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Approach to Pediatric Intoeing

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Introduction:

Hi this is Kero Yuen, a fourth year medical student at the University of British Columbia. This podcast was developed in conjunction with Dr. Shafique Pirani, a pediatric orthopedic surgeon at the Royal Columbian Hospital in New Westminster, BC.

Objectives:

In this podcast we will:

1. Discuss the differential diagnosis and treatments for pediatric intoeing
2. Identify the relevant findings on history and physical exam.

The topic discussed today is very visual, so I strongly encourage you to have a look at the supplemental images I've attached to aid your understanding.

Case Introduction:

Let's imagine you are a medical student on the first day at the general pediatrics outpatient clinic. Melissa, an otherwise healthy 2-year-old girl, comes in smiling and accompanied by her mom who is very distressed about her child's gait. Her mom tells you that Melissa's "toes are starting to point towards each other" and that she is "tripping over herself" more frequently these last 6 months. Melissa's mom has started placing orthotics in her daughter's shoes in hopes of resolving this problem. Her mom is also wondering if Melissa will need X-rays and wishes to be referred to a pediatric orthopedic surgeon. Before starting your history and physical exam, you step out of the room to gather your thoughts.

Background Information:

To be able to appropriately address this situation, we first have to learn some basics about intoeing. **Intoeing**, also known as pigeon toeing, describes the rotation of the lower limbs such that the toes are pointing towards the midline[1,2]. The source of rotation

can be anywhere from the hips to the feet[1]. It is one of the most common reasons for referral to a pediatric orthopedic surgeon[1-3]. Just as in our clinical case Melissa, parents often notice intoeing in their children when they are infants or young children due to their awkward gait or increased tripping and falling[3,4]. It is important to note, however, that the majority of intoeing cases referred to an orthopedic surgery are benign and will resolve spontaneously[1,3,4,5]. One study found that 86% of children referred to an orthopedic surgeon for intoeing were discharged after the initial visit, whereas another study found 95% of the referrals to an intoeing clinic to be benign in nature[2,3].

Differential Diagnosis & Treatment:

Next, let's discuss some of the most common causes of intoeing. The three most common etiologies occur during different ages: for children less than 1, metatarsus adductus is the most common cause; for children between 1-3, internal tibial torsion; and for children older than 3, femoral anteversion[1-6].

First, **metatarsus adductus** or metatarsus varus, which I will refer to as MTA, is a condition where the metatarsal bones are angulated towards the midline relative to a normally-aligned hindfoot, giving the foot a "kidney bean" or "letter C" shape[1,2,4,7,8,9]. It is the most common congenital foot deformity, and the most common cause of intoeing in infants, affecting up to 3% of term newborns[1,6,8]. It is considered a "packaging problem" meaning it is due to intrauterine positioning of the forefoot into adduction[1,2,4,9,10,11,12]. When describing MTA, it can be classified by severity and flexibility[1,4,11]. The severity is determined by the **heel bisector line** where a straight edge is placed to divide the heel symmetrically and longitudinally, extending to the toes[1,6,7]. Normally, the line intersects between the second and third digit, at the second web space[1,4,7]. If the line intersects at the third digit, there is mild MTA[4,11]. If it intersects at the fourth digit, it is moderate, and if at the fifth digit, it is severe[4,11]. Essentially, the more lateral the heel bisector line, the greater the severity of MTA. Next, the flexibility of MTA is determined by trying to passively manipulate the forefoot back into the normal position, using the base of the fifth metatarsal as a fulcrum[1,11]. This is achieved by holding the hindfoot in place. The MTA is considered flexible if the forefoot can be overcorrected, meaning abducted past midline; semiflexible if it can only be corrected, meaning abducted to midline; and rigid or inflexible if it cannot be corrected by abduction[1,4,10,11]. The flexibility of MTA guides treatment decisions[1]. Flexible MTA resolves spontaneously by 1-2 years of age[1,2,6]. Semiflexible MTA requires observation for 6 months to see if there is self-resolution[1]. If there isn't, a referral may be made to orthopedics for possible serial casting[1,2]. Rigid or inflexible MTA tends to worsen with time and requires referral to orthopedics for serial casting[1,2,4,5,6]. Although regular stretching by applying medial pressure to the first metatarsal is often recommended, its efficacy is unclear[1,4,5,7]. Currently, surgical considerations for MTA are controversial as there are high rates of failure and complications[1]. Overall, the majority of outcomes for MTA are positive, with one study reporting 90% spontaneous resolution by age 4[8,10,11]. Even if the MTA does not resolve, it is rarely symptomatic or painful[2,5].

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Another common cause of intoeing is **internal tibial torsion**. This is the internal or medial twisting of the tibia and it is the most common cause of intoeing in children 1-3 years of age, usually noticed as the child starts to walk[1,2,4, 6,7,8,12]. Children with internal tibial torsion have forward facing patella despite midline facing feet[1,8]. Like MTA, it is a result of intrauterine positioning[7,8,12]. It also appears to run in families[7]. Internal tibial torsion is determined by measuring the **thigh-foot angle**[1,6]. The patient is placed prone with knees flexed 90º, then the angle between the axis of the thigh and the foot is measured[1,8]. The average thigh-foot angle at birth is around 5º externally rotated and increases to around 15º externally rotated by age 5. Therefore, internal tibial torsion generally corrects itself by 5 years of age due to the natural tendency of the tibia to rotate externally as the child grows[1,2,4,5,6,7,8]. Despite being commonly recommended, orthotics and braces have not been proven to change outcomes[1,5,6,7,12]. Similar to MTA, even if internal tibial torsion persists, it is rarely symptomatic[1,2]. The rare exceptions that are severe or functionally debilitating require a referral to orthopedics for possible surgical intervention[,6,12].

The last common cause of intoeing is **femoral anteversion**. Similar to internal tibial torsion, it involves the internal or medial twisting of a bone, in this case the femur instead of the tibia. This causes an excessive angle between the axis of the femoral neck, and the axis of the femoral condyles[1,7,13]. Femoral anteversion is usually diagnosed after the age of 3[1,2,6,10,13]. Unlike internal tibial torsion, both the patella and toes are facing midline[1,6,10]. When the child is running, there is often a noticeable lateral deviation of the leg during the swing phase, resembling a windmill or eggbeater[1]. The child may find sitting cross-legged uncomfortable and prefer to sit in the “W position”; this is where they sit on an internally rotated femur, creating the letter “W” with both legs[1,4,6]. Likewise, on physical exam, you may find increased range of motion for internal rotation and decreased range of motion for external rotation[1,6]. Like MTA and internal tibial torsion, femoral anteversion is caused by intrauterine positioning[1,2,13]. The average degree of femoral anteversion is 40º at birth, and this decreases by around 2º every year such that there is around 15º left at maturity[1,2,4,7,10,13]. Therefore, femoral anteversion generally resolves spontaneously by age 11[1,2,6,7,10,13]. Orthotics, shoe wedges, bracing, and splinting have not been shown to be effective[1,6,7,10,13]. Furthermore, preventing the child from sitting in the “W position” does not affect outcomes[1,10,13]. Even if the femoral anteversion does not self-resolve, there is few long-term sequelae[1]. Severely debilitating femoral anteversion can trigger a referral to orthopedics for surgical intervention[1,2,6].

Now that we’ve discussed the more common and benign causes of intoeing, let’s briefly mention some rarer, but more dangerous etiologies to look out for. The main reason they are dangerous is because unlike metatarsus adductus, internal tibial torsion, and femoral anteversion, these causes of intoeing do not self-resolve[1]. The more uncommon causes of intoeing we’ll be discussing today include developmental dysplasia of the hip, clubfoot, and cerebral palsy.

Developmental dysplasia of the hip, or DDH, is a spectrum of hip abnormalities that presents as a range from capsular laxity to frank dislocation of the hip[4,9,414,15]. It is the

most common orthopedic disorder in newborns, occurring 1-2 in 100 births[14,15]. Risk factors include breech presentation at birth, firstborn, being female, and a family history of hip dysplasia[4,9,15]. It is screened for in all newborns and on subsequent well-baby visits through the physical exam. This involves looking for asymmetrical skin folds of the thigh, asymmetric range of hip abduction, leg length discrepancies, and the Galeazzi or Allis sign[4,9,14]. Provocative maneuvers such as the Ortolani and Barlow tests must also be done[4,14]. Treatment for DDH can be started after referral to orthopedics. This is aimed to relocate and stabilize the femoral head within the acetabulum[4]. Under the age of 6 months, a brace known as the Pavlik harness is used; this holds the hip in abduction, flexion, and external rotation[4,6,15]. Between the ages of 6-12 months, a hip spica cast may be needed[4,15]. After one year of age, many children require surgery to reset the hip[4,15]. It is crucial DDH is not missed, if left untreated, it can results in avascular necrosis and premature osteoarthritis[9].

Next is **clubfoot,** which is also known as talipes equinovarus**.** This is a complex foot and ankle deformity that can be remembered by the mnemonic CAVE: “C” for cavus referring to the high midfoot arch; “A” for adductus meaning the metatarsus adductus that we learned about earlier; “V” for varus referring to the turning-in of the hindfoot; and “E” for equinus meaning excessive plantar flexion and inability to dorsiflex the ankle[2,7,8,9,16,17]. It occurs around 1 in 1000 births[4,7,16,17,18]. Prenatal detection of clubfoot has improved in the last decade, allowing it to be picked up by transvaginal ultrasound as early as 12 weeks of gestation[4,7,16,18]. Mainstay treatment after referral to orthopedic surgery involves the Ponseti method, a series of manipulation and casting to reverse the CAVE deformity[4,7,9,16,17]. Functional outcomes are positive, with less than 10% of children requiring surgery[7].

The last condition to be wary of is **cerebral palsy.** This is a large group of movement disorders beginning in childhood which may involve abnormal muscle tone, poor coordination, altered motor development, and abnormal reflexes[19]. Cerebral palsy can present as intoeing if there is spasticity of the internal rotators or adductors of the hip or the inverter muscles of the foot[1]. The red flags to look for here are asymmetry such as spasticity of muscles in one leg but not the other, perinatal issues, delayed developmental milestones, and retained primitive reflexes[1,19]. A referral to neurology or physiatry should be made if a new diagnosis of cerebral palsy is suspected[1].
Lastly, when evaluating a child’s intoeing, remember that multiple causes of intoeing can occur in conjunction with one another, increasing the severity of the intoeing[1,3]. For example, internal tibial torsion is associated with MTA in 1/3rd of cases[1,8].

History & Physical Exam:

With this differential diagnosis in mind, you re-enter the patient room and perform a thorough history with Melissa’s mom. It turns out that the Melissa’s mom first noticed Melissa pointing both her toes together and tripping more around 6 months ago. This was shortly after she started walking by herself at around 15 months of age. No limp was noted. She’s still making progress with her walking, but her mother is concerned

the intoeing is worsening. Melissa's mother has not noticed Melissa sitting more in the "W-position", in fact, Melissa seems to enjoy sitting cross-legged. She also denies any signs of pain. Prenatal and perinatal history are unremarkable, and she's had no problem hitting her developmental milestones. Her mother then mentions that her husband had a similar intoeing problem when he was around 3 years of age, but it had self-resolved.

At this point in time, based on Melissa's age, you have a high clinical suspicion of internal tibial torsion. The father also seemed to have a similar problem in the past that had spontaneously resolved. To further support this working diagnosis, there have been no red flags of asymmetry, delayed developmental milestones, or significant pre- or perinatal history. You thank Melissa's mother for answering your questions in detail and decide to move onto the physical exam to help rule out the other causes of intoeing.
On Melissa's physical exam, there are no frank deformities of the lower extremities. They appear symmetrical and there is no limping, eggbeater, or windmill patterns when you observe her walk or run. You do note, however, that both her feet point inwards, but her patellae point forwards. She has normal range of movement, normal muscle strength, normal reflexes, and is neurovascularly intact in the lower extremities. She has bilateral heel bisector lines that transect the second web space, a bilateral thigh-foot angle of 10^{o} rotated internally, and bilateral femoral anteversion at 25^{o}.
With these findings on physical exam, you are even more convinced that internal tibial torsion is the cause of Melissa's intoeing. The fact that her patellae point forwards despite the feet pointing midline, and her thigh-foot angle being 10^{o} rotated internally support that diagnosis. Since her heel bisector line is normal, MTA is unlikely at play. Also, her patellae point forward and her femoral anteversion angle is normal, so it is unlikely that femoral anteversion is the cause. The lack of spasticity, asymmetry, and deformities of the lower extremities make it unlikely to be the other dangerous causes of intoeing.

Case Conclusion:

You leave the room to review your findings with your attending. You share your provisional diagnosis of internal tibial torsion and recommend no necessary treatment other than observation. Your attending agrees with you based on your history and physical exam. She stresses the importance of parental reassurance as the most important treatment for intoeing[1,2]. Explaining to the parents that intoeing is a normal variation due to how the baby was positioned inside the womb can help ease parental worries[1]. Furthermore, it is crucial to stress that the majority of intoeing self-resolves, and the cases that don't rarely have long-term functional issues[1,2]. Your attending also agrees it would be appropriate to let Melissa's mom know that orthotics and braces have not been proven to change outcomes[1,5,6,7,12].
You follow your attending back into the clinic room, and after your attending reviews the history and re-examines Melissa, she describes the diagnosis of internal tibial torsion to Melissa's mom. While your attending is answering her questions, you suddenly recall that Melissa's mom had asked you at the beginning of the visit whether Melissa would

need any X-rays. Your attending explains that radiographs are generally not necessary with intoeing other than for planning a surgical intervention or excluding other pathological causes of intoeing[1,2,6,12,13]. Your attending further reassures Melissa's mom that an orthopedic surgeon referral is not necessary, but that she'd be happy to follow-up with Melissa if any future concerns were to arise. Melissa's mom thanks you and your attending for your help and Melissa waves "bye" as she skips out of the clinic.

Take-Home Points:

That concludes this podcast on pediatric intoeing. Here are some take-home points:

- Intoeing is a common orthopedic concern and is caused by internal rotation at any part of the lower limb. It can largely be managed by a primary care provider without referral to orthopedic surgery.
- The three major causes of intoeing are most prevalent at different ages: metatarsus adductus in infants, internal tibial torsion in those ages 1-3, and femoral anteversion in those older than 3. All three causes are clinical diagnoses. Furthermore, they are all due to intrauterine positioning and are benign in nature as they self-resolve with time.
- Rarer and more dangerous pathologies of intoeing to be aware of include: developmental dysplasia of the hip, clubfoot, and cerebral palsy.
- Parental reassurance is the keystone in treatment of the benign causes of intoeing. Long-term sequelae are rare even if the intoeing does not resolve. Orthotics and braces have not been proven to affect outcomes.

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