Expert Review  Examination of the Peripheral Nervous System

Sally-Anne Shiels

Abstract  This paper presents an efficient yet thorough method of eliciting the clinical signs of diseases affecting the nervous system of the upper and lower limbs. It focuses on the basic principles of examination and explores relevant anatomy and physiology. The overall objective is to provide the reader with the knowledge and tools necessary to carry out this examination both on the wards and under the scrutiny of examiners in an OSCE situation. It concludes with examples of common and uncommon conditions (found on the wards and in OSCEs respectively). It is based on clinical examination textbooks [1-6] and the author’s clinical experience.  Word count: 4339 (excluding tables and references).

Key words: clinical examination, peripheral nervous system.

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In an exam/OSCE situation you will rarely be asked to “examine this patient’s peripheral nervous system”. Instead you usually be asked to “examine this patient’s leg/arm/foot”. While examining, try and divide the nervous system into descending parts: brain, spinal cord, spinal root, peripheral nerve, neuromuscular junction, muscle. You are essentially looking to fit the signs elicited into a pattern that matches the affected part of the nervous system.

The scheme for this examination is to ask for permission, look at the patient, assess tone, test power, elicit reflexes, examine coordination, assess gait (lower limbs) and finally test sensation. The key is to not get carried away in the detail but rather to develop a fluent core technique.

CONTENTS
I. GETTING STARTED
Ask
Whether in the formal OSCE situation or the hectic medical assessment unit always remember the basics: introduction and permission. The examination of the peripheral nervous system is quite an active exam with a fair amount of manipulation. Always ensure you have asked if the patient is in any pain or has any joint problems.

Look
When approaching a patient who you will be examining, first introduce yourself with a (careful) hand shake. This may provide the first clue to diagnosis. For example, they may be unable to see your hand (neglect, blindness), may be unable to lift their hand to shake yours (paralysis, weakness), or the classic finals OSCE case where the patient does not release the offered hand (myotonic dystrophy). Then take a step back to observe the patient. Looking at a patient can be quite uncomfortable for them as well as for you, so providing a polite explanation of what you are doing can ease the situation. Be swift but thorough. First look around the patient. Some clues are a urinary catheter bag, wheelchair, walking stick, or a spirometer. Then observe the patient looking for asymmetry in positioning, posture, atrophy and fasciculations. You may come to a diagnosis without laying a hand on the patient. For example: a young patient in a wheelchair with a catheter may have a diagnosis of multiple sclerosis while an older patient with posturing of one side and a facial droop may have had a stroke.

II. UPPER LIMS
Tone
Start by observing each muscle group looking for: size, shape and symmetry. Atrophy occurs in
unused muscle groups while hypertrophy is caused by overuse of muscle groups. Hypertrophy in the clinical context (and not the bodybuilding world) is usually indicative of compensation of one muscle group for the loss of function in another muscle group, such as seen in muscular dystrophies.

Tone is a defining characteristic of muscle, determined by its resistance to passive stretching. Examination of tone requires cooperation and understanding on the part of the patient. Ideally the patient needs to be fully relaxed but inevitably the instruction to relax will usually lead to prompt tensing of the muscles. The best approach is to hold the patient’s hand in the handshake position and support their elbow. A helpful instruction to the patient is “let me take the weight of your arm, try not to resist or help me move your arm”. Move each joint of the limb in a purposeful but non-predictable manner. Manipulation of the wrist joint usually yields the most information. Supinate and pronate the hand, initially slowly and then briskly.

Tone will either be decreased (hypotonia) which can occur in lower motor neuron lesions or increased (hypertonia) classical of upper motor neuron lesions. Understanding the physiology of increased tone and the difference between spasticity and rigidity is important in determining the diagnosis. With spasticity the stretch reflex is hyper-excitabile and velocity dependent. The key feature of spasticity is its velocity dependence: the faster the limb is moved the greater the resistance produced. Rigidity is different from spasticity as the resistance is constant throughout the stretch. It is a feature of lesions affecting extrapyramidal pathways, such as Parkinson’s disease. It is caused by increased motor discharge to both the flexor and extensor muscle groups and can be likened to trying to bend a lead pipe. When tremor is superimposed it is described as “cog-wheel” rigidity.

Power

Power is assessed objectively and can be rated on a scale of 0 to 5 according to the Medical Research Council (MRC) grading scale shown in Table 1. Correct use of the scoring system can be helpful in progressive disorders and in the rehabilitation setting. That said, some Neurologists use the terms “mild”, “moderate” and “severe” weakness which are less objective.

As with the assessment of tone, clear communication is crucial, and demonstration of the position you want the patient to take can ease the situation. Use your common sense as to whether you want to do a rapid overall assessment of power (“squeeze my fingers”) or a more discrete assessment of each muscle group. When time is precious, test grip power by asking the patient to squeeze your index and middle finger. You can also ask the patient to pull you towards them and push you away. Table 2 gives the general scheme for examination of power in the upper limb including a general overview of relevant basic anatomy. This is often performed with the patient sitting up in bed.

<table>
<thead>
<tr>
<th>Score</th>
<th>Power</th>
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<tbody>
<tr>
<td>5</td>
<td>Full strength</td>
</tr>
<tr>
<td>4</td>
<td>Movement against partial resistance</td>
</tr>
<tr>
<td>3</td>
<td>Movement against gravity</td>
</tr>
<tr>
<td>2</td>
<td>Movement with gravity eliminated</td>
</tr>
<tr>
<td>1</td>
<td>Feeble contractions</td>
</tr>
<tr>
<td>0</td>
<td>Absent voluntary contraction</td>
</tr>
</tbody>
</table>

Table 1 MRC grading scale for power.

Reflexes

Testing deep tendon reflexes is the main way to differentiate between upper and lower motor neuron lesions: present/increased in upper motor neuron lesions and absent in lower motor neuron lesions. The key to testing reflexes is to ensure that an absent reflex is in fact absent by reinforcing the reflex arc. To reinforce, ask the patient to clench teeth or grasp hands together and pull apart just as you strike with the tendon hammer (Jendrassik’s manoeuvre). Physiologically, reinforcement involves a reduction of descending inhibition at the spinal cord level, increasing depolarisation of the motor unit and decreasing the threshold for contraction of the muscle. Interestingly, anxiety can also lead to increased reflexes due to a similar mechanism. Finally, look at the muscle group involved in the reflex. Many people focus on the foot for the patellar reflex, but a subtle movement of the quadriceps can be missed when looking at the foot.

Most neurologists advocate the correct usage of a tendon hammer, and scorn the use of a stethoscope to strike the tendon. Hold the tendon hammer near the tapered tip and let the rubber head fall onto the tendon being tested (the movement is in the wrist). This means that testing across different examiners can be somewhat standardised as the weight of the tendon hammer head will define the force with which the tendon is struck rather that the strength of the examiner. In addition, if a reflex is found to be brisk, the “briskness” can be quantified by repeating the reflex.
but holding the hammer closer and closer to the head (thus exerting less and less force). Briskness is thus defined as a change in the threshold of the reflex response and not the speed or size of the response.

Unlike power, there is no consistent/accepted scoring system for reflexes. Essentially reflexes are either present or absent. When present, a reflex can be described as hyporeflexic (present with reinforcement), normal or brisk.

The reflexes tested in the upper limbs are the biceps C5/6, supinator C6, and triceps C7/8 deep tendon reflexes. Compare left to right before moving on to the next muscle group. With each strike of the tendon hammer determine whether there is a difference in the threshold response of the reflex. Positioning is everything at this point in the examination. To test the biceps reflex ask the patient to place their hands on their abdomen and let their arms relax. Place a finger over the biceps tendon in the antecubital fossa and strike your finger with the tendon hammer. To assess the triceps reflex hold the hand/wrist on the abdomen with the elbow in a 90 degree angle and strike the triceps tendon just above the olecranon. Finally, test the supinator reflex (brachioradialis muscle): place two fingers at the level of the distal radius and strike your fingers with the tendon hammer. An examiner can easily spot the student that spent more time reading books than seeing patients when they fumble with the tendon hammer and positioning of their hands—make sure you have a system that works for you and looks smooth.

Coordination

In assessing coordination you are testing fine motor skills modulated by higher centres in the brain (i.e. basal ganglia, cerebellum). There are two basic methods of testing coordination in the upper limbs. The first is the finger-nose test. Ask the patient to touch their nose with an index finger. Hold your finger at arms-length distance from the patient and ask them to use the same finger to touch your finger. Then ask them to move between their nose and your finger as quickly and as accurately as possible. Then repeat the same instructions with the other index finger. Look for past pointing and intention tremor. The second method tests for dysdiadochokinesia. Ask the patient to clap their right hand on the palm of their left hand, then alternate clapping with the palm and dorsum of the right hand. It always helps to demonstrate this. Then switch hands (clap their left hand on their right hand.) Disorganisation in this alternating movement indicates dysfunction in the cerebellum or associated circuitry. An additional test of coordination is to ask the patient to oppose finger and thumb repeatedly as fast as possible. Slowing of the frequency and amplitude of this movement is a useful sign of bradykinesia.

III. LOWER LIMBS

Tone

There are three techniques to use when assessing tone of the lower limbs. For the first, have the leg fully relaxed, hold the knee to fix the leg to the bed and roll the thigh left and right repeatedly. In a patient with normal tone the foot will flop in the opposite direction as the way the knee is moved. However in the presence of increased tone the foot will remain in line with the knee. In the second technique put your hand under the knee (at the popliteal fossa) and sharply pull the knee up. In a patient with normal tone, the heel will remain on the bed, but with increased tone the foot will leave the bed. The third technique is the test for ankle clonus. The presence of greater than five beats of clonus (or sustained rhythmic contraction while the tendon is stretched) indicates increased tone.

Power

The same principles of examination apply in the lower limbs as in the upper limbs. Table 3 contains the instructions for testing power in the legs, which is done with the patient lying down. Test each side individually before moving to the next muscle group.

Reflexes

The reflexes tested in the lower limbs are the patellar (L3/4), ankle (S1) and plantar reflexes. Positioning and comparison between left and right again, are key. You must have the muscle group being tested relaxed in order to see the contraction. Place your hand underneath the knee and slightly flex the knee for the patellar reflex then strike the patellar tendon just above the tibial tuberosity. For the ankle jerk, bend the knee and open the leg out, flex the foot slightly and strike the Achilles tendon looking for plantarflexion. Finally the Babinski reflex or plantar response: use a smooth but rigid instrument and apply steady pressure starting at the heel and moving towards the big toe (never use the sharp end of a tendon hammer). Do not scratch the sole of the foot so hard as to leave a visible mark on the skin. Watch the toes for upward or downward movement (predominantly the big toe). Upper motor neuron lesions will cause the big toe to dorsi-flex (an ‘upgoing plantar’), and the other
toes spread out. Knowing the nerve roots that supply each muscle group and reflex being tested will help identify the location (level) at which the motor nervous system is affected. For example if the ankle reflex is brisk but the patellar reflex is normal then the lesion must lie in the spinal cord at L3/4. Below the level of the lesion there are upper motor neuron signs (brisk reflex) and at the level there may be lower motor neuron signs (loss of the reflex) or no change in reflex. In addition the patient will have decreased power in the muscles groups below L3/4 and thus will have weakness of dorsi- or plantar flexion of the foot. This same principle can be applied to the sensory system and is briefly explained below.

Coordination

The heel-shin test assesses coordination in the lower limbs. This requires clear explanation. Ask the patient to “place the left heel on the right knee. Then slide the heel down the shin to the ankle. Now lift your foot in the air and place your heel back on the knee. Slide your heel once again down to your ankle. Please repeat this movement.” Look for the heel sliding off the shin as the patient tries to slide it down towards the ankle. If this is difficult you can grossly test coordination by asking the patient to tap their foot on your hand or use their toe to touch your finger. Remember that coordination can be affected by weakness and lack of sensory perception and may necessarily indicate a lesion in the basal ganglia or cerebellum. This is especially true in the lower limbs where a patient may have sensory loss in the stocking distribution, such as in diabetes.

Gait

Gait can be the first clue to an underlying diagnosis and is best examined when the patient is unaware of the observer. Many neurologists call their own patients into clinic so that they can observe the patient stand and walk. There are only a limited number of pathological gaits that you must commit to memory: Look for posture, arm swing, step size, width of base and inability to walk on toes or heels. Most students will have some personal experience (although perhaps less awareness) of an ataxic or broad-based gait which is often induced by alcohol. Where persistent, such a gait disorder may be due to a cerebellar lesion and the patient will be unable to walk heel-to-toe. A shuffling or festinating gait (“gait apraxia”) is classically seen in extra-pyramidal disease while a tilted gait may be indicative of inner ear disorder. In foot drop, a person will lift their foot far above the ground in order to avoid catching their toes on the ground while walking, also called a ‘steppage gait’. The patient will also have difficulty walking on their heels.

Romberg's Test

Romberg’s test is a method of assessing proprioception and can be positive in sensory ataxia (peripheral neuropathy) and in tabes dorsalis caused by syphilis (affecting the sensory pathways of the spinal cord). Ask the patient to stand with their feet close together and stretch out their arms. Make sure you position the patient so that if they did fall you can catch them or that they fall onto a bed. After giving reassurance that you will catch them if they fall, ask the patient to close their eyes. In a positive Romberg’s test the patient will fall with their eyes closed but not with their eyes open, as the visual input that was compensating for the lack of proprioceptive input is removed. In cerebellar dysfunction the patient will be just as unsteady with their eyes open as closed.

IV. SENSATION: UPPER AND LOWER LIMBS

Testing sensation is the trickiest part of the peripheral nerve examination as it is difficult to test objectively. There are three main principles to apply in this part of the exam: compare left to right, compare distal areas to proximal areas and finally test dermatomes (when indicated). It can be helpful to ask the patient if they have any numbness or tingling.

Start by touching the patients upper chest lightly with your finger or a piece of cotton wool and ask them if it feels like a finger/cotton touching them. Ask them to close their eyes and each time you touch their limb ask them which side you have touched, left or right. Ask them if it feels the same on both sides. In the upper limb the key dermatomes will be covered by touching the following areas: outer shoulder/regimental badge area (axillary nerve C6), outer forearm (lateral cutaneous C5), thumb (median nerve C6), middle finger (median nerve C7) small finger (ulnar nerve C8), back of the hand (radial nerve C5-T1), and medial antecubital fossa (medial cutaneous T1). In the lower limb the dermatomes and main nerve roots can be tested by touching the following areas: inner thigh (upper L1, mid L2), medial side of knee (L3), medial malleolus (L4), big toe (L5), heel (S1) popliteal fossa (S2). Finally, remember that S3 and S4 keeps ‘things off the floor’ (anal sensation/tone will need to be tested in cases of suspected cord trauma/compression such as in patients with
metastatic deposits in and around the spinal cord). In determining the sensory level remember that the pain and temperature pathways decussate at the level of entry at the spinal cord (spinothalamic tract) while the pathways for fine touch and proprioception ascend the spinal cord and decussate at the level of the brain stem (dorsal columns). It is this elegant neuro-anatomy that lies behind the sensory findings in Brown-Sequard syndrome (hemi-section of the cord).

To test sensation thoroughly the above routine should be repeated, testing the rest of the sensory modalities: pain (alternate using the sharp and blunt ends of the neurotip), temperature (can be tested with the metal tuning fork as it tends to be cold), vibration (tested on a bony prominence looking for when the patient stops feeling the vibration) and proprioception. To test proprioception, start at the most distal joint in the limb, such as the distal interphalangeal joint. Place your fingers on either side of the digit to isolate the joint. Move the joint upwards and say “this is up” and then move the joint down and say “this is down”. Ask them to then close their eyes and tell you which way they feel you are moving their joint. If they are unable to tell you move to the next more proximal joint.

Beware of the subjective nature of the sensory exam. If you suspect that the patient is giving spurious answers, or trying to disguise a lack of sensation, instruct them to close their eyes and ask them which side you are touching without touching them at all. Patches of sensory loss that do not follow a dermatomal or nerve distribution are likely to be non-organic in aetiology.

V. SAMPLE CASE PRESENTATIONS FOR MEDICAL OSCE’S

Medical OSCE’s will test your examination skills under pressure and may present you with uncommon diagnoses. Below is a list of diagnoses that are commonly found in OSCE’s as well as on the medical wards. The conditions are grouped by dividing the nervous system into descending parts: brain, spinal cord, spinal root, peripheral nerve, neuromuscular junction, muscle.

Brain

Upper Motor neuron lesion

I examined Mrs. Smith’s legs. There was a walking frame beside the bed and she was unable to walk without support as she could not use her left leg. Her left leg was extended when she lay down. There was no wasting or fasciculations. Tone was normal on the right but increased on the left in all muscle groups. Power was normal on the right. On the left, power was decreased at 0 out of 5 in all muscle groups tested. Reflexes were normal on the right. On the left, the reflexes were brisk. Sensation was normal. Coordination was normal on the right but could not be assessed on the left. In summary she had a spastic paresis of the left leg with increased reflexes. These signs are consistent with an upper motor lesion. A possible diagnosis is a lesion affecting the right cerebral cortex or cerebrospinal tract, such as a stroke.

Parkinson’s Disease

From the end of the bed, Mr Smith had decreased facial expression (hypomimia), decreased blinking, and a resting tremor, which disappeared on movement to shake my hand. On examination of the upper limbs there was increased tone, specifically cogwheel rigidity. Power was difficult to assess due to the rigidity. His movements were slow/bradykinetic. Reflexes were present. Finally on observation of his gait he was slow to start and shuffled. In summary, the cardinal features of rigidity, bradykinesia, resting tremor and gait apraxia would be consistent with Parkinson’s Disease.

Spinal cord/ Peripheral nerve

Cord Compression

Mr Jones presented with a background of advanced prostatic cancer. He complained of sharp pain in the lower back, tingling in his legs and difficulty passing urine. On examination of the lower limbs tone was increased. Power was decreased at 3/5 in both legs. There was bilateral hyper-reflexia, and extensor plantars. He had a global loss of sensation to the level of L1. There was also decreased anal tone on digital rectal examination. There was tenderness on palpation of the thoracic and lumbar spine. These signs are consistent with spinal cord compression above the L1 spinal cord level (i.e. probably cervical or thoracic spine). This is a medical emergency.

Median nerve lesion

I examined this patient’s arms. There were no abnormal findings in the left arm. There was wasting of the right thenar eminence (abductor pollicis brevis). There was general mild weakness of the power grip on the right with specific weakness of abduction of the thumb. There was sensory loss...
over the palmar surface of the thumb, index and middle fingers, as well as the medial half of the ring finger. In summary, these findings are consistent with a median nerve lesion, which might be caused by compression of the median nerve in the carpal tunnel.

**Neuromuscular Junction/Muscle**

I examined Mrs Jones's upper limbs. On general inspection I noted bilateral ptosis and a handheld spirometer beside her bed. On examination I noted normal tone but decreased power. This was more prominent in the proximal muscle groups. I noted that the power in her shoulders was initially 4/5 but then decreased to 3/5 after sustained elevation. There was definite fatigability in the muscle groups which I tested by asking Mrs Jones to hold her arms above her head for as long as possible. Reflexes were present bilaterally and sensation was normal. In summary, the main physical sign elicited in this examination was that of muscle fatigability which could be caused by myasthenia gravis.

**VI. Conclusion**

This paper presents a comprehensive overview of clinical examination of the peripheral nervous system in the upper and lower limbs. There are many ways of carrying out this clinical examination which emphasizes that there is no one perfect style for examining this or any system. However, the framework of all examinations is consistent: patient respect, good communication, thorough inspection and appropriate palpation. The challenge of clinical practice is to fluently apply what you learn through teaching sessions, textbooks, or articles to your own daily practice.

**References**

<table>
<thead>
<tr>
<th><strong>ACTION</strong></th>
<th><strong>INSTRUCTION</strong></th>
<th><strong>ANATOMY</strong></th>
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<tbody>
<tr>
<td>Shoulder abduction</td>
<td>&quot;Lift your arms into a 'chicken position'&quot; Test each side together, push arms down at elbow. &quot;Stop me from pushing your arms down&quot;</td>
<td>1Deltoid 2C5 3Axillary Nerve</td>
</tr>
<tr>
<td>Arm flexion</td>
<td>&quot;Put your arms in front of you in a 'boxer position' fist facing in&quot; Place your hand around wrist and steadily pull out. &quot;Stop me from pulling your arm out&quot;</td>
<td>1Biceps 2C6 3Musculocutaneous Nerve</td>
</tr>
<tr>
<td>Arm extension</td>
<td>Stay in a 'boxer position'. Place your hand around wrist and push arm in. &quot;Push against my hand&quot;</td>
<td>1Triceps 2C7 3Radial Nerve</td>
</tr>
<tr>
<td>Wrist Flexion</td>
<td>&quot;Hold your arms straight out, make a fist.&quot; Hold the forearm and your hand under their fist. &quot;Push my hand down towards the ground&quot;</td>
<td>1Flexor Carpi Ulnaris 2C8 3Ulnar Nerve</td>
</tr>
<tr>
<td>Wrist Extension</td>
<td>&quot;Now cock your wrists back.&quot; Hold the forearm and use your fist to apply force to their hand. &quot;Stop me from pushing your wrist down&quot;</td>
<td>1Carpi Ulnaris 2C7 3Radial Nerve</td>
</tr>
<tr>
<td>Finger Abduction</td>
<td>&quot;Spread your fingers.&quot; Use your index and small finger to squeeze their fingers closed, not your thumbs! &quot;Stop me from pushing your fingers together&quot;</td>
<td>1Interossei muscles 2T1 3Ulnar nerve</td>
</tr>
<tr>
<td>Thumb Abduction</td>
<td>&quot;Turn hand palm up, bring thumb to 90° Use your thumb to push their thumb into their palm. &quot;Stop me from pushing your thumb down&quot;</td>
<td>1Abductor pollicus brevis 2T1 3Median nerve</td>
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Table 2  Testing power in the upper limbs
<table>
<thead>
<tr>
<th>Action</th>
<th>Instruction</th>
<th>Anatomy</th>
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<tbody>
<tr>
<td>Hip Flexion</td>
<td>“Keeping your knee straight, lift your leg off the bed” Hold their thigh with your hand. “Stop me from pushing your leg down”</td>
<td>¹Psoas ²L2 ³Femoral</td>
</tr>
<tr>
<td>Hip Extension</td>
<td>“Keep your leg straight and elevated” Hold underneath their leg. “Push your leg into the bed”</td>
<td>¹Gluteus Maximus ²L5/S1 ³Inf. gluteal nerve</td>
</tr>
<tr>
<td>Knee Flexion</td>
<td>“Bend your leg at the knee and rest your foot flat on the bed.” Hold their leg around the back of the calf. “Don’t let me straighten your leg/Pull your heel in towards your bottom”</td>
<td>¹Hamstrings ²L5 ³Sciatic</td>
</tr>
<tr>
<td>Knee Extension</td>
<td>Holding their leg on the shin. “Try to straighten you leg, push against my hand with your leg”</td>
<td>¹Quads ²L3/4 ³Femoral</td>
</tr>
<tr>
<td>Dorsiflexion</td>
<td>Place leg straight again; point toes toward face. Place your hand on the dorsum of foot. “Stop me from pulling your foot down”</td>
<td>¹Tibialis anterior (and others) ²L4/5 ³Deep Peroneal</td>
</tr>
<tr>
<td>Plantar flexion</td>
<td>Place your hand on the sole of the foot. “Push down against my hand.”</td>
<td>¹Gastronemeus (and others) ²S1/2 ³Tibial nerve</td>
</tr>
</tbody>
</table>

Table 3  Testing power in the lower limbs.