# Chapter 14

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| Learning Outcomes: Students will be able to:   1. Effectively describe a gait pattern using accepted terminology. 2. Describe the specific components of the “Stance Phase” and “Swing Phase” of the gait cycle, including their beginning and ending points for each component. 3. Identify the involved/active muscles during both gait phases and the specific type of muscle contraction that is occurring. 4. Analyze deviations from normal gait and identify the causative or compensatory reasons contributing to atypical  gait patterns. |

It is by walking that a person moves from place to place. Gait is the repetitive components of walking that collectively are known as the gait cycle, or the activity that occurs between the time one foot touches the floor and the time the same foot touches the floor again. Stride length is the distance traveled during the gait cycle, and step length is the distance between heel strike of one foot to heel strike of the other foot.

Each individual has their own unique characteristics that distinguish their style of walk. Those individual characteristics can even be influenced by different moods. Clinical measurements or observations of the components of the gait cycle can be compared against normative values to identify deviations and potential injury risks. The gait cycle has two phases.

* Stance Phase: begins with the heel strike of one foot and ends when that foot leaves the ground. It occurs when the foot is in contact with the ground and accounts for 60% of the gait cycle. During stance, gravity and ground reaction forces (GRF’s) are the external forces acting on the lower extremity and body.
* Swing Phase: begins as soon as the foot leaves the floor and ends when the heel of the same foot touches the ground again. It occurs when the foot is not in contact with the ground and accounts for 40% of the gait cycle. During swing, gravity and air resistance are the external forces acting on the lower extremity.

NOTE: There are two different sources that provide terminology for the components of the gait cycle – the Traditional terminology system and the Rancho Los Amigos system. Research on gait is increasingly using Rancho Los Amigos terminology that looks at “periods of time” vs “points in time”. Therefore, we will use Rancho Los Amigos terminology throughout the rest of this section.

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| Stance Phase |
| Term | Definition | Involved Muscles &  Type of Contraction | Other Key Points or Observations |
| Initial Contact   (stance phase begins) | When heel strikes the ground | Hip: Flexed 30º on contact   * Extensors begin eccentric contraction to prevent further hip flexion   Knee: Flexed 5º on contact   * Extensors contact eccentrically to accept weight/absorb shock   Ankle: Neutral position   * Dorsiflexors isometrically hold foot in dorsiflexed position | Pelvis:  ---Rotates forward on ipsilateral side  ---Rotates backward to Contralateral side  Body is behind stance leg |
| Loading Response | Begins at initial contact  body weight is transferred to leg and entire foot makes contact with the ground.  Ends when opposite foot leaves the ground | Hip: Extensors control external flexion torque eccentrically  Knee: Remains partially flexed, extensors eccentrically absorbing weight/shock  Ankle: Dorsiflexors eccentrically lower the foot to the ground | Body starts to move forward over stance leg |
| Mid-stance | Begins when opposite foot leaves the ground  Ends when body is directly over stance limb | Hip: Extensors are primarily silent as the body’s momentum moves the hip into extension  Knee: Extensors become silent as body shifts over the foot and GRF’s are directed through the joint axis  Ankle: Plantarflexors control dorsiflexion eccentrically | Body is at highest point in gait cycle  Pelvis is in neutral position |
| Terminal Stance | Begins as the heel of the stance leg rises  Ends with initial contact of the opposite foot | Hip: Extensors are silent as momentum and GRF’s continue further hip extension  Knee: Extensors are silent as momentum and GRF’s maintain the knee in extension  Ankle: From a dorsiflexed position, the plantarflexors begin to contract concentrically | Pelvis:  ---Rotates backward on ipsilateral side  ---Rotates upward to Contralateral side  Body has moved in front of the stance leg |
| Pre-swing (stance phase ends) | Begins with initial contact and weight shifts to the other foot  Ends just before toes of stance leg leave the ground | Hip: Flexors contract concentrically to flex hip and bring thigh forward (note: two hip flexors – gracilis and sartorius - contract to flex the knee)  Knee: Flexors are silent allowing hip flexors to do the work  Ankle: concentrically plantarflexes to raise the heel off (push off) and reaches full plantarflexion for toe off (propulsion) | Advancement of leg begins |

Trunk and Upper Extremities: During walking, the arms swing in a rhythmic pattern that is opposite the pattern of the lower extremities. As the hip on one side moves into flexion, the ipsilateral arm moves into extension, and vice versa. The function of the arm swing balances the small rotational movements of the trunk that occur during walking, placing the shoulder girdle in a rotated position opposite the pelvis. Both arm swing and this small amount of trunk rotation contribute to an efficient gait pattern.

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| Swing Phase |
| Term | Definition | Involved Muscles &  Type of Contraction | Other Key Points or Observations |
| Initial Swing  (Swing phase begins) | Begins when the toes leave the ground  Ends when the swing foot is opposite the stance or weight bearing foot, and the knee is in maximum flexion | Hip: Continues flexing (concentric contraction) to bring the leg forward  Knee: Continues flexing “following along for the ride” from hip flexion  Ankle: Begins to dorsiflex (concentric contraction) | Pelvis:  ---Begins to rotate forward on ipsilateral side  Body is behind stance leg |
| Midswing | Begins when the swing foot is opposite the stance or weight bearing foot  Ends when the swing leg is moved in front of the body and the tibia is in a vertical position | Hip: Is at maximum flexion (concentric contraction) but fades in force as momentum carries the leg forward  Knee: Is at maximum flexion (to clear the ground) and begins to extend  Ankle: Is dorsiflexed to neutral position and holding the position isometrically | Pelvis is in neutral position  Leg is passing under and moving in front of body |
| Terminal Swing | Begins when the tibia is in a vertical position  Ends just prior to initial contact | Hip: Is in flexed position as eccentric contraction of hip extensors begins to decelerate forward flexion  Knee: Is extending and the hamstrings begin to contract eccentrically to slow down the forward movement of the leg and prepare for initial contact  Ankle: Is being held in dorsiflexion isometrically | Pelvis  ---Is rotated forward on ipsilateral side  Leg advancement ends out in front of body |

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| Abnormal Gait |

Impairments in the motor, sensory, perceptual, or cognitive systems can contribute to abnormal gait patterns. Muscle weakness or paralysis, joint or muscle ROM limitations, neurological impairments, and pain can lead to abnormal gait patterns. Some common gait dysfunctions that result from muscle weakness or paralysis and the shortening of muscles and/or associated connective tissue will be discussed here.

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| Muscle Weakness/Paralysis “or” ROM Restriction | Gait Pattern: Causative or Compensatory |
| Gluteus Maximus Weakness Gait   * Unilateral (Gluteus Maximus Lurch gait) * Bilateral (Pregnant Woman gait)   Note: person can’t risk going into hip flexion without posterior extensor muscles | * Unilateral: quick trunk extension at initial contact (heel strike) on the involved side to place the COM over the hip joint (compensatory). * Bilateral: trunk is continually shifted posteriorly and hips tend to externally rotate for a broader base of support (compensatory). |
| Gluteus Medius Weakness Gait (Trendelenburg gait)   * Causative: contralateral pelvis drop * Compensatory: ipsilateral trunk shift | * Causative: contralateral pelvis drops upon weight bearing of the involved side. * Compensatory: trunk shifts to the ipsilateral side to place the COM over the hip joint. |
| Hip Flexor Weakness Gait (Circumduction gait)   * Abducts or swings involved leg outward in a circular motion | * Compensatory: ipsilateral or involved leg is abducted and the momentum of the walking motion swings the leg forward in a circumduction movement. Contralateral trunk lateral flexion aides in the hip abduction movement. |
| Quadriceps Weakness Gait (Genu Recurvatum gait)   * Forward leaning with extended knee | * Compensatory: forward lean of the trunk over the involved leg that has been forced into hyperextension (recurvatum). Person may press downward/inward on the involved leg to help force the hyperextension. |
| Dorsiflexor Weakness Gait (Slap Foot gait, Drop Foot with Equinus gait)   * If no dorsiflexion the foot is in a dropped position (Drop Foot) = Steppage gait * If can perform weak dorsiflexion = Slap Foot gait | * Compensatory (Equinus Gait): person will perform high hip flexion to clear the dropped foot from scraping the ground, and then will touch down with the toes, similar to the gait of a horse. * Compensatory (Slap Foot gait): during loading response, the weak dorsiflexors can’t effectively lower or decelerate the foot to the ground so the foot slaps the surface. |
| Gastroc/Soleus Weakness Gait (Sore Foot gait)   * Can’t plantarflex to perform preswing or push off. | * Causative: no plantarflexion at terminal stance or push-off resulting in a shortened step length on the unaffected side. |

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