Idiopathic Toe Walking: Current Evaluation and Management

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INTRODUCTION

Toe walking is defined as the failure of the heel to contact the floor at the onset of stance during gait. Pediatricians, family practitioners and general pediatric orthopedic surgeons have recently noted an explosion in the incidence of children presenting with the chief complaint of "toe walking." This report is stimulated by the obvious need for reevaluation of this somewhat confusing condition.

It appears to be most important that patients who present with toe-walking are categorized correctly. The prognosis can be provided more accurately if the diagnosis is established early and conclusively.

Cerebral Palsy and various Encephalopathies are most important to consider early in developing the differential diagnosis. Spasticity in the form of diplegia or quadriplegia is usually considered early. Spastic hemiplegia should be fairly obvious because of the unilateral involvement; whereas, Idiopathic Toe Walking (ITW) is always bilateral and symmetrical. Ataxic, dystonic and hypotonic types of cerebral palsy may also present with toe walking, but other factors will help in their diagnosis. Prematurity and delayed milestones are very important factors to inquire about when obtaining a careful history. Seizures, speech delay and poor coordination will also be obtained in the early history. The physical examination in these patients will reveal fixed equinus positioning, hyperactive deep tendon reflexes, clonus and positive Babinski reflexes.

Duchenne Muscular Dystrophy is the most common myopathy in males and can present early in a subtle manner at age 2-5 years. Fixed equinus contractures and/or toe walking can be noted but there are always other findings. These include gastrocnemius- soleus muscles that are firm to palpation with possible pseudo-hypertrophy of other muscles including the brachioradialis. Passive ankle dorsiflexion will be limited with a firm end point on stretch; this will be noted in both the supine and standing position. Deep tendon reflexes will be absent early and proximal muscle weakness can be documented by the classic Gowers sign. Enzymes such as CPK, Aldolase, Enolase and SGOT can be elevated early in the clinical course and should be obtained. Chromosome and DNA studies will make a definitive diagnosis but are expensive and take additional time for official results. Muscle biopsies can be very definitive as well, especially if other more esoteric myopathies are being considered. Becker Muscular Dystrophy presents after age eight and can be seen in females as well.

Spinal conditions such as syringomyelia and filum terminale syndrome can present with equinus contractures and/or toe walking. Muscular weakness in other areas, back pain, progressive scoliosis and bladder problems can develop as these conditions progress.

Developmental conditions such as autism, sensory dissociation, PDD (pervasive development disorder) and Asperger Syndrome can present with toe walking as well. These children have communication, sensory and mental development issues which overshadow their gait problems. The equinus deformity in these children may be functional only in early stages. Minimal actual limitation of ankle motion can be present and these other complex conditions should definitely be considered.

EVALUATION AND MANAGEMENT

Idiopathic Toe Walking (ITW) is a diagnosis made by exclusion. It is probably the same condition as "congenital short tendo calcaneus" but presents at an earlier stage and usually an earlier age of life.[1] Persistent equinus positioning will result in contractures, eventually with permanent shortening of the gastrocnemius/soleus muscle complex. The true incidence is unknown but appears to be as high as 5/500 births. ITW is autosomal dominant with a familial incidence of up to 32%.[2] Most children will present a consistent heel strike by 18 months of age. Toe walking is sometimes considered to be a normal gait variant in the first few months of infant walking. However, it has been established that by 18-24 months of age, the body weight should load on the heel, lateral sole, forefoot and toes.

Obviously, the true etiology of ITW is unknown. A "clinically undetectable neural impairment" had been proposed. The eventual result is a fixed equines contracture with secondary changes in the gastrocnemius / soleus muscle – tendon properties.

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Complete evaluation requires an excellent history and a careful musculoskeletal exam. Neurological findings are most important: deep tendon reflexes, muscle tone and joint range of motion. ITW is always symmetrical with no known evidence of progressive muscular weakness. Spine films are required to look for occult anomalies. An MRI of the brain and entire spine may be needed to eliminate the possibility of cerebral palsy, syringomyelia or the various forms of tethering. As mentioned, laboratory studies including muscle enzymes and chromosome tests can help to rule out myopathies. Formal gait analysis can be helpful in diagnostic evaluation as well as prior to more invasive treatments. Recently, several clinical studies have been published evaluating ITW and toe walking in general. Comprehensive gait analysis has been the major tool.[3,4]

"Heel rocker" is defined as progression of the limb while the heel is in the pivotal area of support. Crenna's findings from the careful study of thirteen children included: variable heel strike, reversal of second rocker, early firing of the soleus by EMG evaluation, silence of the gastrocnemius muscle in the swing phase, and normal anterior tibial function by EMG. ITW patients also revealed premature ankle plantar flexion during the second rocker. All of these findings were relatively unexpected.[3]

Armand, et al carried out 2511 gait analyses in 1736 patients with 11950 trials.[4] The authors established three equines gait patterns based on ankle kinematics during stance phase:

- G1 – A long progressive dorsiflexion followed by plantar flexion until toe off. This pattern was more prevalent in old equinovarus feet, myopathies and neuropathies.
- G2 – Short lived dorsiflexion with progressive plantar flexion until toe off. This pattern was most common in ITW patients (up to 44% of all in the series).
- G3 – Double bump pattern, short lived dorsiflexion, short lived plantar flexion and plantar flexion until toe off (cerebral palsy pattern).

The neuropathy group (GI) presented with premature contractures of the entire triceps surae. This is not seen early in ITW. The findings in the myopathy group of patients appeared to be secondary to compensation for weak quadriceps, anterior tibial muscles and triceps surae. All of the gait studies confirmed the clinical findings seen later in children with more established contractures (in ITW). The results of the gait studies were as follows:

- Mean anterior pelvic tilt + 6 degrees
- Mean external hip rotation + 7.5 degrees
- Peak knee flexion – 4.6 degrees
- Peak dorsiflecion in stance – 14.8 degrees
- Dorsiflexion in swing -16.1 degrees
- Foot progression angle / external + 4.7 degrees

All of the above findings are secondary to limited dorsiflexion. Adaptive external rotation of the hip and tibia occur while attempting to place the limb in a more plantigrade position.

Treatment of toe walking remains most controversial in those children without a specific diagnosis (ITW). Equinus contractures in established conditions such as cerebral palsy, myopathies and neuropathies are usually treated with physical therapy, home exercises, bracing, casts, Botox and sometimes surgery. These treatments are fairly well accepted in most medical centers around the world, but confusion still reigns in those "normal" children with ITW.

Anecdotal reports plus sporadic literature reviews suggest that the non operative treatment of ITW is no better than simple observation.[5,6] Brunt[6] reported on five children with ITW, followed closely pre and post Botox for one year. Gait studies were obtained prior to injection, at 20 days post injection, and at one year post injection. Physical therapy was provided after the 20 day point and then was discontinued. The ankle EMG remained normal. It is impressive that the gait pattern is reported as normal by a complex gait study as well as clinically. It was not clear in the paper as to exactly how long the post injection physical therapy continued. The paper only follows five children so that the sampling error could be a problem as well. Two of the children received a second Botox injection at three months post onset with additional use of night splints. The authors point out the adverse relationship between the age at the onset of treatment and the degree of limitation of ankle motion. We have also noted that older children (over age five) will respond less well to non-operative treatment because the premature firing of the gastrocnemius / soleus complex noted in ITW will not allow the anterior tibial muscle to function normally. This logic appears to be correct, but good results will only be possible in younger children (age 3-5) and those with minimal limitation of ankle dorsiflexion.

On our own patients we have avoided surgical treatment as much as possible because of the fear that the untreated "sensory issues" will lead to recurrent deformity and further loss of ankle dorsiflexion. More than 50% of our ITW patients have responded well to treatment with physical therapy, day or night bracing, Botox with or without serial corrective casts. It appears that the most sustainable results are in younger children whose family persists with treatment through 2-4 growth cycles. The contractures improve and correction persists only if constant stretching of the gastrocnemius/soleus complex continues for literally 1-3 years of growth. It appears that the muscle tendon complex must be constantly stretched to allow normal anterior tibial function and to keep up with the growth of the tibia and fibula.

Recent orthopedic literature has supported surgical treatment as the most reliable intervention for children with ITW.[2,7] Papers by Hemo et al and McMulkin et al reviewed small series of ITW patients, all of whom failed non operative therapy. Surgery was preceded by gait analysis. All operations were either Achilles tendon lengthening (when gastroc and soleus were felt to be contracted) or Vulpius type releases (gastroc only contractures). Post operative studies were carried out indicat-

ing an improvement in ankle motion but not a return of plantar flexion power in every case at one year follow up. The authors caution against over lengthening.

DISCUSSION / SUMMARY

It appears that surgical treatment is probably most reliable in these patients if non-operative therapy fails. Most important is the pre-treatment evaluation, allowing the diagnosis to be established as carefully as possible. Gait analysis at the important milestones in therapy can be extremely helpful as well.

It appears that definitive treatment in ITW is indicated in at least 50% of the children presenting over age three with persistent fixed equines. Long term follow up has revealed complications such as increased lumbar lordosis with spondylolysis and osteochondritis dessicans of the talus and/or femoral condyles. This material has been documented in our patients but not in the literature. Further long term follow up will be provided in this group of patients and appears definitely clinically indicated.

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