Normal Gait Mechanics

Normal Gait Patterns Have Two Major Periods:

1. Double Limb Support: a) weight loading
   b) weight unloading
2. Single Limb Support: a) stance phase of ipsilateral side
   b) swing phase of contralateral side

DOUBLE LIMB SUPPORT

WEIGHT UNLOADING: Trailing foot is rolling off floor

Phases: Terminal Stance: when heel rises
Pre-Swing: when 1st MTP rolls off floor

Joint Motions:	**Terminal Stance**	→	**Pre-Swing**
Ankle	Heel rise	→	Max. plantarflexion (20 ^{o})
Knee	Full extension	→	Flexes to approx. 40^{o}
Hip	Max. extension (20^{o})	→	Flexes to approx. 0^{o} (neutral)
Pelvis	Relative anterior rotation	→	Less anterior rotation
	Posterior depression	→	Begin anterior elevation
Trunk	Aligned between legs	→	Aligned towards wt. loading leg

WEIGHT LOADING: Weight is transferred to contralateral leg

Phases: Initial Contact: when heel contacts floor
Loading Response: when sole of foot contacts floor

Joint Motions	**Initial Contact**	→	**Loading Response**
Ankle	Neutral	→	Plantarflexes 10^{o}
Knee	Knee extended	→	Knee flexes 15^{o}
Hip	Flexed 25^{o}	→	Stable 25^{o} flexion Relative abduction
Pelvis	Level	→	Lateral drop to swing leg
Trunk	Aligned between legs	→	Aligned towards wt. bearing leg

SINGLE LIMB SUPPORT — Body is aligned over the stationary foot
Contralateral leg is off the floor

STANCE PHASE: (Initial Mid-Stance, Mid-Stance, Late Mid-Stance)

Joint Motions	**Initial Mid-Stance**	→	**Late Mid-Stance**
Ankle	Slight plantarflexion	→	Max. dorsiflexion (10^{o})
Knee	Slight flexion	→	Extended
Hip	Flexed, Relative adduction	→ 10^{o}	Extended, Relative adduction
Pelvis	Lateral drop to swing leg, externally rotated		
Trunk	Toward stance leg	→	Away from stance leg

Trunk rises in an arc over the stationary foot

SWING PHASE: Leg shortens via hip and knee bend to simplify floor clearance

Sub Phases:
- Initial Swing: big toe leaves ground
- Mid-Swing: contralateral leg is at high point – mid-stance
- Terminal Swing: leg reaching forward for next floor contact

Joint Motions	**Initial Swing**	→	**Mid-Swing**	→	**Terminal Swing**
Ankle	Plantarflexed	→	Neutral	→	Neutral
Knee	Max. flexion (60^{o})	→	Flexion	→	Max. extension (0^{o})
Hip	Flexion, Relative abduction	→	Max, flexion (25^{o}) Max. abduction (10^{o})	→	Flexion, Relative abducted
Pelvis	Lateral drop to swing leg, medial rotated				
Trunk	Aligned over stance leg				

Pathway of Center of Gravity

Sagittal Plane: Rhythmical up and down motion
Highest point: Over extended single leg (MSt)
Lowest point: Double limb support (PSw/LR)
Vertical displacement of 4-5 cm. (sinusoidal wave)

Frontal Plane: Rhythmical side-to-side motion
Most lateral point: Mid-Stance
C. O. G. swings laterally in as arc over the stationary foot
Lateral displacement of 4-5 cm. (sinusoidal wave)

References:

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Perry J. *Gait Analysis. Normal and Pathological Function.* Thorofare, NJ: Slack; 1992.

Critical Events During Gait

Joint	Sagittal Plane	Frontal Plane	Transverse Plane
1st MTP	65° extension at PSw		
Midtarsal: Calcaneocuboid			Control of Abduction at TSt PF of 1st Ray at TSt/PSw (Peroneus Longus) Oblique MT Jnt Axis stability at TSt
Talonavicular		Control of Eversion at MSt (Tib Ant and Tib Post) Longitudinal MT Jnt Axis stability at TSt	
Subtalar		4-6° eversion at IC/LR	
Ankle	10°-20° DF at TSt Control of DF (tibial advancement) after MSt (Gastroc. and Soleus)		
Knee	Control of flexion at LR (Quadriceps and VMO) 0° extension at TSt 60° flexion at ISw Produce full ext. at TSw	Patellar Medial Glide	
Hip	Control of flexion at LR (Hip extensors) 20° extension at TSt	Control of lateral pelvic tilt at MSt (Hip Abductors)	

Common Lower Extremity Musculoskeletal Impairments Associated With Gait Deviations

Joint ROM/Muscle Length Deficits	Motor Control/Strength Deficits	Joint Hypermobility/Instability
1st MTP Dorsiflexion	Tibialis Anterior	Calcaneocuboid/Oblique MTJA
Talocalcaneal Eversion	Tibialis Posterior	Talonavicular/Longitudinal MTJA
Talocrural Dorsiflexion	Peroneus Longus	
Tibiofemoral Extension	Gastrocnemius/Soleus	
Tibiofemoral Flexion	Quadriceps/VMO	
Patellofemoral Medial Glide	Gluteus Medius/Minimus	
Hip Extension	Gluteus Maximus	