Dynamic Chiropractic

DIAGNOSIS & DIAGNOSTIC EQUIP

The Gait Cycle as a Diagnostic and Therapeutic Tool

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As a professor, practicing clinician and educator, I am frequently asked about the place of gait analysis in the evaluation of a patient. As with any examination procedure, the goal is to develop an understanding of where the tissue damage lies and to what degree the affected tissue is damaged.

Often, this process is a fairly direct one for the physician. There is a mechanism of injury, a pattern of pain and expected tissue deficit. A thorough history and physical examination - including observation, inspection, selective tissue-tension tests, and orthopedic, neurologic and functional evaluations - typically reveal adequate information to expose the cause of the patient visit and create a clinical setting in which the doctor can develop a well-supported diagnosis.

Once a diagnosis is made, the damaged tissues identified and the degree of injury recognized, treatment becomes almost an intuitive progression.

Specialized examination procedures, such as posture and gait analysis, are often employed to gain a more precise representation of contributing biomechanical and kinesiological factors that contribute to a patient's presenting situation. These important procedures are especially imperative to perform when the nature or cause of a patient's condition is unclear or unknown. Often represented as "insidious," these patients present not with trauma, *per se,* but some level of overuse contributing to the tissue injury, pain and subsequent disability.

A particularly important adjunct of this examination process for the doctor, and an interesting aspect for the patient, is to have the patient's feet digitally scanned. This technology allows the doctor and patient to assess all three arches of the patient's feet from the bottom, while in the functional weight-bearing position. This position provides indicators of the patient's biomechanical faults, which can later be assessed further by watching the dynamic functional aspects of walking. If necessary, orthotics should be provided, as they are a beneficial and important adjunct to therapy for injuries related to functional defects occurring during gait.[1]

The gait cycle is a fascinating and brilliantly carried-out sequence of neurologic and mechanical events, leading to the synchronized pattern of movement that moves us through the world. There is often confusion when examining the gait cycle. There is very sophisticated, state-of-the-art equipment commonly utilized in the assessment of gait. There is also an apparatus available to assess gait that is not worth the postage it costs to deliver it. Most physicians in an office setting can adequately assess a patient's gait by simply watching the patient walk through the gait cycle. The visual assessment must be organized and calculated as described.

In its most general form, the gait cycle is divided into two phases: stance and swing. These phases refer to the action of the limb that is either in contact with the ground and providing support (stance), or in the air and preparing for the next step (swing). Each phase is further broken down into subphases, based on the action of the various osseous and muscular groups causing movement.

The gait cycle is the time interval or sequence of movements occurring between two consecutive initial contacts of the same foot. To evaluate the gait cycle, you have to describe what happens in one leg, and then duplicate the observations with the other leg. Below is a brief and simplified description of the phases of gait for each lower extremity. Be aware this is not meant to be a complete depiction of all aspects of the gait cycle, which would be beyond the scope of this article. The stance phase takes up approximately 60 percent to 65 percent of the walking cycle, and the swing phase takes about 35 percent to 40 percent of the walking cycle.[2]

The stance phase begins with *initial contact.* The foot touches the ground and is weight-bearing. Normally, the heel touches first, but normal variations exist. The hip is flexed and medially rotated, the knee is extended and the tibia is laterally rotated. The ankle is dorsiflexed to neutral. The pelvis is level and medially rotated on the side of initial contact. Pain on the heel could be due to a bone bruise, heel spur or bursitis. If dorsiflexion is weak, the foot will slap down. This is commonly attributed to peroneal neuropathy or an L4 nerve-root lesion.

The second phase is called the *loading response.* During this phase, both feet are in contact with the ground. This is known as a double-support phase. This lasts until the other foot is lifted off the ground to begin the swing phase. This is an important phase for shock absorption, weight-bearing and forward progression. The laterally rotated hip moves into extension, and the knee flexes 15 to 25 degrees. The tibia is medially rotated and moves forward over the foot. The hind- foot is inverted, and the foot moves into pronation, unlocking the subtalar and metatarsal joints. This movement is necessary, as they are now in a position to absorb shock more efficiently.

During the third phase, also referred to as *mid-stance,* the entire weight of the body is supported by a single limb. The opposite foot is lifted, the ankle is dorsiflexed, and the hip and knee are extended. This is a single-leg stance. The stance leg must be able to support the body weight. There also must be an ability to adequately balance the body. Lateral hip stability must be demonstrated to maintain balance and prevent the airborne side from dropping, which would result in a gluteus medius lurch. Vertical pelvic shift occurs at its highest point during mid-stance, and its lowest point during initial contacts is about a 2 inch difference. Pain in the extremity causes this phase to be shortened as the patient will want to get off the painful limb swiftly. Common problems that manifest at this phase are arthritis, rigid pes planus, and Morton's metatarsalgia.

Mid-stance is followed by *terminal stance.* This phase begins when the heel rises off the floor and continues until the opposite foot makes contact with the ground. As the body is propelled forward, hip extension continues to increase. The heel is in neutral and slight medial rotation, the knee is extended, and the tibia is laterally rotated. The ankle is plantar-flexed, and the forefoot moves into eversion.

Terminal stance is followed by *pre-swing.* This is the second double-support phase of gait. It begins with initial contact and ends with toe off the opposite foot. Increased ground contact causes increased ankle plantar flexion, increased knee flexion to 30-35 degrees, and a concomitant decrease in hip extension and minimal medial rotation. There is a transfer of body weight during this phase. The big toe pushes the leg forward. Pain during this phase is commonly caused by a hallux rigidus, turf toe or any other pathology of the big toe. The clinician will often observe the patient pushing off the lateral side of the foot. If the plantar flexors are weak due to an S1-S2 nerve-root pathology, push-off may be absent.

The sixth phase of the gait cycle is *initial swing.* This phase begins when the foot is lifted off the floor and ends when the swinging foot is opposite the stance foot. The leg is advanced by increased hip flexion and medial rotation; increased knee flexion also occurs. There is ankle dorsiflexion to guarantee ground clearance. If the quadriceps muscles are weak, the pelvis is lurched forward to provide forward momentum to the leg. There is a total of 8 degrees of pelvic rotation, with 4 degrees forward on the swing leg and 4 degrees posterior on the stance leg. To maintain balance, the thorax rotates in the opposite direction.

The next phase of the gait cycle is called *mid-swing.* This is a continuance of the endpoint of initial swing and continues until the swinging limb is in front of the body and the tibia is vertical. Advancement of the leg is accompanied by increasing hip flexion and medial rotation. The knee is allowed to continue to flex, while the ankle continues to neutral. The opposite leg is in late mid-stance. The forefoot is supinated, and the hindfoot is everted. If the ankle dorsiflexors are weak, the patient demonstrates a steppage gait.

The eighth and final subphase of gait is the *terminal swing.* This phase begins when the tibia is vertical and ends when the foot touches the floor. Limb advancement is completed by knee extension. The hip maintains its flexion, and the ankle remains dorsiflexed to neutral. The forefoot is supinated, and the hindfoot is everted. The hamstring muscles contract eccentrically to slow the swing. If there is a S1-S2 lesion, the hamstrings might be weak. Heel strike will be excessively rough to lock the knee into extension.[3]

While observing gait, it is insightful to consider a couple of basic essential requirements fundamental to walking. One is equilibrium and the other is locomotion. Equilibrium is the ability to assume an upright posture and maintain balance. It is a common thought among clinicians that structural and positional imbalances of the foot may contribute to overuse injuries throughout the kinetic chain.[4] Orthotics are meant to place the foot in a position of stability. It has been demonstrated that the application of orthotic intervention increased postural stability in groups of patients who had their eyes open and closed after wearing orthotics for two weeks.[5] Locomotion is observed as the ability to initiate and maintain rhythmic stepping. Other factors the clinician must consider are: There must be intact bones and functioning joints, normal muscle tone and adequate strength.

Muscle tone is controlled at the subcortical level. Muscle tone must be high enough to resist gravity but low enough to allow movement. Reciprocal inhibition of muscles must allow for graded action between the agonist and antagonist. Vision is also critical to normal gait patterns, as sensory information relative to the surroundings is important for the automatic balance response to changes in the earth's surface. Other important systems are the vestibular, auditory and sensorial motor systems.

The normal distance between the two feet is approximately 2 to 4 inches. The average cadence is between 90 and 120 steps per minute. Step length is about 14 to 16 inches.

After performing a physical examination and assessing the parameters of range of motion, muscle strength, nervous-system integrity and a postural examination assessing muscle length, it is time to assess posture. Let the patient walk normally with minimal clothing that will allow visual inspection of the pertinent extremities while maintaining patient modesty. I prefer to remove the patient's shoes and inspect them separately for uneven and abnormal wear problems that might indicate walking abnormalities.

The patient is asked to walk in a typical manner for several gait cycles. The doctor examines the patient from the front, back and side. Observe from proximal to distal during the swing phase and from distal to proximal during the stance phase of gait. One also must observe the trunk and upper extremities, which normally are moving in opposite directions of the lower limbs. Examine each of the eight phases of gait to see if there is conformity to the brief description of body movements outlined above.

Once abnormalities are identified, correction with appropriate adjustments, correct application of a thorough, specific rehabilitation program, and the application of custom-made, flexible orthotics are indicated.

References

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