Gait Assessment

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Introduction

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Simple act falling and catchingOne leg is always in contact with groundTwo period-Single and Double leg supportTill age of 7 years is variable and irregular

Gait assessment

Gait assessment

Need time, skills and PracticeDone by using Force platforms, EMG, High speed video motion.Will learn in this Chapter about:Understand the GaitAssessment of GaitNormal and Abnormal

Definitions

Definitions

Gait cycle: is defined as time interval or sequence of motions occurring between two consecutive initial contacts of the same footMeans Heel strike to heel strike of next foot

Stance phase, = 60% to 65% of the walkingSwing phase, =35% to 40%As Velocity increases the cycle time and length decreases

Periods and Functions

Periods and Functions

Stance Phase

Stance Phase

Initial contact (heel strike)Load response (foot flat)Midstance (single-leg stance)Terminal stance (heel off)Preswing (toe off)Stance phase= Foot on ground and Weight bearing,

Initial contact

Initial contact

Weight loading or Weight acceptance period10% of Gait cycleAlso period of double supportDuring this period, one foot is coming off the floor while the other foot is accepting body weight and absorbing the shock of initial contact.

Load response and Mid stance

Load response and Mid stance

Its single limb stance40% of the gait cycleOne leg alone carries the body weight while the other leg goes through its swing phaseThe stance leg must be able to hold the weight of the body, body must be able to balance on the one leg. In addition, lateral hip stability must be exhibited to maintain balance, and the tibia of the stance leg must advance over the stationary foot.

Terminal stance and Preswing

Terminal stance and Preswing

Weight unloading period10% Gait cycleDuring this period, the stance leg is unloading the body weight to the contralateral limb and preparing the leg for the swing phase.Period of Double support

Swing Phase

Swing Phase

Non bearing weight and is moving forward PhaseThe swing phase allows the toes of the swing leg to clear the floor and allows for leg length adjustments40% gait cycleInitial swing (acceleration)MidswingTerminal swing (deceleration)

Acceleration

Acceleration

Foot is lifted offRapid knee flexion and ankle dorsiflexion occur to allow the swing limb to accelerate forwardPathological: Altered Gait

Midswing

Midswing

The midswing instant occurs when the swing leg is adjacent to the weight-bearing leg, which is in midstance.

Deceleration

Deceleration

Slows down in preparation for initial contactWith normal gait, active quadriceps(control extension) and hamstring muscle(control hip flexion) actions are required

Double-leg stance25% of the cycleThis percentage increases in slow walks;Decreases in Fast walkDisappears in running.Single-leg stance30% of the cycleTwice during normal gait cycle

Running Gait

Running Gait

The stance phase= Decreases Float phase or double unsupported phase occur while the double support phase disappears Although the single leg stance phase decreases, the load increases The motion occurring at each of the joints (pelvis, hip, knee, ankle) is similar for walking and for running, ROM increases with the speed of the activity. Example, Hip flexion in walking is about 40° to 45°, whereas in running it is 60° to 75°.

Normal Gait Parameters

Normal Gait Parameters

Normal 8 to 45 yearsBase WidthDistance between two feet 5 to 10cmWider base is the problem- Cerebellar and Inner earIncreased speed, the base width normally decreases to zero, Some cases, crossover occurs, in which one foot lands where the other should and vice versa leads to problem.

Step Length

Step Length

Step length, or gait length, is the distance between successive contact points on opposite feetNormally, this distance is 35 to 41 cmShould be equal for both feetChildren taking smaller steps than adults Females taking smaller steps than males. Height also has an effect: a taller person takes larger steps. Step length tends to decrease with age, fatigue, pain, and disease. If step length is normal for both legs, the rhythm of walking will be

smooth.If there is pain in one limb, the patient attempts to take weight off that limb as quickly as possible, altering the rhythm.

Male and Women Difference Parameters(Decreased in Women)

Male and Women Difference Parameters(Decreased in Women)

VelocityStride and step lengthProportional distance of centre of gravity from groundSagittal hip motionKnee flexion in initial swingWidth of base of supportVertical head excursionLateral head excursionShoulder sagittal motionElbow flexion

Stride length

Stride length

Stride length is the linear distance in the plane of progression between successive points of foot-to-floor contact of the same foot.Normally about 70 to 82 cmStride length, like step length, decreases with age, pain, disease, and fatigue. The age changes are often the result of decreased walking pace or speed

Lateral pelvic shift

Lateral pelvic shift

Lateral pelvic shift, or pelvic list, is the side-to-side movement of the pelvis during walking.It is necessary to center the weight of the body over the stance leg for balance2.5 to 5 cmIt increases when if the feet apart. The pelvic shift causes relative adduction of the weight-bearing limb, facilitating the action of the hip adductors. If these muscles are weak, a Trendelenburg's gait results

Vertical pelvic shift

Vertical pelvic shift

Vertical pelvic shift keeps the center of gravity from moving up and downAround 5 cm (2 inches)Vertical pelvic shift, the high point occurs during midstance and the low point during initial contact.The height of these points may increase during the swing phase if the knee is fused or because of protective spasm or swelling.

On the swing phase, the hip is lower on the swing side, and the patient must flex the knee and dorsiflex the foot to clear the toe. This action shortens the extremity length at midstance and decreases the center of gravity rise.

Pelvic rotation

Pelvic rotation

Pelvic rotation is necessary to lessen the angle of the femur with the floor, and, in so doing, it lengthens the femur.There is a total of 80 pelvic rotation, with 40 forward on the swing leg and 40 posteriorly on the stance leg.To maintain balance, the thorax rotates in the opposite direction. When the pelvis rotates clockwise, the thorax rotates counter clockwise, and vice versa.These concurrent rotations provide counter rotation forces and help regulate the speed of walking

The farther the joint is from the trunk, the greater the amount of rotation. For example, rotation in the tibia is three times greater than rotation in the pelvis.

Center of Gravity

Center of Gravity

Normally, in the standing position, the center of gravity is 5 cm (2 inches) anterior to the second sacral vertebraThe vertical and horizontal displacements of the center of gravity 5-cm (2-inch) square within the pelvis during walking.The vertical displacement, which describes a smooth sinusoidal curve during walking, can be observed from the side.

Cadence

Cadence

Steps per minute90 to 120 steps per minuteThe cadence of women is usually 6 to 9 steps per minute higher than that of men.Age reduces Cadance

Normal Pattern of Gait

Normal Pattern of Gait

Stance Phase

Stance Phase

Closed kinematic phase of chainThe foot becomes the fixed stable segment, and alterations occur from the foot up, with the joints of the foot adapting first, followed by those of the ankle, knee, hip, pelvis, spine, and finally the upper limb, which acts as a counterbalance to movement in the lower limb.

Initial contact

Initial contact

The pelvis is level and medially rotated on the side of initial contact, whereas the trunk is aligned between the two lower limbs. The hip is flexed 30° to 49° and is medially rotated; the knee is slightly flexed or extended; the tibia is laterally rotated; the ankle is at 90° with the foot supinated; The hindfoot is everted.

If pain occurs in the heel at this time.This pain may cause increased flexion of the knee, with early plantar flexion to relieve the stress or pressure on the painful tissues. If the knee is weak, the patient may extend the knee by using the hand or may hit the heel hard on the ground to "whip" the knee into extension.

If the dorsiflexor muscles are weak, the foot drops "slaps" or "flops“ down. The weakness may be caused by a peroneal neuropathy A knee flexion contracture or spasticity may cause the same alteration.

Load response

Load response

Load response is a critical event in that the person subconsciously decides whether the limb is able to bear the weight of the body. The trunk is aligned with the stance leg. The pelvis drops slightly on the swing leg side and medially rotates on the same side. The flexed and laterally rotated hip moves into extension, Knee flexes 15° to 25°. The tibia is medially rotated and begins to move forward over the fixed foot as the body swings over the foot. The ankle is plantar flexed, and the hindfoot is inverted. Abnormal responses include excessive or no knee motion as a result of weak quadriceps, plantar flexor contractures, or spasticity.

Mid stance

Mid stance

Weight of the foot is evenly distributed over the entire footThe trunk - aligned over the stance leg, The pelvis - slight drop to the swing leg.During this stage, there is maximum extension ofthe hip (10° to 15°) with lateral rotation.

Painful hip, knee, or ankle conditions cause this phase to be shortened.Weak gluteus medius- Trendelenburg's sign.The knee flexes, and the ankle is locked at 5° to 8° of dorsiflexion, Ankle rolling forward on the forefoot (roll-off). Forefoot is pronated, and

the hindfoot is inverted. If pain is elicited during this period, the phase will be shortened and the heel may lift off early.This pain is commonly caused by conditions such as arthritis, rigid pes planus, fallen metatarsal or longitudinal arches, plantar fasciitis, or Morton's metatarsalgia.Therefore, pathology at the hip, ankle, or knee can modify the gait in this phase.

Terminal Stance

Terminal Stance

In the final stages, the trunk is initially aligned over the lower limbs and moves toward the stance leg. The pelvis is initially level and posteriorly rotated and then dips to the swing leg side, remaining posteriorly rotated.The hip is in extension;The knee is extended with the tibia laterally rotated. At the ankle, plantar flexion occurs as the critical event.

This action helps to smooth the pathway of the centre of gravity. The forefoot is initially in contact with the floor, and then the weight on the foot moves forward with plantar flexion so that only the big toe is in contact with the floor.At the same time, the forefoot moves from inversion to eversion.

Preswing (Toe Off)

Preswing (Toe Off)

The preswing phase is the acceleration phase as the toe pushes the leg forward. The trunk remains erect, the pelvis remains posteriorly rotated, and the hip is extended and slightly medially rotated. The knee flexes to 30° to 35° (critical event), and the ankle is plantar flexed.

If pain is elicited during this instant, it may be caused by any pathology involving the great toe (hallux).With injury to the joint, the patient is unable to push off on the medial aspect of the foot; instead, the patient push off on the lateral aspect of the foot. If the plantar flexors are weak (e.g., 51-52 nerve root pathology), push-off may be absent. During this phase, the foot pronates so that there is a rigid base for better push-off.

Swing Phase

Swing Phase

The swing phase of gait involves the lower limb in an open kinetic chain; the foot is not fixed on the ground, and the stresses are less. During this phase, alterations occur from the spine down through the pelvis, hip, ankle, and foot.The pelvis and hip provide the most stability in the lower limb during the non-weight bearing phase.

Initial Swing

Initial Swing

Flexion and medial rotation of the hip Flexion of the knee occur. The pelvis medially rotates and dips to the swing leg side. The trunk is aligned with the stance leg. The ankle continues to plantar flex. The forefoot continues supinating, and the hindfoot continues everting. The dorsiflexor muscles of the ankle contract to allow the foot to clear the ground, and the knee exhibits its maximum flexion during gait of about 60°.If the quadriceps muscles are weak, the pelvis is thrust forward by the trunk muscles to provide forward momentum to the leg.

Midswing

Midswing

The hip continues to flex and medially rotate The knee continues to flex.The ankle is in the anatomic position. The forefoot is supinated, and the hindfoot is everted. The pelvis and trunk are in the same position as during the previous stage. If the ankle dorsiflexor muscles are weak (e.g., drop foot), the patient demonstrates a steppage gait. In such a gait, the hip flexes excessively so that the toes can clear the ground.

Terminal Swing

Terminal Swing

The hip continues to flex and medially rotate.The knee reaches its maximum extension. At the ankle, dorsiflexion has occurred. The forefoot is supinated, and the hindfoot is everted.The trunk and pelvis maintain the same position as before.The hamstring muscles

contract during the terminal phase to slow the swing; if the hamstrings are weak heel strike may be excessively harsh to lock the knee in extension.

Joint Motion
Joint Motion

Muscle Action in GaitStance Phase
Muscle Action in GaitStance Phase

Muscle Action in GaitStance Phase
Muscle Action in GaitStance Phase

Overview and Patient History
Overview and Patient History

Shall be part of any Lower limb assessmentEven the posture can affect the gait without any pathologyShall take detail gait history.Questions to ask for Gait History?

Observation
Observation

Look at the posture as a wholeGait observation: Stride length, Step length, cadence, time of swing, speed of walking, and duration to complete gait cycle.Without shoes and socksAfter an over view, look at the specific parts of the gait.

The examiner must watch the upper limbs and trunk, as well as the lumbar spine, pelvis, hips, knees, feet, and ankles during these changes.The examiner should observe- front, behind, the side, observing from proximal to distal and watching the pelvis and lumbar spine down to the ankle and foot as well as from the foot up.RANCHO LOS AMIGOS MEDICAL CENTER, PHYSICAL THERAPY DEPARTMENT

Anterior View
Anterior View

CheckLateral tilt of the pelvis, Sideways swaying of the trunk, Pelvis rotates on a horizontal plane, Trunk and upper extremity rotate in the opposite direction to the pelvis,

Reciprocal arm swing is present.Movements at the hip (rotation and abduction-adduction), knee (rotation and abduction-adduction), and ankle and foot

Lateral view

Lateral view

These movements include flexion-extension at the hip, flexion-extension at the knee, and dorsiflexion-plantar flexion at the ankle.From the lateral aspect, the examiner may also observe step length, stride length, cadence, and the other time dimensions of gait.

Posterior view

Posterior view

The examiner should notice the same structures that were viewed from the front.Rotation of the shoulders and thorax, reciprocal arm swing, and pelvic list and rotation may be noted posteriorly, as well as hip, knee, ankle, and subtalar joint movement. Heel rise and base of support (base width) are easier to view posteriorly.

Examination

Examination

The majority of gait assessment involves observation.However, altered gait is noticed, measure muscle strength and range of movement at each joint involved in the gait cycle.Examine Leg length discrepancies.

Locomotion score

Locomotion score

Locomotion scales or grading systems have been developed that include subjective and objective scores, which are combined for a total scoreLocomotion scoring scale

Abnormal Gait

Abnormal Gait

Antalgic (Painful) Gait

Antalgic (Painful) Gait

Stance phase on the affected leg is shorterThe result is a shorter step length on the uninvolved side, decreased walking velocity, and decreased cadence.

Arthrogenic (Stiff Hip or Knee) Gait

Arthrogenic (Stiff Hip or Knee) Gait

Stiffness, laxity, or deformity, and it may be painful or pain free. If the knee or hip is fused, the pelvis must be elevated by exaggerated plantar flexion of the opposite ankle and circumduction of the stiff leg (circumducted gait) to provide toe clearance.

Ataxic Gait

Ataxic Gait

If the patient has poor sensation or lacks muscle coordination, there is a tendency toward poor balance and a broad base.movements are exaggerated, with sensory ataxia slap the ground because they cannot be felt.

Contracture Gaits

Contracture Gaits

Hip flexion contracture often results in increased lumbar lordosis and extension of the trunk combined with knee flexion to get the foot on the ground. With a knee flexion contracture, the patient demonstrates excessive ankle dorsiflexion from late swing phase to early stance phase on the uninvolved leg and early heel rise on the involved side in terminal stance. Plantar flexion contracture at the ankle results in knee hyperextension (midstance of affected leg) and forward bending of the trunk with hip flexion (midstance to terminal stance of affected leg). Heel rise on the affected leg also occurs earlier.

Equinus Gait

Equinus Gait

Weight bearing is primarily on the dorsolateral or lateral edge of the foot.Weight-bearing phase on the affected limb is decreased, and a limp is present.The pelvis and femur are laterally rotated to partially compensate for tibial and foot medial rotation

Gluteus Maximus Gait

Gluteus Maximus Gait

The patient thrusts the thorax posteriorly at initial contact (heel strike) to maintain hip extension of the stance leg.

Gluteus Medius (Trendelenburg's)Gait

Gluteus Medius (Trendelenburg's)Gait

If the hip abductor muscles (gluteus medius and minimus) are weak, the stabilizing effect of these muscles during stance phase is lost, and the patient exhibits an excessive lateral list in which the thorax is thrust lateral to keep cog at centreIf there is bilateral weakness of the gluteus medius muscles, the gait shows accentuated side-to side movement, resulting in a "wobbling" gait

Hemiplegic or Hemiparetic Gait

Hemiplegic or Hemiparetic Gait

Swings the paraplegic leg outward and ahead in a circle (circumduction) or pushes it aheadNeurogenic or Flaccid gait.

Parkinsonian Gait

Parkinsonian Gait

The neck, trunk, and knees of a patient with parkinsonian gait are flexed. The gait is characterized by shuffling or short rapid stepsThe arms are held stiffly and do not have their normal associative movementDuring the gait, the patient may lean forward and walk progressively faster as though unable to stop.

Plantar Flexor Gait

Plantar Flexor Gait

If the plantar flexor muscles are unable to perform their function, ankle and knee stability are greatly affected.Loss of the plantar flexors results in decrease or absence of push-off. The stance phase is less, and there is a shorter step length on the unaffected side

Psoatic Limp

Psoatic Limp

The psoatic limp is seen in patients with conditions affecting the hip, such as Legg-Calve-Perthes disease.The limp may be caused by weakness or reflex inhibition of the psoas major muscle.

Quadriceps gait

Quadriceps gait

If the quadriceps muscles have been injured the patient compensates in the trunk and lower leg.Foward flexion of the trunk combined with strong ankle plantar flexion causes

the knee to extend (hyperextend).If the trunk, hip flexors, and ankle muscles cannotperform this movement, the patient may use ahand to extend the knee

Scissors Gait

Scissors Gait

This gait is the result of spastic paralysis of the hip adductor muscles, which causes the knees to be drawn together so that the legs can be swung forward only with great effort. This is seen in spastic paraplegics and may be referred to as a neurogenic or spastic gait.

Short leg Gait

Short leg Gait

If one leg is shorter than the other or there is a deformity in one of the bones of the leg, the patient demonstrates a lateral shift to the affected side, and the pelvis tilts down on the affected side, creating a limpThe patient may also supinate the foot on the affected side to try to "lengthen" the limb.The joints of the unaffected limb may demonstrate exaggerated flexion, or hip hiking may occur during the swing phase to allow the foot to clear the ground.The weight-bearing period may be the same for the two legs. With proper footwear, the gait may appear normal. This gait may also be termed painless osteogenic gait.

Steppage or Drop Foot Gait

Steppage or Drop Foot Gait

The patient with a steppage gait has weak or paralyzed dorsiflexor muscles.Compensate and avoid dragging the toes against the ground, the patient lifts the knee higher than normal

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