

The Child with Tip-Toe Gait

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Abstract

Idiopathic toe walking (ITW) is a common finding in otherwise normal children who walk on feet held in equinus position. Parents bring the child to medical attention some time after the age at which the child begins to walk. It is the role of the physician or surgeon to identify the child with ITW as compared to the child with other pathologic forms of toe walking. The child with ITW begins walking in equinus as his or her initial independent pattern of gait. Toe walking developing later usually has a pathologic etiology. Children with ITW may be able to rock back into a foot flat position when cued, but resume "toe walking" preferentially. Neurological examination is normal with no cutaneous signs of spinal dysrhapism. Physical examination may reveal mild to moderate contracture of the Achilles tendon. Diagnosis of ITW is made by exclusion and is frequently determined on the basis of history and physical examination alone. When necessary, laboratory tests for inflammatory joint disease or muscular dystrophic etiologies are obtained. Radiographic, ultrasonic, and magnetic resonance imaging may be useful. Electrodiagnostic and computerized gait analysis are occasionally utilized. Treatment of ITW is usually indicated in the child who continues to toe walk after the age of 2 years and certainly if over the age of 3 years. Treatment varies across the country but usually includes some combination of exercises, casts, and braces. Surgery is rarely indicated. Spontaneous resolution does not always occur, but it is rare to see a child with ITW after school age. *Int Pediatr.* 1999;14(4):235-238.

Key words: ideopathic toe walking, tip-toe gait

Introduction

Often ignored as a self-resolving problem of childhood, idiopathic toe walking (ITW) represents a spectrum of abnormal gait development that requires careful assessment and consideration. Although the majority of children displaying this common variation of gait early in childhood

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will spontaneously resolve the pattern, a small percentage of them will persist in walking on their toes. Specific causes of pathologic toe walking can be identified and it is possible to differentiate the child with benign ITW from the child with a neuromuscular, vascular, or structural cause. Having identified the cause, appropriate treatment can be reliably prescribed. Idiopathic toe walking may be treated with observation, nonoperative, or even operative treatment. This article describes the process by which this diagnosis and treatment decision is made.

Normal Gait

Usually at around 1 year of age, the normal infant begins to walk independently. The pattern is wide-based with stiff knee motion. Usually the child walks with a "foot-flat to foot-flat" pattern. At about 3½ years of age, the child develops an adult pattern of heel-to-toe gait.¹ Any variation of this sequence is cause to delve further into possible pathologic developmental processes.

Occasionally, a child will begin walking in the tip-toe position. Typically, the child will begin cruising on tip toe but will relax back into foot-flat position when standing still. As the child progresses to independent gait, he will do so on tip toes. This is not economical in terms of energy consumption, so most children initiating this pattern will resort to the typical heel-to-toe pattern that will become their adult gait pattern. Usually, this occurs by the beginning of the second year of life, but almost always by the end of the third year.¹

Case Presentation

A 5½-year-old boy was brought for evaluation because of persistent toe-walking. His typical gait pattern was toe-to-toe and only occasionally would he walk heel-to-toe. He did not complain of pain. He could walk heel-to-toe when cued by his parents.

Past medical history revealed his mother's pregnancy was normal and his delivery was normal. There were no unusual problems in his perinatal period and he experienced no serious illnesses or injuries in his childhood. His developmental milestones had been met on schedule. He walked by age 1 year. His initial gait pattern was toe-to-toe.

Family history was negative for heritable diseases such as muscular dystrophy or other neurological diseases. No other family members were known to have been toe walkers.

Physical examination revealed ankle dorsiflexion to be 5

above neutral (knee extended) bilaterally. His knees came to full extension when his hips were extended and his popliteal angle when hips were flexed was 10° from full extension. He had no unusual hypertrophy of his calf musculature and Gower's sign was negative. There was no increased tone in his gastrosoleus muscles or any other muscle groups. His spine was normally curved in the sagittal plane and straight in the frontal plane. He had no cutaneous signs of dysrhaphism. His deep tendon reflexes were 2+/4+ and bilaterally symmetrical. His umbilical reflex was intact symmetrically in all quadrants. His gait was with a toe-to-toe pattern for casual gait. When cued, he could achieve a heel to toe gait pattern but hyperextended his knees to do so. He was unable to walk independently on his heels.

Treatment with stretching exercises was attempted but after 6 months his gait pattern was unchanged and range of motion of the ankles were the same. Serial casting was then initiated. Short leg walking casts were applied initially with the ankles a 5° above neutral. Two weeks later, these were changed to new casts with the ankles in 10° of dorsiflexion. This was repeated 2 weeks later with the ankles at 15° of ankle dorsiflexion. He was then allowed to wear normal shoes but was maintained on a rigid heel cord stretching program performed by his parents on a daily basis. At end of casting, ankle dorsiflexion was 15° above neutral with the knees extended. This was maintained at 6 weeks, 3 months, and at 1½ years later. He continues to be active in sports without problems but tends to run high onto his forefeet even though range of motion has been maintained. He does not hyperextend his knees when he walks heel-to-toe and he is able to independently walk on his heels.

Discussion

The child who persists in walking on tip toes presents a dilemma. The parents usually bring the child for evaluation shortly after independent gait begins if toe walking persists. If another family member had a similar developmental pattern, the child may not present for evaluation until after the second birthday.

Unfortunately, the cause of ITW is unknown. Habit is frequently used to explain the child who walks on tip toes and in whom no other cause is found. Why one child would develop such a "habit" and another does not is unclear. Because there appears to be a familial incidence in ITW,^{2,3} other explanations must be considered. Congenital contracture of the heel cord is sometimes diagnosed and would certainly explain ITW. However, no clearly documented case of a true Achilles contracture has been demonstrated in a newborn who later was diagnosed as ITW. Thus, the proverbial question arises: does ITW cause Achilles contracture or do congenital contractures of the Achilles cause ITW? Regardless, the condition exists, and in some children, it produces a functional problem.

Other causes of toe walking must be ruled out in order to make the diagnosis of ITW. Of these, mild cerebral palsy is the other most common cause of persistent toe walking. Spinal cord anomalies, such as tethered cord or syringomyelia, have been associated with toe walking. Spinal cord tumors may also present with this finding. Intramuscular hemangioma of the gastrosoleus and other popliteal space lesions may cause inability to walk with the heel touching the ground. Children who develop toe walking later, after walking heel-to-toe initially, must be evaluated for neuromuscular diseases such as muscular dystrophy, Charcot-Marie-Tooth disease, and other hereditary sensorimotor neuropathies (HSMNs). Knee flexion contracture from various causes can cause unilateral toe walking, or even bilateral toe walking if both knees are involved. Many possibilities exist, yet only occasionally are any of these causes identified.

When an anxious parent brings a child in for assessment, they sometimes expect the worst. Often, the child has already been evaluated by other physicians and the parents are seeking reassurance or searching for a reasonable alternative for treatment. Regardless, several key points in the history should be raised. The range of normal gait patterns in the 1- to 3-year-old group is quite broad. Initial gait may be toe-to-toe or foot-flat to foot-flat, but is typically wide-based and "stiff kneed".¹ Toe walking at the beginning of independent gait is typical of ITW. It is not typical of ITW for the child to develop a typical foot-flat to foot-flat pattern then subsequently begin walking on his or her toes. Asymmetric patterns are not typical and should be further evaluated. Persistence of toe walking after the age of 2 years, and certainly after the age of 3 years, is abnormal and is indication for treatment.¹

Other than ITW, the most common cause of persistent toe walking is mild cerebral palsy. Birth and perinatal history are explored for such risk factors as prematurity, low APGAR scores and fetal distress during labor. Serious perinatal illness may certainly be important. Developmental history can be quickly reviewed and more specifically explored if delayed motor milestones are apparent.

Family history may offer critical information leading to early diagnosis of more serious problems such as muscular dystrophy or heritable neurological disorders such as Charcot-Marie-Tooth disease or other HSMNs. A positive family history can help to confirm the diagnosis^{2,3}; however, a familial pattern is not always present.

Generally, the physical examination will focus on the spine, lower extremities, and neurologic findings. As always, that which is not found on physical examination is just as important as the positive findings. The spine is examined for sagittal and frontal alignment. Deviation from normal may reflect congenital intraspinal anomalies requiring radiographic evaluation. Cutaneous signs of dysrhaphism are sometimes overlooked but must be sought.

A general examination of the extremities for asymmetry may reveal atrophy or hypertrophy of one side. Hemihypertrophy may be obvious and require other testing. Hypertrophy of the calf musculature may be out of proportion to that expected by persistent toe walking. Indeed, the normal response of the gastrocnemius and soleus to exercise may be rather impressive, but a positive Gower's sign may confirm suspicions of muscular dystrophy as opposed to normal exercise induced hypertrophy.

Palpation of the popliteal space and the gastrosoleus complex may reveal a mass. Hemangioma, neurofibroma, and various other tumors may present in the leg or popliteal space, forcing the child to walk on his or her toes. Of course, this produces an asymmetric toe walking pattern with late onset and would require further investigation.

Hip, knee, and ankle motion are evaluated for contractures. Thomas test for hip flexion contracture isolates the joint and allows evaluation of complete hip extension. Assessing the extension of the knee with the hip extended and with the hip flexed separates primary knee pathology from hamstring contracture. Likewise, assessing ankle dorsiflexion with the knee flexed and with the knee extended separates the effects of the soleus muscle from the gastrocnemius. Of course, in examining for dorsiflexion of the ankle, care has to be taken not to evert the foot since subtalar eversion and rotation can compensate for a tight heelcord. Inability to passively dorsiflex more than 10 degrees is abnormal and will interfere with gait. Contractures in the hips or knees indicate the possibility of the various arthrogyrosis syndromes, significant cerebral palsy, arthritis, and various bone dysplasias.

The foot examination may only reveal excess callus formation in the areas of the metatarsal heads. However, the presence of cavus deformity or claw toes may quickly reveal a probable neurological etiology of the toe walking and mandate further investigation.

Neurologic examination is carefully performed. Although a cursory screening examination of deep tendon reflexes, abdominal reflex, plantar reflexes, and hyperactive stretch reflexes may be sufficient, abnormalities in any of these may lead to a more detailed examination. The need for certain neurodiagnostic tests may also be identified.

Most children diagnosed as ITW do not require radiographic evaluation; however, findings of scoliosis, cutaneous changes along the spine, or cavus foot or claw toes may require radiographs of the cervical, thoracic, and lumbosacral spine. Depending on the results of these films, magnetic resonance imaging (MRI) may be necessary. The presence of a tethered cord, diastematomyelia, syringomyelia, or intraspinal tumor may only be identified through MRI. Even in the presence of normal plain radiographs, the presence of abnormal physical findings may indicate spinal MRI (even if separate examinations

for cervical, thoracic, and lumbar spine have to be ordered). The need to proceed with such extensive studies is usually based on clear historical or physical examination findings.

The need for electromyogram, nerve conduction, or somatosensory examinations is unusual, but obvious findings in the history or physical examination may require these examinations to confirm a diagnosis. Specifically, focal deficits, late onset of toe walking, and family history of HSMNs or muscular dystrophy may require neurodiagnostic evaluation.

Investigators have utilized computerized gait analysis to investigate ITW and compare these children to those with cerebral palsy.^{2,4,5} Griffin et al⁴ found a prolonged and increased tibialis anterior activity in children with ITW. This was presumably a reflection of the child trying to overcome the tight gastrosoleus complex. As one would expect, this increased activity reverted to normal after successful treatment of the toe walking. Kalen et al² could find no significant difference between children with mild cerebral palsy compared to children with ITW. However, Papariello and Skinner⁵ found that the gastrosoleus complex had "out of phase" activity in children with cerebral palsy, not in ITW. Kinematic studies have also shown that, although children with ITW and those with mild cerebral palsy lacked heel strike, children with mild cerebral palsy showed sustained knee flexion at terminal swing phase whereas children with ITW did not.⁵ The utility of computerized gait analysis in assessing these children has been defined. The necessity for this expensive tool has not been defined.

Unfortunately, a well-studied natural history for children with ITW has not been produced. In my practice, I have cared for patients in their teen age years who still lack an effective heel strike during gait, but this is very rare. They were troubled with forefoot pain, particularly along calluses, and by tendonitis of the Achilles. Their complaints were not severe and were similar to other patients with typical overuse symptoms such as Severs disease. Other children have been followed into their early school years with only mild complaints. Still, these children are frequently teased in typical childhood fashion because of their walking pattern. How this affects their life and psychosocial development is for others to assess. Certainly, the majority of children with ITW do spontaneously modify their gait pattern to a typical heel-to-toe gait cycle and symptoms are relatively mild until they do so. But there is a definite group of children who do clearly benefit from treatment to at least accelerate the resolution of the problem.

Typically, a child with ITW is expected to resolve without specific intervention if he or she has normal passive dorsiflexion of the ankle and can walk heel-to-toe when cued. The child with heel cord contracture (passive ankle dorsiflexion, knee extended, of less than 10 degrees), who can't walk heel-to-toe without hyperextending

the knee and is older than 2 years will benefit from treatment. This presumes other causes of toe walking have been excluded.

Though apparently mild, the effects of persistent ITW are enough to warrant treatment providing that treatment has less risk than the disorder. The goal of treatment is simply a normal heel-to-toe gait. This requires 10 degrees of ankle dorsiflexion.¹ Several methods of treatment can be considered. Exercises (stretching, strengthening) is usually the first treatment approach, and is continued in any subsequent treatment program. The effectiveness of exercise alone is probably little different than the natural history. Serial casting has been shown to be effective,^{3,4} although the long-term success of this method is uncertain. Night braces may be of some benefit, and the use of chemoneurolysis is being assessed (Stricker, unpublished data).⁶ Surgical treatment has been successful and with low morbidity.⁷ Serial casting has had uniformly good results with no need to proceed to surgical treatment.^{3,4}

In the final analysis, the "treatment of choice" for these children is a personal choice made by the physician and the parents. In my experience I have evolved to an approach that has been effective and reasonable. Generally, a child who persistently toe walks past the age of 2 years, does not have passive dorsiflexion to 10 degrees at the ankles, and has no other neuromuscular or mechanical explanation for his gait pattern is considered for treatment. I discuss with the parents the options of treatment or observation. If the parents prefer treatment, I recommend serial casting consisting of short leg walking casts applied with the ankle in neutral position for 2 weeks, 5 to 10 degrees above neutral for 2 weeks, then 10 to 15 degrees above neutral for 2 weeks. Usually, at the end of casting, I have the family do daily stretching exercises for the next 3 months and the child wears regular footwear. For those children that seem to retain the tendency to toe walk, I

recommend a solid foot plate insert for their shoes or high-top shoes with a relatively rigid sole. Occasionally, I recommend night braces with dorsiflexion straps. To date, I have not operatively treated any child with ITW. I have had occasional recurrence in older children (ages 3 to 5) but these children have readily corrected without further recurrence with another series of casts. During casting treatment, all children have remained ambulatory and participated in most activities with the obvious exception of swimming.

Although idiopathic toe walking is a relatively common problem, the treatment for it—even the need to treat—is not clearly defined. Perhaps the most important aspect of this gait anomaly is that the benign ITW must be separated from the more serious, possibly progressive disorders so that appropriate treatment is not delayed. But as benign as the disorder of ITW may seem, it does reflect a less than optimal quality of life in some selected individuals, and can be successfully treated with very little risk or morbidity.

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