

Gait Abnormalities

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Normal gait cycle

The **gait cycle** has **six phases**:

1. **Heel-strike**: initial contact of the heel with the floor.
2. **Foot flat**: weight is transferred onto this leg.
3. **Mid-stance**: the weight is aligned and balanced on this leg.
4. **Heel-off**: the heel lifts off the floor as the foot rises but the toes remain in contact with the floor.
5. **Toe-off**: as the foot continues to rise the toes lift off the floor.
6. **Swing**: the foot swings forward and comes back into contact with the floor with a heel strike (and the gait cycle repeats).



Gait cycle ¹

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Hemiplegic gait

A **hemiplegic gait** is typically caused by a lesion in the central nervous system (e.g. stroke) which results in **unilateral weakness** and **spasticity**.

Patients with hemiplegia exhibit **spastic flexion of the upper limb** and **extension of the lower limb**.

Due to the extension of the lower limb (fixed ankle plantar flexion and knee extension), the leg is **elongated** meaning patients have to **circumduct their leg** to prevent their foot from dragging on the ground.

Associated clinical features

Clinical features which may be associated with a hemiplegic gait include:

- Increased tone with clasp-knife spasticity
- Hyperreflexia with or without clonus
- Upgoing plantars (i.e. positive Babinski)
- Reduced power
- Sensory deficit: the pattern of sensory loss depends on the site of the lesion in the nervous system

Causes

Unilateral cerebral lesion:

- Stroke
- Space-occupying lesion
- Trauma
- Multiple sclerosis

Hemisection of the spinal cord:

Trauma

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Diplegic gait

A **diplegic gait** (a.k.a scissoring gait) may be caused by a lesion in the central nervous system (e.g. stroke, or complete transection of the spinal cord).

Clinical findings are similar to those in hemiplegic gait but are **bilateral** in nature.

Spasticity is typically **worse in the lower limbs** compared to the upper limbs.

The **hips** and **knees** are **flexed** and **abducted** whilst the **ankles** are **extended** and **internally rotated**.

The knees are forced together due to spasticity in the adductor muscles resulting in **leg overlap** when walking (a.k.a. scissoring).

In an attempt to overcome this adduction, the patient **circumducts both legs** during the swing phase.

The **upper limb** may have **flexor posturing** of the elbows and wrist with shoulders and fingers in adduction (known as 'low guard' or 'mid-guard' position). They also typically **lack the swinging movements** present in a normal gait.

Associated clinical features

Clinical features which may be associated with a diplegic gait include:

- Increased tone with clasp-knife spasticity
- Hyperreflexia with or without clonus
- Upgoing plantars (i.e. positive Babinski)
- Reduced power
- Sensory deficit – if a diplegic gait is caused by spinal cord pathology, the 'sensory level' (ie. the lowest dermatome level with normal sensation) correlates with the level of spinal cord pathology
- Wasting and fasciculations (consider motor neuron disease)

Causes

Spinal cord lesion (sensation usually affected):

- Prolapsed intervertebral disc
- Spinal spondylosis
- Spinal tumour
- Transverse myelitis
- Spinal infarct
- Syringomyelia
- Hereditary spastic paraparesis

Bilateral brain lesion:

- Cerebral palsy
- Multiple sclerosis
- Bilateral brain infarcts
- Midline tumour (e.g. paraspinal meningioma)

Motor neuron disease: associated with lower motor neuron findings

Parkinsonian gait

A **Parkinsonian gait** (a.k.a. festinant gait) is caused by rigidity and bradykinesia as a result of the loss of dopaminergic neurons in the basal ganglia.

Features of a **Parkinsonian gait** include:

- **Initiation:** typically slow to start walking due to failure of gait ignition and hesitancy.

- **Step length:** reduced stride length with short steps is common (shuffling gait). Each step may get progressively smaller as the patient attempts to retain balance (known as festinant gait).
- **Arm swing:** reduced arm swing on one or both sides (often an early feature of Parkinson's disease).
- **Posture:** flexed trunk and neck causing a stooped appearance.
- **Tremor:** resting tremor can be observed when the patient is distracted by walking.
- **Turning:** impaired balance on turning or hesitancy is common due to postural instability.

Associated clinical features

Clinical features which may be associated with a Parkinsonian gait include:

- Tremor
- Rigidity
- Bradykinesia
- Hypomimia

Causes

Features of the Parkinsonian gait are observed in both **idiopathic Parkinson's disease** and other **Parkinsonian disorders**.

Idiopathic Parkinson's disease usually has most features of the gait described above and the classic triad of **tremor**, **rigidity** and **bradykinesia**.

Other Parkinsonian disorders may only have a few of the gait features, may not have all features of the triad, and may be associated with other findings.

Examples of disorders with Parkinsonian features include:

- Vascular Parkinson's disease
- Dementia with Lewy bodies
- Parkinson's plus syndromes (e.g. multisystem atrophy and progressive supranuclear palsy)
- Drug-induced Parkinsonism (e.g. antipsychotics, antiemetics)
- Dementia pugilistica

Ataxic gait

An **ataxic gait** is typically broad-based and associated with **midline cerebellar disease** (e.g. alcoholic cerebellar degeneration), **vestibular disease** (e.g. labyrinthitis) or **loss of proprioception** (known as sensory ataxia).

Features of an **ataxic gait** include:

- **Stance:** a broad-based ataxic gait is typically associated with midline cerebellar pathology (e.g. a lesion in multiple sclerosis or degeneration of the cerebellar vermis secondary to chronic alcohol excess).
- **Stability:** a staggering, slow and unsteady gait is typical of cerebellar pathology. In unilateral cerebellar disease, patients will veer towards the side of the lesion.
- **Turning:** patients with cerebellar disease will find the turning manoeuvre particularly difficult.

Associated clinical features

The presence of an ataxic gait may be the result of **cerebellar**, **vestibular** or **sensory impairment**.

Clinical features associated with **cerebellar ataxia**:

- Nystagmus
- Ataxic dysarthria
- Dysmetria
- Intention tremor
- Dysdiadokokinesia

Clinical features associated with **sensory ataxia**:

- Positive Romberg's sign
- Impaired proprioception
- Impaired vibration sensation
- Absence of other cerebellar signs (e.g. dysmetria, nystagmus, dysarthria)

Clinical features associated with **vestibular ataxia**:

- Vertigo
- Nausea
- Vomiting

Causes

Cerebellar ataxia:

- Cerebellar stroke (ischaemic or haemorrhagic)
- Space-occupying lesion
- Multiple sclerosis
- Alcoholism
- B12 deficiency
- Drugs (e.g. phenytoin, carbamazepine, barbiturates, lithium)
- Genetic disease (e.g. Friedreich's ataxia, spinocerebellar ataxia)
- Paraneoplastic disease

Sensory ataxia:

Peripheral neuropathy (e.g. diabetes mellitus)

Vestibular ataxia:

- Labyrinthitis
 - Meniere's disease
 - Acoustic neuroma
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Neuropathic gait

Neuropathic gait (a.k.a. high-steppage gait) is caused by **weakness of the muscles in the distal limb** (typically the dorsiflexors of the foot) as a result of damage to the peripheral nerves providing motor innervation.

Weakness of the dorsiflexors of the foot results in **foot drop** and **dragging of the toes** during the swing phase of the gait cycle. To prevent the toes from dragging on the floor, the **knee** and **hip flex excessively**, thereby creating a "high stepping" gait.

Associated clinical features

Clinical features which may be associated with a neuropathic gait include:

- Peripheral vascular disease
- Peripheral sensory impairment
- Distal muscle weakness
- Reduced or absent reflexes

Causes

Foot drop is caused by **weakness of the muscles of ankle dorsiflexion** (tibialis anterior) supplied by the common peroneal nerve (L4, L5 and S1 nerve root).

Foot drop may therefore be caused by:

- Isolated common peroneal nerve palsy (e.g. secondary to trauma or compression)
 - L5 radiculopathy (e.g. disc prolapse)
 - Generalized polyneuropathy involving multiple nerves (e.g. diabetic neuropathy, motor neurone disease, Charcot-Marie Tooth disease)
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Myopathic gait

A **myopathic gait** (a.k.a. waddling gait or Trendelenburg gait) occurs due to **weakness of the hip abductors** resulting in a waddling appearance.

Hip abductor weakness results in an inability to stabilize the pelvis during the stance phase. As a result, the **pelvis tilts downwards towards the unsupported side** during the swing phase of the gait cycle.

The body compensates to prevent the swinging foot from dragging by:

- Laterally flexing the torso away from the leg in swing phase; this draws the pelvis and leg up off the floor (causing the characteristic 'waddling' appearance)
- Circumducting the leg

Associated clinical features

Clinical features which may be associated with a myopathic gait include:

- Difficulty standing from a seated position without the use of the arms
- Difficulty standing from a squat or sitting up from a lying position
- Positive Trendelenburg's sign; when the patient stands on one leg, the pelvis drops towards the contralateral side

Causes

Systemic disease:

- Hyperthyroidism
- Hypothyroidism
- Cushing's syndrome
- Acromegaly
- Polymyalgia rheumatica
- Polymyositis
- Dermatomyositis

Muscular dystrophies:

- Duchenne's muscular dystrophy.
- Becker's muscular dystrophy.
- Myotonic dystrophy

Choreiform gait

A **choreiform gait** (a.k.a. hyperkinetic gait) presents with **involuntary movements** such as:

- Oro-facial dyskinesia (grimacing or lip-smacking)
- Choreic movements of the upper and lower limbs (writhing, dance like semi-purposeful movements)

The involuntary movements are usually present at rest, however, walking can accentuate the movements.

Causes

Basal ganglia disease:

- Huntington's disease
- Sydenham's chorea
- Cerebral palsy (choreiform type)

- Wilson's disease
 - Dopaminergic medications (e.g. Parkinson's medications)
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Antalgic gait

An **antalgic gait** is an abnormal gait pattern which develops as a result of **pain**. Typically the stance phase is reduced on the affected leg resulting in a limping appearance.

Causes

Any cause of **lower limb pain** such as:

- Osteoarthritis
 - Inflammatory joint disease
 - Lower limb fracture
 - Nerve entrapment (e.g. sciatica)
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References

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