**A TOE WALKING WITH CLINICAL INTERPRETATION AND MANAGEMENT – A OVERVIEW**

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**INTRODUCTION**:

Toe walking is a physical manifestation that is accepted as a natural stage of a child's developing gait. A 2-year-old youngster with a toe-to-toe pattern, however, is seen as aberrant. A paralysing muscular condition like Duchenne muscular dystrophy, cerebral palsy, congenital Achilles tendon contracture, and idiopathic toe walking are among the potential causes of chronic toe walking. Other diseases include autism or other developmental problems, spinal tumours or dysraphism, myopathic disorders, and neuropathic disorders may also be linked to toe walking. Long-term analysis of the natural history of protracted idiopathic toe-walking is inconclusive. Untreated prolonged toe-walking can increase a child's risk of falling, limiting their ankle mobility, and developing structural issues including persistent outward tibial torsion. However, one study indicated that minor development of heel chord contractures occurred just as frequently as mild regression when no treatment was provided. Long-term toe walking does not cause considerable functional disruption, foot deformity, or pain, the study stated. Idiopathic toe walking is linked to learning difficulties, according to a different study, and its authors recommend that it be taken into account as a sign of developmental issues. Idiopathic toe walking is diagnosed through exclusion. Children with a normal neurological examination and birth history can develop idiopathic toe walking. Idiopathic toe-genesis walking's is unknown, but some authors have hypothesised that a congenitally short tendon calcaneus is to blame. Furthermore, it has been shown that 30% of kids with idiopathic toe walking had a favourable family history, suggesting that autosomal dominance and variable expression may be at play. Idiopathic toe walking is most frequently diagnosed by a medical history and physical examination, although it can be particularly challenging to tell it from from other mild forms of cerebral palsy such mild spastic diplegia.

**CHARACTERISTIC FEATURES OF TOE WALKING:**

The most frequent cause of toe walking, a common gait variation, is spastic paralysis. People with cerebral palsy (CP), traumatic brain injury, stroke, and kids who have been diagnosed with idiopathic toe walking frequently fail to make heel contact with the floor at the beginning of stance. Functionally speaking, toe walking has been linked to premature and protracted electromyographic ankle plantar flexor activity, often known as plantar flexor spasticity or contractures. Because less of the foot is in contact with the ground, stance stability is weakened. Reduced velocity and shorter strides are frequently the results of these functional restrictions. Recently, it has been proposed that toe walking, as opposed to conventional heel-toe walking, may offer compensating benefits for people with upper motoneurons lesions. In 17 physically fit subjects, Kerrigan et al. recorded motion and force platform data during toe and heel-toe walking. They determined the internal moments of force at the ankle and knee when toe walking using these data. During terminal stance and the pre-swing, the ankle's plantar flexor moment and power generation were both diminished, whereas in the loading response, the ankle dorsiflexor and knee extensor moments were absent. Based on the research, Kerrigan hypothesised that toe walking would offer possible compensatory benefits because it required less ankle plantar flexion, ankle dorsiflexion, and knee extensor muscle strength than heel-toe walking. In accordance with other studies, toe walking might demand more energy from the muscles in the ankle, knee, and hip than heel-toe walking does.

In order to compare the muscle activity patterns during heel-toe and toe walking, Rose et al. used surface EMG. The reference limb gait cycle, which corresponds to a single stride, was divided into percentage points, with 0% of the cycle denoting first contact and 100% denoting the following initial contact. Premature gastrocnemius activity was observed throughout the previous swing (91% of the gait cycle) and onset during the early stance (9% of the gait cycle) while toe-walking. Additionally, longer tibialis anterior activity and quadriceps activity with cessation in terminal stance (38% gait cycle) versus mid stance (15% gait cycle) were seen during toe walking. These results imply that toe walking may modify the demand on the calf muscles while simultaneously altering the amount of effort put forth by the knee extensors and ankle dorsiflexors. It is possible that the different research populations—those with spastic CP versus those without pathology—are to blame for the apparent discrepancy in results between the electromyographic activity at the ankle and knee during toe walking and the internal moments that were calculated. The potential consequences of greater muscular activity brought on by heightened reflexes and the predominance of primitive locomotor patterns are introduced by spastic paralysis. Because there were no shared data, further settlement of this conceptual disagreement was not conceivable. Kerrigan did not report electromyographic activity, while Rose did not record mechanical events. The effect of joint position on both the active force generation of muscles and the passive force generation of the surrounding ligaments, tendons, and aponeurosis could provide a biomechanical explanation for the variations.

According to Gordon et al., the degree of overlap between the actin and myosin filaments within the sarcomere influences the muscle force output (i.e, the sarcomere length-tension curve). As a result of inadequate filament alignment within the sarcomere, too shortened positions greatly impair the muscle's ability to produce force. Muscle fibres have a preferred length at which maximal force can be produced. A joint position also modifies the passive contributions of muscles, ligaments, and soft tissue to the internal moment. In particular, as ankle dorsiflexion increased, Siegler et al. observed a steadily growing passive plantar-flexor moment.

The importance of EMG and mechanical moment variations as joint positions vary during walking cannot be overstated. In today's environment of decreasing medical expenses, conclusions that treatment attempts to diminish equinus may not be as required as the clinical norm could have a significant impact on patient care. Toe walking is connected to cerebral palsy and is a characteristic of muscular dystrophy, autistic spectrum disorders (ASD), and global developmental delay (GDD). Most often, trauma-related events like injury or tumours have been associated with unilateral toe walking, which results in a physical incapacity to put the heel on the ground.

**HABITUAL TOE WALKING / Idiosyncratic or Idiopathic toe walking:**

Currently, idiopathic toe walking is described as a problematic tiptoe gait pattern without a neurological or orthopaedic aetiology. The aberrant persistence of mostly physiological toe walking after the age of two is another way to define it. Weight bearing happens on the front of the foot instead of the heel at the initial contact of the gait cycle. For 30% to 42% of children who habitually toe walk, there has been evidence of a positive family propensity; nevertheless, for roughly 60% of these kids, the explanation is unknown.

Youngsters with habitual toe walking prefer to walk on the balls of their feet and do so consistently. This issue affects children who are neurologically and orthopedically normal. Walking on the toes is typically not a part of the typical developmental process for learning to walk; instead, it typically progresses progressively toward a heel-toe pattern, beginning with a heel strike at 18 months and ending with a heel-to-toe stride by age three. However, many people believe that tip-toe walking is a common variation or stage that some kids go through when learning to walk. This stage is often outgrown three to six months after the child begins to walk or by the age of seven. Even in adolescence and adulthood, toe walking has been seen.

The aetiology of toe walking has been attributed to

• Congenital short tendo calcaneus

• Abnormal soleus muscle

• Unknown central nervous system defect

• Autosomal dominant inheritance with unequal penetrance

• Delayed maturation of the cortical spinal tract

• A normal transient phase of development

• Vestibular dysfunction

• Viruses

• Time spent in baby walking

• Habit

Despite the fact that the precise origin of idiopathic toe walking is unknown, muscle biopsies performed on a group of 25 toe walkers revealed certain similar abnormalities in the muscle fibres and related capillaries, suggesting that there may be an underlying neuropathic process. Children with cerebral palsy and muscular dystrophy have been reported to exhibit toe walking frequently, and it has been linked to

• Autism

• Childhood schizophrenia

• Delayed language development

• and low IQ

Toe walking that is not associated with cerebral palsy has been estimated to occur in 7% to 24% of the normal childhood population.

CLASSIFICATIONS

Two types

**Alvarez’s classification :**

**D**etermines the severity of toe walking according to the presence of ankle rockers.

Type 1 – Presence of ankle rocker, absence of early third rocker, and predominant first ankle moment.

Type 2 – Presence of ankle rocker (Yes/no), and early third rocker may be there (Yes/no), Predominant first ankle moment is absent (no)

Type 3 – NO presence of ankle rocker and predominant first ankle moment. Presence of early third rocker

**Perry ‘s Classification:**

The ankle kinetic, according to Perry, is separated into three rockers. On the first rocker, there is an eccentric contraction of the anterior tibial muscle when the heel strikes the ground, causing a heel strike and ankle plantarflexion. At the second rocker, the gastrocnemius contracts eccentrically with some dorsiflexion; at the third rocker, the push-off action occurs, the ankle is plantarflexed, and the gastrocnemius and soleus muscles contract concentrically. The rockers are altered in toe walkers. The first rocker is absent, causing the foot to touch the ground with the sole or forefoot rather than the heel; the second rocker is inverted, and during the swing phase, disruptions with increased.

**Pomarino classification**,

Based on clinical features found in toe walkers.

 Pomarino asserts that a variety of distinct traits are present in kids who tiptoe walk, suggesting that a variety of causes could cause this gait anomaly. The physical characteristics discovered during a clinical examination were used by Pomarino et al. to categorise the toe walkers. Idiopathic toe walkers can be categorised into one of three groups, as follows:

a. Type I: People who walk on their toes are born with a small triceps surae muscle, which causes them to walk on tiptoes. They can be identified by their heart-shaped calves, deep creases over the Achilles tendon, and a fat deposit under the second and third metatarsals on the forefoot. A pointed heel, a pes cavus, and a short adductor magnus muscle are further prevalent characteristics.

b. Type II: People who fall into this category have a favourable family history, a "V" sign above the Achilles tendon, and hypertrophy of the gastrocnemius muscle.

c. Type III: Members of this category can typically support their heel when walking. The tiptoe gait pattern usually resolves on its own between the ages of 4 and 5. The style may continue to appear in some situations such as fear, anxiety, tiredness, or stress

**MEDICAL AND FAMILY HISTORY**

In order to rule out alternative causes of toe walking, such as ankle equinus, cerebral palsy, or myopathy, the diagnosis of habitual toe walking is one of exclusion. For this, a thorough medical history, family history, gait analysis, musculoskeletal exam, and neurologic exam are required. To rule out neuromotor illness, a prenatal, intrapartum, and postnatal history is crucial. The prenatal history is crucial for excluding neuromotor disorders (Development or acquired disorder). Along with maternal history, the prenatal history should contain family history. Knowing whether or not other family members are toe walkers is crucial. According to the research, toe walking is thought to run in families, with rates ranging from 10% to 88%. Under-16 and over-30 pregnant women are in the obstetric high-risk group, which increases the likelihood of the baby being delivered with a neurologic disability.Previous obstetric history, including Number of pregnancies, Miscarriages, Birth weight, The health status of other children should be obtained.It is crucial to have a history of drug misuse, both narcotic and non-narcotic, and of taking any medications or over-the-counter remedies during pregnancy because these things could have an impact on the foetus and the newborn. Given that infants that are premature or postmature are at danger, the gestational length should be determined. When determining the foetus' age and rigidity, the mother's measure of foetal activity can be useful. It is important to gather information on intrapartum occurrences like foetal heart rate, membrane rupture, duration of labour, maternal drugs, and delivery. A central nervous system injury may be indicated by the history of the immediate postnatal course, which includes foetal discomfort and hypoxia episodes. Getting the child's developmental milestones should make up the following section of the history. By six to seven months, a child should be able to sit up unassisted, and between nine and fifteen months, they should be ready to walk. Toe walkers have been seen to walk on time, toe walk right away when they first begin to walk, and to typically have a heel-toe gait. A child that walks on his or her toes frequently will typically have a typical birth and developmental history. Predicting how long a youngster will stay on his toes compared to the entire amount of time spent walking is dependent on whether or not this ratio is increasing or decreasing.

**EVALUATION OF TOE WALKING:**

The most crucial conditions to take into account right away when creating a differential diagnosis are cerebral palsy and other encephalopathies. Spasticity that manifests as diplegia or quadriplegia is typically taken into account early. Due to its unilateral involvement, spastic hemiplegia should be very clear, but idiopathic toe walking (TW) is always bilateral and symmetrical. Toe walking may also be a symptom of cerebral palsy in patients with ataxic, dystonic, or hypotonic forms, however additional characteristics will aid in the diagnosis. When collecting a thorough history, it is crucial to enquire about prematurity and delayed milestones. In the early history, seizures, delayed speech, and impaired coordination will also be noted.

These individuals will exhibit fixed equinus positioning, clonus, hyperactive deep tendon reflexes, and positive Babinski reflexes upon physical examination. The most prevalent myopathy in males, Duchenne Muscular Dystrophy, can manifest insidiously as early as age 2 to 5 years. There may be other symptoms in addition to fixed equinus contractures and/or toe walking. These include the firm-to-palpate gastrocnemius and soleus muscles, as well as any potential pseudo-hypertrophy of other muscles, such as the brachioradialis. With a strong endpoint on the stretch, passive ankle dorsiflexion will be restricted; this will be noticeable in both the supine and standing positions. The traditional Gower's sign can be used to confirm proximal muscle weakness and the early absence of deep tendon reflexes. Early in the clinical course, enzymes such CPK, Aldolase, Enolase, and SGOT can have high levels and should be acquired. A conclusive diagnosis can be made with chromosome and DNA tests, but these are expensive and take longer to complete. Multiple biopsies may also be quite conclusive, particularly if other, less common myopathies are being evaluated. Females can also experience Becker muscular dystrophy, which often manifests after the age of eight. Toe walking and/or equinus contractures can be symptoms of spinal disorders such syringomyelia and filum terminale syndrome. As these disorders worsen, extra muscle weakening, back discomfort, increasing scoliosis, and bladder issues can appear. Toe walking can also be a symptom of developmental disorders such autism, sensory dissociation, PDD (pervasive development disorder), and Asperger syndrome. Overshadowing their gait impairments are problems with communication, sensory development, and cerebral development in these kids. These children's equinus deformities might only be functional in their early stages. There may be a very slight actual restriction of ankle motion, and these additional complicated situations should be taken into account.The movement of the limb with the heel in the pivotal region of support is known as "heel rocker." The meticulous examination of thirteen youngsters by Crenna revealed the following: variable heel strike, reversal of the second rocker, early soleus firing by EMG evaluation, quiet of the gastrocnemius muscle in the swing phase, and normal anterior tibial function. Premature ankle plantar flexion was seen in people with idiopathic toe walking during the second rocker. These results were all rather unexpected. 2511 gait assessments were performed by Armand et al. in 1736 subjects with 11950 trials. The ankle kinematics during the stance phase were used by the authors to develop three equinus gait patterns.

 Table 1 Three gait styles of the equinus are:

|  |  |  |
| --- | --- | --- |
| 1. | G1 | A long progressive dorsiflexion followed by plantar flexion until toe-off. This pattern was more prevalent in old equinovarus feet, myopathies, and neuropathies. |
| 2. | G2 | Short-lived dorsiflexion with progressive plantar flexion until toe-off. This pattern was most common in Idiopathic Toe Walking patients (up to 44% of all in the series). |
| 3. | G3 | Double bump pattern, short-lived dorsiflexion, short-lived plantar flexion, plantar flexion until toe off (Cerebral palsy pattern) |

The whole triceps surae was prematurely contracted in the neuropathy group (GI). Early on in idiopathic toe walking, this is not evident. The results in the patients with myopathy seemed to be a result of compensatory mechanisms for weak quadriceps, anterior tibial muscles, and triceps surae. The clinical findings observed later in children with more developed contractures were supported by all of the gait studies (in ITW). The gait studies' findings were as follows:

 **Table .2 Gait Studies Findings**

|  |  |  |
| --- | --- | --- |
| **S.No** | **Gait Parameters** | **Degrees** |
| 1. | Mean anterior pelvic tilt | + 6 degrees |
| 2 | Mean external hip rotation  | + 7.5 degrees |
| 3 | Peak Knee flexion  | * 4.6 degrees
 |
| 4 | Peak dorsiflexion in stance  | * 14.8 degrees
 |
| 5 | Dorsiflexion in swing  | * 16.1 degrees
 |
| 6 | Foot Progression angle / External  | + 4.7 degrees |

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

**GAIT EVALUATION**

Gait analysis should be the first step in treating a child who frequently walks on his or her toes. This process should start with attentive gait observation. Given that shoes can frequently conceal a kid's natural walking pattern, it is important to analyse the child both with and without show gear. The observations listed below support the diagnosis of habitual toe walking. These observations are made as the youngster is strolling on bare feet.

1. The child walks on his / her toes (balls of their feet) are a well-coordinated, balanced, and efficient manner.
2. While toe walking, the child exhibits a normal angle and base of gait.
3. The child is capable of running with minimal to no tipping or falling
4. The child is capable of walking both forward and backward easily while toe-walking.
5. The child is capable of standing with his/her heels on the ground (full foot contact)
6. The child may take his/her first few steps in a heel-to-toe or full-foot contact fashion and rise-to-toe walking only when increasing the speed of ambulation.

In conclusion, a child who habitually walks on his or her toes should have gait observations that are comparable to those of a normal, well-coordinated child who chooses to walk on his or her toes for a brief period of time. The only significant difference is that the normal child will typically start to get tired while walking on his or her toes much earlier than the habitual toe walker. The tread mat and video recording are just two of the gait analysis methods that can be helpful in making a diagnosis and gauging the development of habitual toe walking. A permanent, impartial record is also provided by these techniques.

1. TREAD MAT

2. VIDEO GAIT ANALYSIS

Tread mat reveals changes that are not always perceptible to the eye. A Tread mat is a simple, inexpensive method of creating a permanent record of a child’s gait pattern. The material required for making a tread mat includes

* 1. A roll of dark-coloured paper, approximately 20 inches wide
	2. Fine powder such as talc or plaster powder, and
	3. A can of hair spray to permanently affix the powder to the paper if so desired

The powder is put at the end of a paper strip that is 15 to 25 feet long in order to create a tread mat. The kid is then encouraged to stroll along the mat after being submerged in the powder. Asking the parent to stand at the other end of the paper will enable you to do this. A powder imprint is left on the paper when the youngster runs or walks to the parent. The amount of forefoot and heel contact in a child's habitual tow walking can be evaluated by watching the powder spread on the paper. This method frequently reveals heel contact indications that visual gait analysis can miss. The tread mat can also be used to evaluate the angle of gait, the base of gait, the length of the step, and the width of the stride.

The evaluation of habitual toe walking as well as any other gait disorders can be done using video gait analysis. Both stop-frame and slow-motion evaluations of gait patterns are possible with video gait analysis. In order to compare measurements between visits, such as heel elevation at any given phase of gait, straight-line comparison drawings can be constructed. This analysis offers a useful resource for keeping thorough records of treatment-related progress.

**PHYSICAL EXAMINATION**

All patients presenting with the major complaint of persistent toe walking should have a complete musculoskeletal assessment. The habitual toe walker's static lower extremities examination should show normal foot and leg alignment and appearance. There shouldn't be any obvious sagittal, transverse, or frontal plane anomalies, or any indications of muscle atrophy. Ankle dorsiflexion measurement needs special consideration. With the knee extended and the subtalar joint kept in its neutral position, the habitual toe walker will often exhibit at least 5 to 10 degrees of passive ankle dorsiflexion. Even while some patients who have just been identified as habitual toe walkers have a small ankle equinus, this seems to be an adaptation brought on by their extended toe-walking times. Even if it is present, a large ankle equinus does not seem to be the primary cause of habitual toe walking. Regular toe walkers ought to exhibit a healthy neurological condition. Their deep tendon reflexes, vibratory sensitivity, positional sensation, pain sensation, temperature sensation, and muscle power should all be within normal ranges in addition to showing typical neuromotor development for their age.

Griffin et al Electromyographic .'s investigations revealed that regular tow walkers showed no signs of clonus or muscular activation at rest. These investigations also demonstrated that both habitual toe walkers and normal walkers engaged their gastrocnemius and soleus muscles during the swing phase of the toe-toe gait. Regular toe walkers showed higher amplitude and prolonged duration of tibialis anterior muscle activity during heel-toe gait, as well as overlap of tibialis anterior activity with gastrocnemius and soleus activity, prior to therapy. The habitual toe walker's electromyographic gait pattern was normal following treatment with successive castings.

Any of the five tests can gauge how severe the tiptoe walking pattern is. Pomarino et al. reported on them.

1. Execution of the Spin Test

The patient is asked to perform a maximum of 10 quick spins in one location. The subject is observed spinning as many times as possible. When the tiptoe walking pattern appears, the test is considered successful. The patient is more negatively impacted by toe walking the earlier the tiptoe walking appears.

2. Performance of Walking After Spin Test

The patient is then instructed to take 10 straight steps after the spinning test. The step at which toe walking first manifests itself is noted. The more the patient is impacted by toe walking, the earlier the tiptoe walking returns. The purpose of these latter two tests was to gauge equilibrium and induce a tiptoeing gait.

3.Performance of the Heel Walking Test

The patient is told to walk on his heels. Compensations are permitted, such as decreased ankle dorsiflexion or hip flexion and/or external rotation. If the patient cannot heel walk or heel walks with trunk, knee, and ankle compensations, the test is deemed positive for toe walking. The goal of this test was to gauge tibialis anterior muscle strength during walking. It is crucial to pay attention to the compensatory gestures used to accomplish heel flexion.

4. Range of Motion for the Ankle Joint in Dorsiflexion

Measurement of ankle dorsiflexion with a flexed knee and extended knee has been used in different studies. The greater the ankle limitation, the more affected the patient.

5. Angle Degree of the Lumbar Lordosis

The lumbar lordosis is measured with a goniometer. It is placed at the greatest convexity of the lumbar spine. The patient is more affected if the lordosis is more

**DIFFERENTIAL DIAGNOSIS**

Early assessment of toe walkers is crucial in separating habitual toe walking from the following significant neuromuscular, psychiatric, and skeletal disorders that might induce other types of toe walking since habitual toe walking is a diagnosis of exclusion.

***Cerebral Palsy***

Perinatal encephalopathy, sometimes known as cerebral palsy, is a permanent non-progressive neurologic deficiency that develops before to, during, or shortly after birth. Despite the fact that the harm is not progressive, as a child gets older, the clinical manifestation could change. Despite the fact that the harm is not progressive, as a child gets older, the clinical manifestation could change. The perinatal cerebral injury may be revealed by the medical past. Although there are many different types of cerebral palsy, a spastic variety is the most prevalent and most likely to cause a gait that resembles toe-walking. Independent ambulation is one of the neuromotor development milestones that is typically significantly delayed. Extensor plantar responses, increased tone, and hyperactive reflexes are all seen during the physical examination. Usually, the youngster is presented to the doctor out of concern for motor retardation. Any one limb, or any group of limbs, may experience a movement problem. An unstable scissors gait pattern frequently coexists with talips equinovarus or equinovalgus foot abnormalities. A spastic gastrocnemius or a spastic gastrocnemius and soleus muscle may be the cause of equinus.

According to electromyographic research, people with severe cerebral palsy have a primitive extensor reflex that is triggered by knee extension and causes the soleus and gastrocnemius muscles to contract. As the gastrocnemius muscle is spastic or there is a primitive extensor reflex, it causes a bouncing gait pattern where the heel drops when the knee is bent. According to studies, electromyographic testing may assist distinguish between people with idiopathic toe walking and those with moderate cerebral palsy.

**Pseudoscissor gait**

Pseudoscissor gait, a variation of habitual toe walking, needs to be distinguished from cerebral palsy's scissor gait pattern. When there is a mix of habitual toe walking and an adducted limb position, pseudoscissor gait ensues (femoral antetorsion). In contrast to a youngster with a scissor gait caused by cerebral palsy, a child with a pseudoscissor gait pattern typically exhibits higher stability. The youngster who walks with a pseudoscissor gait may trip and fall rather often, but he shows no symptoms of spasticity or neuromotor deficiency.

**Mental Retardation**

Toe walking is frequently connected with mental impairment. Cognitive aptitude and the subsequent summation of a person's competency in social adaption are referred to as mental retardation. By seeing an infant's overall problem, it is frequently easy to infer that the infant has a mental disability (for example, Down syndrome). Preservation, regular dependence, distractibility, fear, lack of spontaneity, and poor judgement are behavioural indicators for the diagnosis. It's likely that repetitive physical behaviours that are upsetting to other people may occur, such as head banging, rocking, and tantrums. As seen by hypertonicity, ataxia, abnormal reflexes, poor coordination, and seizures, neurologic functioning is frequently disrupted. Speech is slurred and degeneracy's hallmarks are frequently visible in facial expression.

**Autism**

Children with autism are primarily troubled by their lack of emotional connection and behavioural traits. They exhibit secrecy, anger when secrecy is disrupted, daydreaming, strange conduct, a decline in interest, a reversion to interpersonal interests, and sensitivity to criticism. There is a steady separation from interpersonal affective engagement, and the propensity to brood is growing. Disorganized speech is limited to early infantile interest. Ten of the 52 autistic children, aged 3 to 13, that Colbert and Koegler observed toe-walked repeatedly. This toe walking was not a singular occurrence; rather, it was a component of their irrational whirling, dancing, and jumping. Although all of these kids evaluated cognitively deficient, their neurology evaluations were all within normal ranges. Weber observes that between the ages of 9 and 16 months, a typical child's forefoot makes its final stepping motions prior to independent walking. She came to the conclusion that toe walking is caused by the "fixation of a normal temporary stage of development" in both autistic and non-autistic children with developmental abnormalities but without pyramidal symptoms.

**Diastematomyelia**

The spinal cord may be partially or completely divided by tissue that lies in the middle of the spinal canal in a condition known as diastematomyelia. Deficits in neurologic function are typically not visible at birth. The spinal canal, which develops caudally in relation to the cord, anchors the spinal cord. Around the age of two or three, a combined upper and lower motor neuron deficit that affects bladder and bowel control as well as progressive gait problems starts to manifest. Overlapping cutaneous anomalies including hypertrichoses, dimples, lipomas, or vascular malformations raise suspicion. It is typical for feet to have a cavus deformity. Flaccid or spastic paralysis causes the feet to slant varus or valgus. Analgesia and trauma are the two main causes of foot ulcerations. The progressive aspect of diastematomyelia, where toe walking starts at two or three years of age and gets worse, makes it simpler to distinguish from habitual toe walking. At the beginning of autonomous walking, habitual toe walking is evident, although it gets less frequent with age.

**Muscular Dystrophy**

Toe walking is related to Duchenne muscular dystrophy and the mild limb-girdle type. The antagonistic balances of the differentially affected muscle groups are disturbed, which leads to toe walking and a pointed foot posture when at rest. After some time, contracture becomes apparent. It is particularly challenging to regain muscle function if the diagnosis of muscular dystrophy is missed and the patient is immobilised either to stretch the triceps surae or after surgical lengthening. In order to rule out muscular dystrophy as the source of a child's toe walking, temporal indicators are crucial. The first signs of limb-girdle muscular dystrophy typically show in the second decade. When a child has the more prevalent Duchenne muscular dystrophy, they might walk later than they should and experience numerous stumbles as they learn to walk. Before the age of three or four, toe walking gradually becomes apparent. Other symptoms of Duchene muscular dystrophy include lumbar lordosis, difficulty ascending stairs, and a waddling stride that rocks from side to side.

**Gastrocnemius Soleus muscle equinus**

When examining the diagnosis of habitual toe walking, gastrocnemius soleus muscle equinus is probably the most frequent entity that needs to be eliminated. A lot of chronic habitual toe walkers did, in fact, exhibit a little limitation in ankle dorsiflexion, but not nearly enough to account for the observed 30 to 60 degrees of positional equinus during locomotion, according to the author's findings. The Silfuerskjold test, originally developed to distinguish between spastic gastrosoleus equinus and spastic gastrocnemius equinus, can also be used to assess non-spastic short calf muscles. When the knee is flexed and limited dorsiflexion is present, this suggests a functionally shorter gastrocnemius muscle. When the knee is extended or flexed, dorsiflexion is equally restricted, this is consistent with a combined gastrocnemius soleus muscle equinus. A child with a gastrocnemius soleus muscle equinus would typically have a genu recurvatum (knee hyperextension), substantial midtarsal pronation, and an abducted stance angle when standing. The child has a bouncy gait pattern when walking and running because of an early heel lift-off.

There are two other age groups of kids who toe walk and are sometimes labelled as idiopathic toe walkers. Type I genetic sensory neuropathy. Despite the fact that the tiptoe walking pattern is brought on by neuropathy, these kids are frequently misdiagnosed as idiopathic toe walkers. These kids frequently have clawed hands and feet as well as hypotrophy of the gastrocnemius muscles. There has only been one case study that has described this neuropathy thus far.

Mc Ardle illness Idiopathic toe walkers are a common diagnosis among kids with Mc Ardle illness. The girdle muscles in these kids have hypotrophy, their forefoot is wider, and their gastrocnemius muscle has a more proximal belly. Only two case studies have documented children with Mc Ardle illness walking on their toes, though. Despite the fact that these latter 2 categories of kids walk on their toes, they do not fall within the category of kids with idiopathic toe walking since the first is brought on by a neurological disorder and the second by a muscular disorder. The reasons why these kids walk on their tiptoes are still a mystery, thus more research needs to be done in this area.

**INTERVENTION:**

Most debated over how to treat toe working in kids who don't have a definite diagnosis (idiopathic toe walking). In well-known diseases including cerebral palsy, myopathies, and neuropathies, equinus contractures are typically treated with physical therapy, home exercises, bracing, casts, Botox, and occasionally surgery. Although most medical facilities throughout the world recognise these therapies, uncertainty still exists regarding "normal" youngsters who have idiopathic toe walking (ITW).

The non-operative management of idiopathic toe walking appears to be no more effective than simple observation, according to anecdotal reports and infrequent literature reviews. Because the premature firing of the gastrocnemius and soleus complex seen in idiopathic toe walking prevents the anterior tibial muscle from functioning normally, older children (beyond the age of five) will respond less favourably to non-operative treatment. This reasoning seems to be sound, but successful outcomes are only likely in younger children (between the ages of 3 and 5) and those who have only slight restrictions in ankle dorsiflexion. Due to concerns that uncorrected "sensory difficulties" might result in recurrent deformity and additional loss of ankle dorsiflexion, surgical therapy was avoided. Over 50% of individuals with idiopathic toe walking respond to therapy that includes physical therapy, daytime or nighttime bracing, Botox, with or without serial corrective casts. Younger children seem to see more long-lasting outcomes when their families stick with the treatment for two to four growth cycles. Only if regular stretching of the gastrocnemius/soleus complex occurs for literally 1-3 years of growth will the contractures improve and the repair last. It appears that in order to maintain adequate anterior tibial function and keep up with tibial and fibular growth, the muscle-tendon complex must be under constant tension.

The most effective strategy for kids with idiopathic toe walking, according to recent orthopaedic research, is surgery. A limited group of patients with idiopathic toe-walking were reviewed in papers by Hemo et al. and McMulkin et al. who all struggle with non-surgical treatment. Gait analysis was performed prior to surgery. All procedures involved either Vulpius-type releases or Achilles tendon lengthening (when the soleus and stomach muscles felt tight) (Gastroc-only contractures). At a one-year follow-up, post-operative examinations showed an improvement in ankle motion but did not always show a recovery of plantar flexion power.

The author advised against going too long. Complications including osteochondritis dessicans of the talus and/or femoral condyles and increased lumbar lordosis with spondylolysis have been identified through long-term follow-up. If non-operative therapy fails, it appears that surgical treatment is likely the most reliable option for these patients. The pre-treatment evaluation is crucial because it enables the diagnosis to be made as precisely as possible. Additionally, gait analysis during key therapy turning points can be very beneficial.

Even while habitual toe walking is frequently thought of as a temporary delay in a period of development, it is nevertheless linked to issues that call for active treatment. Ambulation is uncomfortable, and when internal limb rotation abnormalities are present, they frequently cause instability and injuries from tripping and falling. Additionally helpful in minimising parents' worry about this issue is hastening the transition from toe walking to heel-toe gait. This will likely also lessen any structural ankle equinus that may develop as a result of chronic toe walking. Numerous methods have been used to cure children who habitually step on their toes. These techniques include orthotics, serial casting, cognitive muscle management, shoe treatment, and surgery.

**Shoe Modifications:**

Shoe therapy involves wearing rigid-soled, straight-last shoes. The child's metatarsal-phalangeal joint cannot dorsiflex due to the inflexible sole, which prevents forefoot movement and causes the heel to drop to the ground. High-top footwear must to always be worn. In addition to preventing the child's heel from falling out the back of the shoe, this enables interior shoe modifications such the inclusion of heel lifts. Addition of a 1/8 to 3/8 inch outside sole wedge can improve the shoes' ability to prevent toe walking. The wedge causes foot abduction and increases the rigidity of the sole, further driving the heels to the ground. We have discovered that it is advantageous to raise the heel of the shoe on older kids until they begin to walk with a heel-toe gait pattern. Later, during following visits spaced out over a few months, the heel height is gradually decreased. Another option is to wear a high-top construction boot with a firm sole and a wedged outer sole. The authors have discovered that this therapeutic approach significantly slows the progression of toe walking. Starting treatment at a young age (as soon as toe walking is discovered) and continuing to use the shoes until the kid no longer toe walks when barefoot are essential to the effectiveness of shoe therapy. The stiff shoes typically last between six months and two years (the older the child the longer the shoes are worn).

Orthotic Prescription:

Heel lifts, gait plates, and ankle-foot orthoses are orthotic devices used to cure habitual toe walking. Shoes with heel lifts allow for dynamic equinus and serve as biofeedback for muscular cognition by giving the heels proprioception while walking. Before gradually lowering, the lifts should be high enough to make touch with the heels during walking. In mild cases of habitual toe walking, gait plates, rigid foot orthoses intended to encourage out-toeing, may be beneficial. When gait plate orthoses are used with flexible-soled sneakers, the abductory influence that results frequently causes the heels to touch the ground. Both ambulatory aids and night splints can be made from ankle foot orthoses, braces that stop motion at the ankle. These devices can be used as an effective alternative to walking casts during ambulation and as night splints to prevent contractures from forming in the muscles of the posterior leg. It has been proven that short-leg walking casts used for six to eight weeks are effective in treating habitual toe walkers. Following this course of treatment, electromyographic testing showed a normal gait pattern.

Auditory feedback

It has been demonstrated that the cognitive muscle management technique of auditory feedback reduces toe walking. One study found that six months after the conclusion of augmented auditory feedback training, eight children with dynamic equinus were able to increase the duration their heels made contact with the ground by 45 percent and the number of times their heels made contact with the ground by 42 percent. One youngster missed five degrees to reach the perpendicular with his foot inverted and knee extended. Seven of the eight children could initially dorsiflex their ankles to the perpendicular. The heel that was more complicated had a switch underneath it, and pressing it down made a sound. Over the course of three months, each youngster practised for an hour every day in an effort to make that sound as frequently and as long as possible.

Surgical intervention

Only when a significant structural gastrocsoleus muscle equinus can be proven should surgical lengthening of the Achilles tendon be taken into consideration. It is important to note that the structural equinus is most likely a coexisting physical finding and is not the main cause of toe walking. Although it has been the author's experience as well as that of Hall and associates, who treated a group of 20 children who were persistent toe walkers with tendo-Achilles lengthening, that postoperatively some of the children still walk on their toes, tendo-Achilles lengthening has been reported to yield positive results. The idea that habitual toe walking is neurogenic in origin rather than musculoskeletal would seem to be strengthened by this.

**Interventions for idiopathic walking**

Congenital short tendo calcaneus was the first term used by Hall to describe persistent tow walking in healthy youngsters. The population in this study had tight Achilles tendons, hence this definition was provided. Later, this condition was diagnosed as habitual toe walking, and in 1980 the term "idiopathic toe walking" was coined. Investigations on the cause of idiopathic toe walking are ongoing. There are numerous hypotheses as to why healthy children continue to walk, including the usage of newborn walkers, an increase in the number of type I muscle fibres, and a hereditary genetic condition with an autosomal dominant pattern of inheritance and variable expression.

Conservative interventions – Observation, Muscle stretching exercise programs targeting gastrocnemius, soleus, or both, motor control intervention, auditory feedback, footwear, ankle-foot / foot-only orthoses, serial casting, different flooring surfaces, and Botulinum toxin A.

Surgical interventions – percutaneous Achilles tendon lengthening, open Achilles tendon lengthening via a Z-lengthening or slide technique. Baker’s gastrocnemius – soleus lengthening. Vulpius procedure (gastrocnemius recession surgery). Most surgical interventions aim to achieve at least 10 degrees of ankle dorsiflexion.

The majority of therapies, aside from basic observation, work to extend the Achilles tendon, promote ankle joint dorsiflexion, and facilitate a conventional heel-toe gait pattern. Other therapies have attempted to facilitate heel contact and hinder the gait pattern and exert pressure on the child's sensory system. To identify the need for intervention and keep track of any developing limitations in ankle dorsiflexion, observation (frequent review) is used. When there is decreased ankle dorsiflexion, stretching activities are frequently suggested. The general notion of stretching is described in the Cochrane review on the stretch for the treatment and prevention of contractures, which also provides extensive evidence. A stretching intervention may take longer if you use footwear, ankle-foot orthoses, full-length foot orthoses, or serial casts (according to the theory about stretching presented by Katalinic 2010). The child may be physically prevented from standing up on their tiptoes by these devices. For gait re-education, motor control, or both, these therapies are frequently employed in children with good ankle dorsiflexion range of motion. A device that generates an audio signal when the foot switch is closed on heel contact is known as enhanced auditory feedback. A normal muscle reaction and heel-strike gait are the devices' goals. The use of footwear with a hard sole and a straight last is known as footwear treatment. According to this shoe's design, toe walking is prevented by restricting dorsiflexion at the metatarsal-phalangeal joint.