Gillette Children's Specialty Healthcare

A PEDIATRIC Perspective

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Intoeing and Outtoeing: Common Concerns During Childhood

by Stephen Sundberg, M.D.

When children begin to walk, most parents expect the child to walk "normally." Many children, however, demonstrate some degree of intoeing (feet point inward) or outtoeing (feet point outward), which might cause concern among family members and the medical staff who care for these children.

Is the child's walk normal? Will it resolve? Does it lead to problems in adulthood? What can be done about it? You might be able to answer these common questions, ease concerns and eliminate multiple physician visits by effectively communicating with parents about the cause of the gait deviation, the natural history of the problem, and its treatment options.

The evolution of gait in childhood results from a complex set of factors that ultimately result in a stable, mature gait. Progressive maturation of a growing child's brain and peripheral nervous system during the first five to six years of life means that each child's gait gradually becomes more stable and consistent. For example, torsional changes at the level of the femur and tibia might make an immature child's walk appear abnormal and result in frequent consultations with physicians.

Natural History

Explaining the natural history of a child's skeletal development before and after birth can help guide your discussions with families.

During the first five to seven weeks of intrauterine life, limb buds appear on the developing fetus. Initially, the great toe points outward. The lower leg and foot gradually rotate, so that the tibia and femur are rotated internally at birth. Intrauterine molding can result in external rotation of the hip's soft tissues. This leads to a physiologic hip external rotation and flexion contracture at birth. This soft-tissue contracture masks the underlying normal femoral anteversion (internal rotation of the proximal portion of the femur) that is present at birth. As these soft-tissue contractures resolve during the first six months of life, the underlying hip internal rotation (femoral anteversion) becomes more obvious. With otherwise healthy, weight-bearing children, progressive external rotation of the tibia and femur occur normally up to age 10 years.

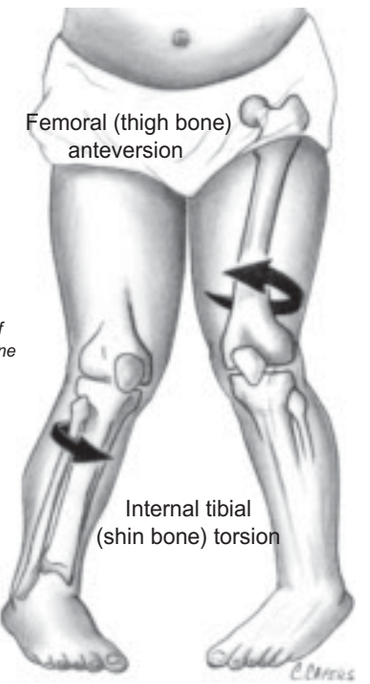

Figure 1
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Evaluation

When a concern is raised about a child's walk, you must differentiate problems that are pathologic and require treatment from those that are physiologic, and will resolve spontaneously, and aren't associated with long-term problems.

Before performing a physical exam on children, it's essential to gain information about the child's development. Is there a history of prematurity or perinatal complications that suggests the presence of an underlying neurologic abnormality, such as cerebral palsy? Is there a family history of hip dysplasia, or was the child breech in utero? Is there a family history of endocrine or metabolic problems, such as vitamin D-resistant rickets or bone dysplasia? Do any adult family members have

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significant rotational abnormalities that cause functional problems?

Perform a methodical physical examination to determine the source of the child's intoeing or outtoeing. Assess the child for outer signs of spinal pathology (hair patches; sinus tracts; dimples; skin discolorations, such as café-au-lait patches; and thoracic or lumbar prominence on a forward-bending spine examination). In addition, assess limb lengths and observe angular deformities such as *genu varum* (bowleg) or *genu valgum* (knock-knee). Evaluate the child's lower extremity torsional profile and the child's internal and external hip rotation; thigh-foot axis and tibial-fibular bimalleolar axis at the ankle; and foot shape. Perform this exam with the child prone, either on the exam table or the parent's lap.

You can assess the hip internal rotation by stabilizing the pelvis with one hand over the posterior aspect of the sacrum — to keep the pelvis level — while gently internally and externally rotating each hip. For the medical record, note the range of hip internal and external rotation, and monitor any asymmetry closely. You can check the alignment of the foot with the thigh by having the patient lie in a prone position with the knee flexed. Measure the number of degrees of internal or external rotation with a goniometer. Identify the center of the medial and lateral (fibular) malleoli, and measure and note the degree of rotation relative to the thigh. Assess the foot shape. Is the forefoot adducted, or is the foot flat, resulting in an externally rotated foot position relative to the thigh?

After completing the static examination, observe the patient walking in the hallway with legs exposed. For young children, remove their pants, shoes and socks, leaving their diapers in place; for older children, have a supply of shorts available for them to wear. Observe and document the direction of the feet as the child walks, relative to an imaginary straight line down the center of the hall. Is each foot internally or externally rotated, and is the gait symmetric? Do both patellas face the opposite thigh ("squinting patella"), suggesting the presence of increased hip internal rotation? Perform a neurologic exam to assess the child for spasticity, clonus, or abnormal or asymmetric reflexes.

After completing this examination, you should be able to identify the source of the gait disturbance (thigh, tibia or foot). You can then discuss with the family the specific problem and potential treatment options — if treatment is necessary.

The three typical causes of intoeing are:
- Metatarsus adductus (curved foot)
- Femoral anteversion (twisted thighbone)
- Tibial torsion (twisted shinbone)

Metatarsus Adductus

Incurving of the forefoot, common in newborn children, is usually the result of intrauterine positioning. This deformity is different from a clubfoot deformity because there is no heel-cord tightness in the child with metatarsus adductus. The foot deformity isn't a true clubfoot if you can readily dorsiflex the child's ankle above neutral.

Metatarsus adductus occurs in one of 5,000 births and in one of 20 siblings of patients with metatarsus adductus. The incidence is higher in preterm children, multiple births and boys, and it occurs more often on the left. Recent studies have lessened concerns about hip dysplasia in children with metatarsus adductus. The majority of these foot deformities will resolve spontaneously without treatment. Less than 5 percent of children will have a severe residual deformity at follow-up. Long-term foot problems — including fitting shoes — aren't common in adults. Be careful not to overtreat metatarsus adductus. On rare occasions, casting or special shoes might be required.

Dynamic forefoot adduction during walking is common in children up to age 24 months, due predominantly to increased activity in the abductor hallucis muscle. This dynamic great toe adduction occurs when balance and stability are improving. Spontaneous resolution — without treatment — is the norm. Surgery is rarely required.

Femoral Anteversion

At birth, the proximal femur is internally rotated an average of 40 degrees relative to the femoral shaft. As children approach age 8, anteversion diminishes to 10 to 15 degrees without treatment. As neonatal soft tissue contractures begin to resolve, the initial hip position of flexion and external rotation improves, and the thigh tends to internally rotate. As a result, intoeing due to retained neonatal femoral anteversion tends to become clinically evident as children begin to walk.

Children with femoral anteversion usually sit in the W position. Running is often characterized by a windmill motion of the legs, because of the internal rotation of the thigh during the swing phase of gait (the portion of the gait cycle when the foot is off the ground). Intoeing is most noticeable between the ages of 2 and 5 years and gradually improves thereafter, up to age 12, as anteversion spontaneously improves.

Few children with persistent femoral anteversion experience functional difficulties in adulthood. There's little evidence that femoral anteversion leads to hip arthritis. Some adolescents, however, might experience patellar pain or instability due to their increased internal hip rotation,

especially if they develop an associated tibial extorsion (miserable malalignment syndrome). Rarely, intoeing in children older than 10 years leads to significant functional problems and requires femoral derotational osteotomy surgery. Typically, such children have internal hip rotation of more than 70 degrees and anteversion of at least 45 degrees.

Tibial Torsion

The most common cause of intoeing in children 1 to 3 years old is internal tibial rotation. Parents of the majority of such children report that the children appear clumsy (fall and trip frequently). Parents often note that the children seem a bit bowlegged.

In most cases, tibial torsion is bilateral. If unilateral, it's more often noted on the left. Intrauterine molding is usually responsible. At birth, the average tibial internal rotation is 4 to 5 degrees (range -30 to +20 degrees). Spontaneous resolution occurs up to age 8 years. At maturity, the average bimalleolar axis allows 25 to 30 degrees of external rotation, and the thigh-foot axis allows 10 degrees of external rotation. Associated physiologic *genu varum* positioning is common, resolving when the child is about 24 months old.

Braces and Shoe Modifications

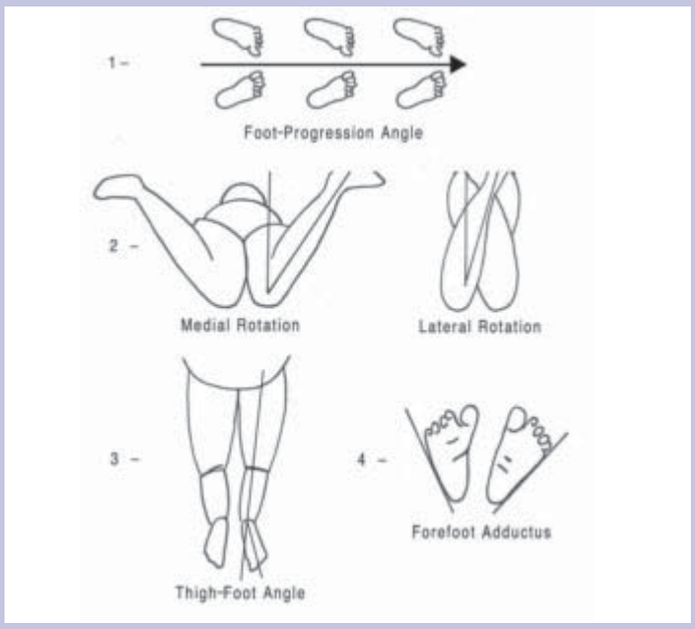
Historically, orthopaedic surgeons used straight-last shoes, attached to a bar with the shoes externally rotated, to attempt resolving tibial intorsion. There's little scientific evidence to support the use of these or other orthotic devices. Some research indicates that children treated with derotation devices during childhood may have lower self-esteem as adults. Similarly, there's no evidence that exercise or participation in specific sports helps resolve intoeing. Long-term disability is rare and, in fact, some evidence suggests that tibial intorsion improves a person's sprinting ability.

Because most cases of tibial intorsion resolve spontaneously, and because little long-term disability is created by persistent intoeing, treatment is rarely required. If an older child experiences significant functional difficulties because of this disorder, you might perform a tibial derotational osteotomy.

Outtoeing

Intoeing causes little functional difficulty in adults. Outtoeing, however, can be problematic because of tibial external rotation or excessive femoral retroversion, and it might be associated with more functional problems than intoeing is. Tibial external rotation might aggravate

Figure 2 **Rotational Profile**



Rotational Profile Helps Differentiate Conditions That Cause Intoeing

Measuring a child's rotational profile and comparing values with published normal values can differentiate conditions that cause intoeing and determine the level and severity of the problem. The rotational profile includes several measurements.

1) Foot progression angle (FPA) is the number of degrees the foot turns in or out relative to the direction of walking. Intoeing values have a minus sign preceding the number of degrees. Usually, mild intoeing is 0 to -10 degrees; moderate is -10 to -20 degrees; and severe is more than -30 degrees. When estimating the FPA, focus on one foot at a time, because the FPA will often change with each step.
2) Arc of hip rotation measures the arc of motion with the child in a prone position. Flex the knees to a right angle and rotate both thighs concurrently. Let the limbs fall to the level of maximum rotation without force. Measure both the medial and lateral rotation. When measuring lateral rotation, make sure the child's legs are crossed. Measure the maximum rotation at the vertical tibial angle. During childhood, the upper range of medial rotation is about 70 degrees for girls and 60 degrees for boys. Beware of asymmetric hip rotation, which is often a sign of hip disease.
3) Thigh-foot angle (TFA). This is a measure of tibial rotation. With the foot in resting position, estimate the angle by comparing the axis of the foot with that of the thigh. The TFA rotates more laterally with increasing age. Infants often have a minus value for TFA. Medial tibial torsion is present when a minus value during childhood or the teen years falls outside the normal range. The upper range of normal is about +30 degrees. Values beyond that level are abnormal and are described as lateral tibial torsion.
4) Foot. With the child in a prone position, the shape of the sole of the foot is easily assessed. Normally, the lateral border is straight. A convex lateral border indicates forefoot adductus.

patellar tracking problems. Both tibial external rotation and increased external hip rotation might result in reduced push-off power during walking and running. On occasion, formal gait analysis is necessary to evaluate such people, and surgical treatment might be necessary.

Summary

Torsional problems in childhood can cause significant concern for families. Careful attention to relevant medical histories and appropriate physical examinations usually let primary-care physicians identify the source of the concern. Physicians need to take family concerns seriously. An in-depth discussion – regarding the nature of the problem, its natural history, and the rare need to address torsional issues – usually reassures the family that observation is appropriate. Don't hurry through the exam or simply tell a family that the problem will get better. Offer to re-examine the patient should ongoing concerns exist, but don't have the child return in three to six months. Little will change during a short time.

Referral to a pediatric orthopaedist is appropriate if children experience functional difficulties because of their torsional abnormality and if they are old enough that the majority of spontaneous resolution has occurred. Also refer children whose deformities are asymmetric or causing pain.

Author's PROFILE

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Stephen Sundberg, M.D., specializes in pediatric orthopaedics at Gillette Children's Specialty Healthcare in St. Paul, Minn. He graduated from the University of Minnesota Medical School and completed an orthopaedic residency at Mayo Clinic in Rochester, Minn. Sundberg completed a pediatric orthopaedic fellowship at Adelaide Children's Hospital in Adelaide, Australia. He began working at Gillette in 1986, is a member of Pediatric Orthopaedic Associates and is certified by the American Board of Orthopaedics.

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Burnsville Clinic Open

Gillette Children's Specialty Healthcare opened a new outpatient clinic in Burnsville, Minn., a Twin Cities south-metro suburb, in June. The clinic offers evaluations and treatment for children and teens who have cerebral palsy, torticollis, cleft lip and palate, speech and motor delays, orthopaedic conditions, neurological conditions and other complex medical needs.

Burnsville patients have access to a rehabilitation center and various ancillary services, including assistive-technology, casting, radiology, psychology and spasticity-evaluation clinics.

The following physicians provide care at our Burnsville location:
James Gage, M.D., pediatric orthopaedic surgeon
John Garcia., M.D., sleep disorder specialist
Mark Gormley Jr., M.D., pediatric rehabilitation medicine specialist
Shalene Kennedy, M.D., pediatric psychiatrist
Steven Koop, M.D., pediatric orthopaedic surgeon
Betty Ong, M.D., pediatric neurologist
Michael Partington, M.D., pediatric neurosurgeon
Joseph Petronio, M.D., pediatric neurosurgeon
Stephen Sundberg, M.D., pediatric orthopaedic surgeon
Beverly Wical, M.D., pediatric neurologist
Robert Wood, M.D., craniofacial surgeon
Deborah Quanbeck, M.D., pediatric orthopaedic surgeon

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Admitting	651-229-3944
Center for Cerebral Palsy	651-290-8712
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Center for Pediatric Rheumatology	651-229-3914
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