

Gait Disorders



류철형

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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	
	Protective reaction	
Locomotion	Initiate steps	Shift center of gravity
	Stepping	Start stepping
	Adapting stepping to circumstances	Voluntary
Non-neurologic factors	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

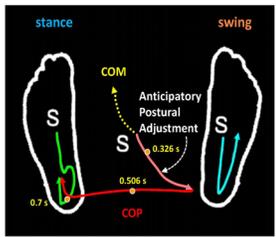
Center of pressure (COP)

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



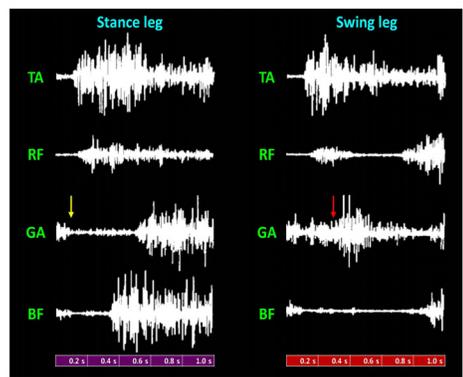
Center of mass (COM)

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



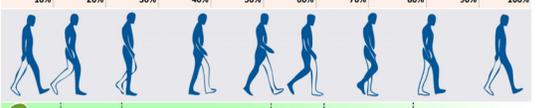
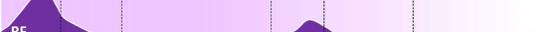
Eble RJ, Mov Disord 1993;9:139

Step initiation activation of leg muscles

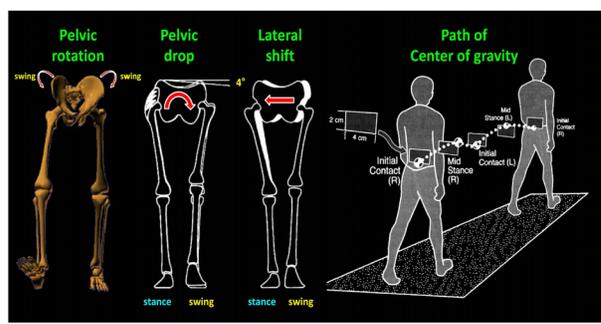


Eble RJ, Mov Disord 1993;9:139

Gait cycle

Stance phase					Swing phase				
loading response	mid stance	terminal stance		pre swing	initial swing	late swing			
10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
									
									
									
									
									

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	Ataxic : Disequilibrium and hypermetria of stance and gait : somatosensory, cerebellar, vestibular
	Spastic : Associated with increased postural tone : hemiparetic, paraparetic, tetraparetic
	Bradykinetic/hypokinetic : slow or small steps and/or slow or small postural responses
	Dyskinetic/choreic/dystonic : Involuntary movements
	Paretic : Associated with muscle weakness or paralysis
	Trunkal : Static, axial postural deformities
	Antalgic : Secondary to musculoskeletal or central pain
Episodic	Higher level (Frontal) Apractic Anxious, fear of falling, cautious Bizarre Severely depressed Psychogenic
	Undetermined : Sometimes it may be difficult to classify.
	Freezing : Transient inability to create effective stepping
	Festination : Unintentional increase in speed, usually with small steps
	Disequilibrium : 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