

# Gait Disorders



류 철 형

연세대학교 의과대학 강남세브란스병원 신경과

**Chul Hyung Lyoo, MD, PhD**

Department of Neurology, Gangnam Severance Hospital, Yonsei University College of Medicine, Seoul, Korea

## Outline of Talk

1. Normal physiology of gait to initiate gait and to move forward
2. New classification of gait disturbance
3. Video cases showing various types of gait disturbance

## Physiological aspects of Normal Gait

## Basic requirements for gait

	Neural control mechanism	Physiologic mechanism
Equilibrium	Arising to erect posture	Righting reactions
	Support upright position	Supporting reactions
	Correct perturbations & Adapt to circumstance	Anticipatory postural reaction
		Reactive postural response
		Rescue reaction
Locomotion		Protective reaction
	Initiate steps	Shift center of gravity
	Stepping	Start stepping
Non-neurologic factors	Adapting stepping to circumstances	Voluntary
	Mechanical support system	Bone, joints
	General health	Exercise tolerance

Nutt JG, Neurology 1993;43:268

## Systems required for locomotion

### Prerequisite steps for locomotion

#### Locomotion initiation processes

volitionally elicited locomotor commands from cerebral cortex  
emotionally triggered commands from limbic-hypothalamic system

#### Locomotion regulation processes

cerebral cortex, basal ganglia, cerebellum

#### Basic locomotion execution process

brainstem, spinal cord

### Prerequisite functions for locomotion

**Locomotion system** : rhythm generation

**Muscle tone excitatory system**

Takakusaki K, J Neurol 2008;255 54:19

### Step initiation shift of body center

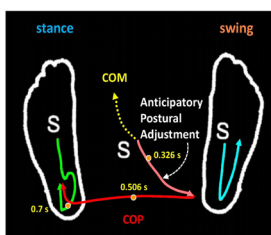
#### Center of pressure (COP)

2 - 9cm anterior to the ankle  
24 ± 5% of foot length



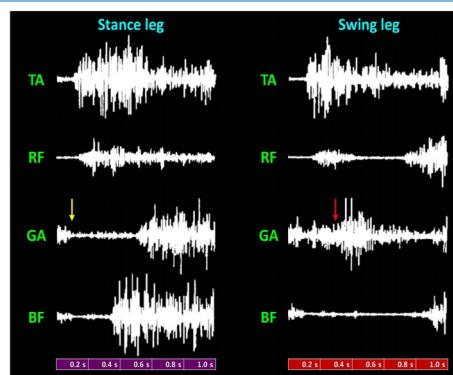
#### Center of mass (COM)

0.552 ± 0.016 fraction of height  
AP & Lat coordinates = COP  
COM starts to move after 0.29 s



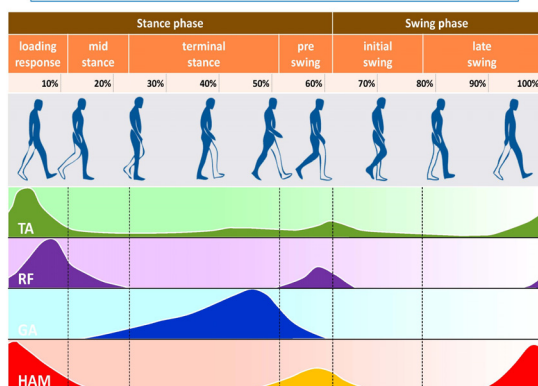
Elble RJ, Mov Disord 1993;9:139

### Step initiation activation of leg muscles

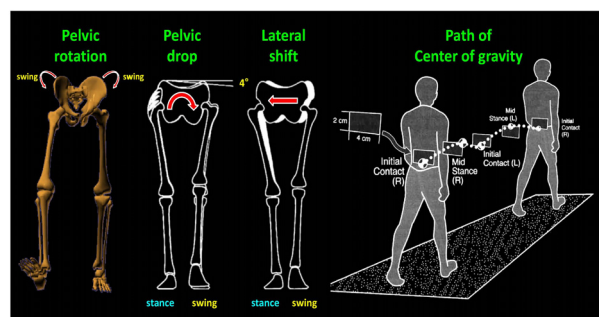


Elble RJ, Mov Disord 1993;9:139

### Gait cycle



### Pelvic movements to shift center of gravity from swing leg to stance leg



Perry J, Gait Analysis 1992

Robot can be programmed  
to mimic human gait.

Application of human gait  
to robotics

### Pathological Gait

New classification of gait disturbance by clinical presentation	
Continuous	<b>Ataxic</b> : Disequilibrium and hypermetria of stance and gait : somatosensory, cerebellar, vestibular
	<b>Spastic</b> : Associated with increased postural tone : hemiparetic, paraparetic, tetraparetic
	<b>Bradykinetic/hypokinetic</b> : slow or small steps and/or slow or small postural responses
	<b>Dyskinetic/choreic/dystonic</b> : Involuntary movements
	<b>Paretic</b> : Associated with muscle weakness or paralysis
	<b>Trunkal</b> : Static, axial postural deformities
	<b>Antalgic</b> : Secondary to musculoskeletal or central pain
	<b>Higher level (Frontal)</b>
	Apractic Anxious, fear of falling, cautious Bizarre Severely depressed Psychogenic
	<b>Undetermined</b> : Sometimes it may be difficult to classify.
Episodic	<b>Freezing</b> : Transient inability to create effective stepping
	<b>Festination</b> : Unintentional increase in speed, usually with small steps
	<b>Disequilibrium</b> : Transient loss of balance
Mixed	Where a person suffers from more than one continuous disturbance, or continuous and episodic disturbances, for example, are possible.

Giladi N, Mov Disord 2013;28:1469

Ataxic gait

Ataxic gait  
MSA

Spastic gait

Spastic gait  
Cerebral palsy

Parkinsonian gait

Parkinsonian gait  
PD

Choreic gait

Choreic gait  
Huntington's disease

Dystonic gait

Dystonic gait  
DRD

**Hemiplegic gait**

**Hemiplegic gait**  
Stroke

**Paraplegic gait**

**Paraplegic gait**  
Spastic paraparesis

**Antalgic gait**

**Antalgic gait**

**Frontal gait**

**Frontal gait**  
Vascular parkinsonism

**Apraxic gait**

**Apraxic gait**  
CBD

**Freezing in Parkinsonism**

**Freezing of gait**  
PD

**Freezing in Pallidal lesion**

**Freezing of gait**  
**Bilateral pallidal lesion**

**Psychogenic gait**

**Psychogenic gait**  
**Knee buckling**

**Psychogenic gait**

**Psychogenic gait**  
**Ataxic, Frontal lesion**