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Approach to Pediatric Toe Walking

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Introduction

In this podcast, we will first work through an approach to pediatric toe walking, what to ask for on history, look for on physical exam, investigations to consider, and potential treatment options. We will then briefly touch on some of the various causes of toe walking.

Our main objectives for this podcast include:

1. Elucidate key findings on history and physical exam for pediatric patients presenting with toe walking.
2. Discuss main investigations and management options for pediatric patients presenting with toe walking.
3. Review the various causes for pediatric toe walking and ways to differentiate their presentations.

General Definitions/Explanations

Alright, so let's jump right into it. What is pediatric toe walking?
Just as it sounds, pediatric toe walking is the presentation of a child that walks on the balls of their feet ("on their toes"), without their heels contacting the ground.[1] Landing on the forefoot is a normal developmental pattern when children are learning to walk, however, most children will achieve foot flat contact by mid stance. By the time a child is two, initial contact is typically made with the heel. If it is still present in an older child or is acquired later on, it may be a sign of an underlying developmental disorder. The differential diagnosis is quite broad, and can include Cerebral Palsy, Duchenne's Muscular Dystrophy (DMD), Charcot Marie Tooth (CMT), spina bifida, limb length discrepancy, clubfoot and Autism Spectrum Disorder (ASD), to name a few.[1] If a specific cause cannot be elucidated, idiopathic toe walking (ITW) may be diagnosed.[1,2,3]

Clinical Case

Okay, so let's start off with a clinical case. You are a third-year medical student working on a family medicine rotation when Katrina, a four-year-old girl comes to see you with her mother. Katrina is presenting with bilateral, persistent toe walking that has been present since she started walking at around one year of age. Katrina can walk normally when she focuses hard, and when her mom reminds her to. There is no pain or weakness, but she has had a few

associated falls. Katrina has a normal birth history, immunizations are up to date, and she is meeting all her developmental milestones. She attends preschool and although she plays well with other children and is starting to recognize the letters of her name, she can't quite keep up with her classmates on the playground and in the gym. She has no relevant family history. On physical exam you do not notice any swelling, hypertrophy, erythema, deformity, or skin changes. When you ask her to walk across the room you notice bilateral toe walking, however when you ask her if she can focus hard to get her heels to touch the ground, she is able to do so. She can get up from a sitting position without using her hands or other assistance. Dorsiflexion at the ankle seems to be limited, while all other ranges of motion are normal.

Approach:

Okay, so let's start framing our approach so we can understand Katrina's presentation.

History

As with all things, we want to start off with a thorough history. We will begin by asking questions specific to the toe walking, and then move on to other developmental and medical questions that may be relevant.

Questions we will want to make sure not to miss include when the toe walking started, how long it has been going on for, if it is continuous (happens every time the child walks), or episodic (only occasionally). Getting the parent to quantify the percentage of time the child is on their toes is helpful. You can even directly ask them "what percentage of time is your child on their toes?" Some causes of toe walking are actively correctable, meaning the child is able to walk normally when they are instructed to do so. Whereas in other presentations this may not be the case, and thus, the presence of correctability is an important point.[1]

Some further questions include asking if the toe walking has been progressing/getting worse, or if it has been staying the same. Is it one foot or both? We also want to make sure we ask what the patient (and their family) has tried, what has helped and what has made it worse. When taking our history, we want to ensure we are understanding the full functional limitations that may be present with our patient. Is the child tripping or falling as a result of the toe walking? Are they able to function at home or school? Are they having difficulty playing and keeping up with their peers? Do they have pain? Is there weakness with the toe walking or difficulty performing other motor tasks? Sometimes children may present with painless toe walking, but the main concern is purely cosmetic. It is important to know what is most concerning to the patient and their family.[1]

Additionally, we want to ensure that we are screening for any potential red flag associated symptoms. For example, asking if the child has headaches may be relevant in the case of a Chiari malformation. Spinal cord pathology may manifest with challenges in control of bowel or bladder, so be sure to ask if the child is toilet trained or if they are having any bowel or bladder accidents? Significant asymmetries or associated challenges with one's upper extremities may be relevant for CNS pathology. Toe walking that develops later on after a period of normal gait can point to a neuromuscular cause.

As always, after the history of the presenting condition, we want to take a thorough "BIND" history. Remember this includes a Birth history (including prenatal, delivery, and postnatal), if their Immunizations are up to date, details on their Nutrition, and an assessment of their Development. Remember the pneumonic "Gotta Find Strong Coffee Soon" as an easy way to

remember our developmental milestones. It stands for Gross Motor, Fine Motor, Speech/Language, Cognitive/Problem Solving, and Social/Emotional milestones. For our case, we want to make sure we focus in on the motor milestones. Asking age-specific questions may determine if the child is experiencing any delays in their motor milestones. Some things to consider asking include their ability to run, jump, and climb stairs. Can they dress themselves, draw, and use utensils?[1,2] Asking about social development and communication can glean clues into associated diagnoses such as Autism Spectrum Disorder. Challenges with attention and learning disabilities can also be associated with toe walking. For school aged children asking if there are any concerns with reading or writing is important for this reason as there is higher incidence of learning disabilities in children that walk on their toes.

Next, make sure to get a full past medical history, surgical history, social history, and family history. Several of the neuromuscular causes of toe walking as well as idiopathic toe walking can be inherited and so it is important to determine if similar presentations were noted in their family members.[1] Do they remember any relative having gait difficulties or using a wheelchair/walking aid at a young age?

Finally, there have been several questionnaires developed, such as the *Ages and Stages Questionnaires* and the *Toe Walking Tool (*by Williams et al, 2010) that may give additional information to a family physician or general pediatrician to determine if their patient should be referred to a sub-specialist, such as a Pediatric Physiatrist or Developmental Pediatrician[4] Using these along with other questionaries may help you to determine what next steps to take for your patient.

Physical Exam

Now it is time to move onto the physical exam. As with many things, a lot of our information may be gained just by watching our patient before the exam officially begins. Observing them walk into the room without them knowing you are watching them might give you a lot of information about their toe walking.

As with most musculoskeletal physical examinations, we are going to structure it into four main sections; Look, Feel, Move, and Special Tests. Starting with “Look”, we can use the acronym “SEADS” for “swelling, erythema, atrophy, deformity, and skin changes/scars.” Inspect how the patient stands and their legs in general. Observe for any swelling, callouses, ulcers, birthmarks, or erythema.[1] Are their heels touching the ground? Do they have a leg length discrepancy? Is there a pelvic tilt? Any lateral curvature of their spine suggestive of scoliosis? Any stigmata of spina bifida including midline hair tufts, dimples, lipoma, or skin changes? Is there any muscle atrophy, as may be present in conditions like club foot, spinal cord injuries or cerebral palsy? Is there pseudohypertrophy, possibly suggesting muscular dystrophy?[1]

Next, we want to get the patient to walk in the hallway outside the exam room, with and without their shoes. When they are walking, we want to be watching if their heel contacts the floor, their ankle motion (specifically dorsiflexion) in both swing phase and stance phase, and if the toe walking is unilateral or bilateral.[1] Not only is it important to look at the lower legs during walking, but also the knees, hips and even arms. A knee/hip problem may present with a walking difficulty, and a condition like cerebral palsy may have associated arm and leg abnormalities. These arm abnormalities might appear as increased elbow flexion and fisting on one side when walking fast or running, so it is also important to watch the child run.

For the “Feel” section we want to make sure we are palpating the bony and soft tissue structures around the foot and ankle for any possible tenderness.

When we begin to “Move” the patient’s leg, we will be assessing for any weak or lax ligaments, and assessing for range of motion of the back, hip, knee, ankle (aka talocrural) and subtalar joints.[1] There are two key Special Tests to include when assessing a child for toe walking. They include the Silverskiold maneuver, in which you measure the amount of ankle dorsiflexion with the knee bent and flexed.[1] This test helps to determine whether the gastrocnemius, soleus muscle or both is contributing to a loss of range of motion at the ankle. A second key test, and perhaps the most important test is asking the patient to stand up from a supine position, observing if they need to lean on their arms or have significant help to stand up; this would be a positive Gowers Sign and may indicate proximal muscle weakness.[1]

After you have completed a full MSK exam, it is then very important that you do a thorough neurological examination, as many MSK conditions can have an underlying neurological cause. This includes an assessment of their sensation, strength, muscle tone, reflexes, and presence of any upper motor neuron findings (Hoffman’s and Babinski’s) or lower motor neuron findings (areflexia).[1]

Investigations

Once the history and physical exam are completed, you may have a better idea of what may be causing the toe walking in your patient. You may then need to order investigations to help you further narrow in on your diagnosis.

This may include a creatine kinase (CK) level, MRI of the brain or spine, nerve conduction studies (NCS), electromyography (EMG), genetic tests and potentially even a muscle biopsy. A CK is indicated in the context of delayed motor milestones or proximal weakness on examination. TSH and liver enzymes are also typically included in the basic work up to look for an underlying metabolic disorder. Radiographs of the spine, pelvis or foot and ankle may be indicated in the context of scoliosis, asymmetry on hip exam, leg length discrepancy or a rigid foot deformity. An MRI of the brain may be indicated if the patient is having morning headaches or if they had an abnormal neurological examination and you need to rule out other causes. An MRI of the spinal cord may be indicated in the context of UMN or LMN findings and in the setting of an acquired foot deformity. Ordering an EMG may be helpful to diagnose lower motor neuron conditions such as Charcot Marie Tooth Disease and can be helpful if there is weakness and especially if the patient is areflexic on exam. With advances in genetic testing for suspected neuromuscular causes, a muscle biopsy is very rarely indicated.[1]

Management

When a family physician or pediatrician is presented with a patient with pediatric toe walking without an obvious etiology, a referral to a pediatric physiatrist may be indicated for a thorough evaluation and management.

The treatment for toe walking largely depends on the etiology, age of the child, and severity of the presentation. Common conservative treatments for toe walking include physical therapy (stretching and strengthening), orthotics, and casting. More severe causes of toe talking may require surgery.[1]

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Some presentations of toe walking may be accompanied by other behavioural signs or symptoms, potentially suggesting developmental causes such as Autism Spectrum Disorders, and thus may indicate a referral to a Developmental Pediatrician.[5]

If all other causes of toe walking are ruled out and the child is diagnosed with ITW, the following things may aid in managing their condition:[1,2,3] Please refer to the treatment algorithm within Le Cras *et al*'s *Evidenced Based Clinical Care Guideline* for further details on the specific treatments indicated for certain degrees of ankle dorsiflexion.[5]

1. Cueing: Consistently reminding the child to be aware of their walking and to not walk on their toes. This management strategy is very patient dependent; it may work well for some, or not at all for others. It frequently causes frustration for the patient and their family.
2. Physical Therapy: There seems to be limited evidence of benefit for patients that choose to undergo physical therapy. A general approach is to provide the patient and family with stretches for the gastrocnemius and soleus, as well as strengthening exercises for the dorsiflexors. A great handout for families as a starting point is provided in the references.[8]
3. Footwear: Getting the child to wear shoes indoors can be helpful. A trial of crocs or flip flops may be effective in some cases. A rigid custom carbon foot plate can also be effective.
4. Ankle-Foot Orthoses: Seem to be more effective than a simple foot orthosis by providing sensory feedback and limiting the ability of the child to go on their toes. However, they can be uncomfortable, expensive, difficult to fit into footwear, have an unappealing appearance, and limit the child's ability to run.
5. Casting: Short leg casts work to keep the foot in dorsiflexion, thus stretching the gastrocnemius-soleus-achillies tendon complex when the child walks. Serial casting (applying a new cast each week for 2-4 weeks) can be used to correct tightness and is often used in the setting of pain or functional impairment. They are worn full-time for a period of time, and then followed by just at night. However, toe walking often recurs when the casting is stopped and may not be an effective option for children over the age of seven.
6. Surgery: This is indicated if there is little or no response to conservative management. The procedure aims to lengthen the gastrocnemius-soleus-achillies tendon complex. A post-operative dorsiflexion cast is typically required for 4-6 weeks, and complications may include nerve injury, scars, and infections.

Causes of Toe Walking

The most common cause of toe walking is idiopathic; however, we will want to ensure that we rule out other causes before diagnosing a patient with ITW. There are many potential conditions or disorders that may cause a patient to present with toe walking, we will only discuss a few of the more common causes here and some of the specific things you may notice on history/physical for each cause.

Cerebral Palsy (CP)[1,5,6]

If a patient has CP, they may have had a premature birth or difficult delivery, have delayed milestones, weakness, hyperreflexia, and spasticity. Their toe walking may be unilateral or

bilateral and be persistent in nature. Additionally, their range of motion may be asymmetric. A brain MRI may be indicated if you suspect your patient has CP.

Tethered Spinal Cord[1,5,6]
This may cause an individual to present with toe walking due to a contracture of the heel cord, or due to hip/knee flexion contractures. On history the child may have changes in their bowel/bladder habits, have leg or back pain and/or weakness. On physical exam, look for sacral dimples, hair tufts, abnormal reflexes, abnormal tone, and maybe even scoliosis. If you suspect this cause, MRI imagining of the spine may be indicated.

Myopathies (Duchene's Muscular Dystrophy)[1,5,6,7]
Toe walking in myopathies and other paralytic muscle diseases is often multifactorial but may be due to a patient using the plantar flexors to compensate for proximal weakness or weakness in the dorsiflexors, leading to a contracture. Weakness in these children is typically observed around three to five years old. On history they may have relatives with this condition, previous falls, muscles cramps, and weakness. On physical exam observe for lordosis and a lean over the stance limb when walking, calf pseudohypertrophy, contractures, bilateral toe walking, and Gower's sign (as discussed earlier). A creatine kinase (CK) level and genetic testing may help diagnose Duchene's Muscular Dystrophy. Other non-dystrophic myopathies can present as toe walking but are less common and are outside the scope of this podcast.

Peripheral neuropathy (Charcot Marie Tooth)[6]
On history be sure to ask if the patient is experiencing weakness, and if relatives had this condition or similar presentations. On physical exam, the patient may have pes cavus, foot drop (potentially with a high steppage gait), weak dorsiflexion, decreased sensation and hyporeflexia. Genetic testing or EMG and nerve conduction studies may be indicated here.

Congenital Orthopedic Conditions (congenital short heel cord, congenital vertical talus, clubfoot, leg length discrepancy, hip dysplasia)[1,5]
To rule in/out certain orthopedic causes of toe walking, some things to consider are if the child has a limp, an asymmetrical thigh crease, a leg length discrepancy (as described as >2.5cm difference in leg lengths), pelvic tilt or rotations, pes cavus, metatarsus adductus, varus alignment of the foot, and foot equinus (a plantarflexed ankle). Depending on the determined orthopedic cause, different treatment options are available.

Developmental Disorders (Autism Spectrum Disorders)[1,5]
Your patient presenting with toe walking may likely have an underlying developmental disorder such as autism spectrum disorder, attention deficit hyperactivity disorder, or a learning disability. It is important to determine if the patient is reaching their other developmental milestones. You may be suspicious if they are also presenting with social, language and learning differences. Referral to developmental specialist or pediatrician may be indicated.

Idiopathic Toe Walking (ITW)[1,2,3,5]
Many presentations you see will be due to ITW. However, it is a diagnosis of exclusion and so it is important that you rule out all other concerning causes first. As the name implies, this is toe walking that does not seem to have a clear cause. You may suspect ITW if the child began walking at a normal age (as opposed to other medical causes where walking may have been delayed). ITW is typically present when the child first starts walking, is symmetrical, can be corrected by actively moving the patient's foot into the proper position or by cueing, and may

even resolve on its own. The patient usually has a normal neurological examination, but may have secondary musculoskeletal changes associated with toe walking including external tibial torsion and restriction in ROM at the ankle. Pain, loss of ROM and functional impairment may prompt intervention.

Conclusion

Alright, so now that we have worked through an approach and some of the various causes of toe walking. Let's return to our clinical case.

Remember our patient Katrina, a four-year-old girl with bilateral, persistent toe walking. Her history and physical exam were not in keeping with a neuromuscular, orthopedic, developmental, or other secondary etiology. You do not believe any investigations are warranted as you believe she most likely is presenting with ITW. As you know you are not the expert, you decide to refer her to a pediatric physiatrist for further evaluation.

Before we close, lets briefly review what we have learned.

1. Idiopathic toe walking is relatively common but always requires a thorough assessment especially when there is pain and when it impacts function.
2. When working up a patient presenting with toe walking, clarify specific details including when the toe walking began, if it is persistent, correctable, has pain/weakness, or if the patient is experiencing associated delays in their milestones.
3. Remember to use your Look, Feel, Move, Special tests approach when examining the patient. Do a neurological exam and watch the child stand up from supine (Gower sign).
4. There are many causes of toe walking, including neurologic and developmental conditions. Idiopathic toe walking does not have a clear etiology but is quite common. Depending on the presentation, there are various investigations or further steps you can take to determine the cause of the patient's toe walking.

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