingers extended, whilst supporting their wrist ask them to resist your attempt to flex their fingers.

“Stop me trying to bend your fingers down”
Summary of lower limb motor supply

Lower limb movements

Hip flexion (L2/3) and extension (L5/S1/2)

Position the patient with the leg elevated to approx. 30°

Attempt to overcome by pressing down on thigh

Position patient with leg flat on couch

Place your hand underneath thigh and attempt to elevate leg while the patient presses down
Knee flexion (L5/S1)
Position the patient seated with their knee flexed and heel off the bed. Place one hand on the patient’s thigh and your other hand behind the heel/ankle/calf
Ask the patient to bring their heel towards buttocks against resistance

Knee extension (L3/4)
Position patient seated with knee flexed and heel off the bed, place one hand on the patient’s thigh and place your other over the patient’s shin. Ask patient to straighten their leg against resistance

Dorsiflexion (L4) and plantar flexion (S1/2) of the foot
Dorsiflexion: Ask patient to bring foot upwards
Attempt to overcome by pressing down on foot.
“Stop me from pushing down”

Plantar flexion: Ask patient to push foot down.
“Stop me pushing your foot up”
Attempt to overcome by pressing upwards on sole
Alternatively you can ask the Patient to stand on tiptoes
Patterns of weakness

In an Upper Motor Neurone lesion, there is weakness of the:

- extensors in the arms
- flexors in the legs
- The unopposed action of unaffected muscles produces the characteristic posture seen in patients with stroke

In a Lower Motor Neurone lesion, there is involvement of nerve endings (peripheral neuropathy) producing a predominantly distal pattern of weakness.

Reflexes

A normal reflex arc requires:

- Stimulus to stretch receptors
- Intact sensory afferent pathway
- Link with a motor unit
- Intact motor neurone
- Contractile element

The order in which you test reflexes should be logical and may vary from one examiner to another. The patient must be relaxed in order to elicit a response.
Testing for reflexes

Hold the tendon hammer like a hammer, don’t be too tentative. You will not hurt the patient if you strike the intended tendon.
Position the limb correctly, place your finger over the tendon and strike it the finger with the percussor or tendon hammer, although for some reflexes you will strike the tendon itself.

Observe the relevant muscle belly for contraction (not the limb movement), maintaining awareness of the range of normality; from obtainable with reinforcement (or even absent) to very brisk (but with flexor plantar responses). Abnormal reflexes are rarely seen without other relevant signs.

Reinforcement

Where a reflex appears difficult to elicit, reinforcement might be tried.
Ask the patient to close their eyes and:
- For lower limb - ask the patient to grasp the fingers of each hand and to pull apart on instruction just as the reflex is tested
- For upper limb - ask the patient to clench their teeth

Reinforcement for a lower limb reflex – with patient’s eyes closed
The upper limb reflex testing

**Supinator (brachioradialis) reflex (C5/6)**

Position the patient sitting relaxed, elbows flexed and hands resting on thigh/groin.
Place your left index/middle finger(s) over supinator tendon.
Strike finger(s) with falling head of hammer.
Observe slight elbow flexion or contraction of belly brachioradialis.

- Observe for contraction of brachioradialis here
- You may notice momentary of elbow flexion

**Biceps reflex (C5/6)**

With the patient’s arm resting on their other arm clasp the patient’s elbow so that the biceps tendon can be felt under your thumb or finger.
Strike your thumb or finger and observe for elbow flexion, there may be little movement but you should feel the contraction.

**Triceps reflex (C7/8)**

Position the patient with their arm across their abdomen with elbow flexed to 90°.
Strike the triceps tendon directly,
Observe for elbow extension or contraction of the muscle belly.

**The finger jerk (C8)**

This is only performed if clinically relevant. Ask the patient to rest their fingers on the index and middle fingers of your hand and curl their fingers slightly. Strike your fingers, if reflex elicited, the patient’s fingers will flex.
Reflex Testing of The Lower Limb

Knee reflex (L3/4)
Support one or both knees by placing your arm underneath the patient's knee, so that they are slightly bent, strike the patellar tendon direct and observe quadriceps contraction with or without knee extension.

Ankle reflex (S1/2)
The ankle reflex may be elicited in either of the two positions shown;

The hip is externally rotated and the knee flexed. The ankle is held in slight dorsi-flexion to stretch the Achilles tendon.

Let the head of the hammer fall onto the achilles tendon.

Plantar flexion should occur.

The patient is seated with their leg flat on a couch, place your hand on the ball of the patient's foot, passively dorsiflex the ankle, strike your fingers and observe or feel for plantar flexion.
Plantar reflex (L5/S1/2)

The patient is seated with their leg flat on a couch. Drag a thumbnail or blunt object i.e. pen lid, along the lateral border of the foot and across the sole towards other side. The normal response is flexion of the big toe which may be absent if the feet are cold.

Documenting reflexes
Reflexes should be recorded as follows:

<table>
<thead>
<tr>
<th>Reflex</th>
<th>Right</th>
<th>Left</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absent</td>
<td>-</td>
<td>+/-</td>
</tr>
<tr>
<td>Present with reinforcement</td>
<td>+ or ++</td>
<td></td>
</tr>
<tr>
<td>Normal</td>
<td>+</td>
<td>++</td>
</tr>
<tr>
<td>Brisk</td>
<td>+++</td>
<td></td>
</tr>
</tbody>
</table>

An example of how to write up an examination with normal reflexes:
### Patterns of reflex change

**UMN lesion**
- Reflexes are brisk below the level of the lesion
- Plantar response is usually extensor
- A pathologically brisk finger flexion jerk is the upper limb equivalent of an extensor plantar response

**LMN lesion (peripheral neuropathy)**
- Reflexes are absent
- Distal reflexes are first to be lost

### Summary

<table>
<thead>
<tr>
<th>Parameter</th>
<th>UMN lesion</th>
<th>LMN lesion (peripheral neuropathy)*</th>
<th>Peripheral neuropathy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Posture</td>
<td>Flexed UL, Extended LL</td>
<td>May be wasting, fasciculation</td>
<td>Altered gait in diabetes</td>
</tr>
<tr>
<td>Tone</td>
<td>Increased (spasticity)</td>
<td>Reduced (flaccidity)</td>
<td>Reduced muscle tone e.g. 10q trisomy (rare chromosomal disorder)</td>
</tr>
<tr>
<td>Power</td>
<td>Weakness of UL extensors and LL flexors</td>
<td>Distal weakness</td>
<td>Weakness associated with diabetes</td>
</tr>
<tr>
<td>Reflexes</td>
<td>Brisk</td>
<td>Absent</td>
<td>Absent</td>
</tr>
<tr>
<td>Plantar response</td>
<td>Extensor</td>
<td>Flexor or absent</td>
<td>Absent</td>
</tr>
</tbody>
</table>

There are other patterns of lower motor neurone lesions (nerve root, individual peripheral nerve).

### Reminder

What you have learned so far will allow you to distinguish between UMN and LMN lesions
You will learn additional skills needed to localise lesions according to particular presentations for example; examination of the intrinsic hand muscles in someone with weakness or tingling in the hand/fingers.

### Additional movements

The next section gives you an example of some additional movements that we can perform based on the clinical presentation.
This patient has come in complaining of weakness in their hand – “I keep dropping my keys”

### Finger abduction
Support the patient’s wrist and ask the patient to spread their fingers, ask the patient to maintain this position while you try to push their little finger inwards, then ask the patient to maintain this position while you try to push their index finger inwards.

**Thumb abduction (T1, median)**

*“Stop me pushing your thumb down to your palm”*

Thumb abduction is 90° to finger abduction

Support the patient’s wrist, ask the patient to lift their thumb upwards, ask them to maintain that position against resistance.

**Thumb opposition (T1, median)**

*“Stop me pulling your fingers apart”*

Support the patient’s wrist, ask the patient to place the tip of their thumb onto the tip of their index finger and to hold this position while you try to separate the thumb and index finger.
Thumb adduction (T1, Ulnar)

“Stop me trying to lift your thumb up”

Support the patient's wrist and ask the patient to trap your index and middle fingers between the base of their thumb and their index finger. Ask them to maintain that position while you try to lift their thumb.