Gait, Cerebellar Function, and Movement Disorders

MHD – Neuroscience Module

Matthew Wodziak MD
Assistant Professor, SSOM
Department of Neurology, LUHS

originally created by Michael P. Merchut, MD

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Gait
Essentials for normal walking:

* Strength (UMNs, LMNs, NMJs, muscle)
* Coordination (cerebellar system)
* Postural control (extrapyramidal system)
* Sensation (particularly proprioception)

* Memory or concept of walking “put into action”
  (praxis: concept is executed or performed
  “on command”; patients with gait apraxia
  are immobile when asked to walk, despite
  having all the other essentials)

Abnormal stance prior to walking

1. patient stands steadily with feet together, but sways and topples when
   eyes are closed (Romberg sign)
   * due to a posterior column (or sensory nerve) lesion;
   * visual orientation compensates for impaired proprioceptive input;

2. patient cannot stand with feet together, regardless of whether eyes
   are open or closed
   * due to cerebellar disease
   * visual clues cannot compensate

1. Broad-based ataxic gait

* feet spread wide apart for stability;
* gait much more unsteady walking a straight line (tandem or
  heel-to-toe);
* found with lesions of posterior columns or sensory (proprioceptive)
  nerves (worse with eyes closed) or cerebellum;
2. Hemiplegic gait

* affected lower limb is stiffly extended and swung or circumducted;
* affected ipsilateral upper limb is flexed at elbow and wrist with decreased arm swing;
* commonly observed in stroke patients;

Videotaped patient

3. Tabetic gait

* “foot slapping” gait, where patient compensates for impaired sensation by forcibly planting the feet down to “feel” the floor;
* from neurosyphilis (tabes dorsalis), or severe neuropathy;

4. Steppage gait

* caused by foot drop (weak dorsiflexion);
* to prevent tripping over the toes, the hip is flexed even higher to elevate the drooping foot, which is lowered to the floor toe first;
* from peroneal nerve or L5 root lesions, or severe peripheral neuropathy;
5. Waddling gait

* when walking, weak pelvic or hip muscles cannot support the body "on one leg" while the opposite foot is lifted off the ground;

* patient compensates by swaying or leaning to the left when the right foot is raised and vice versa, alternately tilting the pelvis from side to side, reminiscent of a waddling duck;

* usually from myopathy (muscle disease);

6. Scissors gait

* although the legs are weak, marked spasms and tightness in the adductor muscles of the thighs force the knees stiffly together when walking;

* legs tend to cross over each other, like the closing blades of a scissors;

* due to corticospinal tract lesions affecting the legs (spastic paraparesis), as in cerebral palsy or multiple sclerosis;

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7. Parkinsonian gait

* slow, shuffling gait, with "stooped forward" posture and lack of a normal arm swing;

* festination—leaning further and further forward to walk, the patient then runs to "catch up" with the center of gravity;

* turning around is laboriously slow, requiring multiple, small steps, often with a tendency to fall over;
Cerebellar Function

Other tests of cerebellar function:

* Speech: cerebellar dysarthria (left cerebellum)
  - slurred, thick, scanning (erratic, jerky, explosive or “hyphenated” quality);
* Eye movements: nystagmus with erratic, jerky eye movements;

Abnormal limb control in cerebellar disease:

* kinetic tremor—rhythmic oscillations during limb movement towards a target;
* dysmetria—overshooting or undershooting a target;
* decomposition of movement—a normally smooth movement becomes jerky, “broken down”
* loss of check response (rebounds)—sudden release of contracted biceps leads to striking the face; triceps does not normally “check” (protect) this action due to imbalance of agonist/antagonist muscles;
Cerebellar afferents mapped out in animal model:

Midline or vermis (esp. anterior lobe): trunk.
Hemispheres: ipsilateral limbs.

Cerebellar syndromes

Hemispheral syndrome:
* predominantly affects ipsilateral limbs (kinetic tremor, limb dystonia, dysdiadochokinesia, rebound phenomenon);
* from ipsilateral infarction, hemorrhage, tumor or multiple sclerosis lesion; (bilateral lesions in degenerative disease)

Vermal (vermian) syndrome:
* predominantly affects the trunk (truncal unsteadiness with standing or walking, tremor, postural impairment, gait ataxia);
* from hemorrhage, tumor, MS, degenerative disorders;
* alcoholic cerebellar degeneration: atrophy of anterior-superior vermis, with gait ataxia and lower limb dystonia;

Spinocerebellar degenerations or ataxias

* hereditary, degenerative disorders of unknown cause with no curative treatment;
* predominantly affect the nuclei and tracts of the cerebellum and spinal cord in progressive fashion;
* older patients become wheelchair-dependent;
* most common type is Friedreich’s ataxia;

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Movement Disorders
(Hyperkinesias)

Movement Disorders: Tremor
- rhythmic, oscillatory movement of hands, limbs, head or voice;
- predominantly resting tremor—in parkinsonism;
- predominantly when maintaining a position (postural tremor) —typical of familial essential tremor (often with kinetic tremor);
- predominantly when performing a movement (kinetic tremor) —in cerebellar disease;

Movement Disorders: Choreoathetosis
- slow, writhing, continual limb movements (athetosis) plus brief, irregular, flowing “dancelike” movements (chorea) affecting limbs, trunk and face;
- from a lesion in the caudate nucleus (Huntington’s disease) or its connecting pathways;
- high levels of dopaminergic medications may produce choreoathetosis or dystonia;

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### Movement Disorders: Hemiballismus

- rapid, violent (“ballistic”), flinging movements of proximal upper and lower limbs on one side;
- due to a lesion (usually infarction) of the contralateral subthalamic nucleus;

[Video]({#})

### Movement Disorders: Dystonia

- continual or sustained painful contraction of muscles, causing turning and spasm of the limbs or neck, with fixed, unnatural postures;
- focal (e.g., torticollis) or generalized (e.g., dystonia musculorum deformans);
- no specific lesion or pathology has been correlated with this disorder;

[Video]({#})

### Movement Disorders: Tic

- brief, semipurposeful, stereotyped, repetitive contractions of groups of muscles (e.g., eye blink, facial twitch, sniff);
- Tourette’s syndrome:
  - motor and vocal (e.g., grunts, growls) tics;
  - inherited, with variable penetrance; more often in boys;
  - attention deficit disorder;
  - behavioral problems;
- no specific lesion or pathology has been correlated with this disorder; (decreased motor inhibition in the basal ganglia may cause tics?)

[Video]({#})
Movement Disorders: Myoclonus

- rapid, shocklike movements of the limbs or body, usually bilateral, but often asynchronous;
- due to diffuse encephalopathies from neurological (e.g., Creutzfeldt-Jakob disease) or medical diseases (e.g., renal or hepatic failure, anoxia);

Videotaped patient

Movement Disorders: Asterixis

- a “flapping tremor” of the extended hand or foot, due to loss of postural tone;
- seen bilaterally in diffuse encephalopathies from medical diseases (e.g., renal or hepatic failure);
- seen unilaterally in structural brain lesions;

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Pharmacotherapy for movement disorders:

- Parkinsonian resting tremor (anticholinergics, L-dopa, dopamine agonists)
- essential tremor (beta-adrenergic blockers, barbiturates)
- choreoathetosis, hemiballismus, tics (dopamine antagonists)
- dystonia (anticholinergics, benzodiazepines, botulinum toxin injections)