



## In-Toeing Is Often a Primary Care Orthopedic Condition

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**Objective** To evaluate in-toeing consults to a pediatric orthopedic clinic to determine the proportion that could be managed by a primary care physician.

**Study design** A prospective registry was created for 143 consecutive children referred to a pediatric orthopedic clinic for “in-toeing.” Each patient underwent a careful history and physical examination, which included a rotational profile. We recorded the final diagnosis, treatment offered, follow-up visit results, and the source of the referral.

**Results** After pediatric orthopedic evaluation, 85% of patients had a confirmed diagnosis of in-toeing, and 15% had a different final diagnosis. Seventy-four percent of patients had 1 consultation visit, 18% had 2, and 8% had >2 visits. None of the referred patients was a candidate for treatment by casting or surgery.

**Conclusion** In most cases, in-toeing is a normal variation of development that can be managed by counseling and observation by the primary care physician alone. Rare cases of severe in-toeing >2 standard deviations from the mean should likely still prompt referral to a pediatric orthopedic surgeon for potential intervention. (*J Pediatr* 2016;177:297-301).

“In-toeing” constitutes a group of diagnoses that pediatricians commonly refer to pediatric orthopedic surgeons for a second opinion.<sup>1-3</sup> The American Academy of Pediatrics (AAP) has developed a set of guidelines for referral to pediatric surgical subspecialists.<sup>4,5</sup> Although the guidelines specify many instances for which a limb deformity should be referred, most cases of in-toeing are not among these diagnoses.<sup>4,5</sup> However, lack of inclusion in a “should be referred” list does not imply that other concerns should not be referred. Two years after the guidelines were published, 1 in 4 referrals to the pediatric orthopedic surgeon were for an in-toeing diagnosis.<sup>1</sup>

In-toeing is a general term that refers to  $\geq 1$  of 3 conditions: femoral anteversion, internal tibial torsion, and metatarsus adductus.<sup>3</sup> The extensive study of in-toeing shows that most cases resolve spontaneously without treatment.<sup>6,7</sup> Very often, the perceived abnormality is a variation of normal lower limb development.<sup>8</sup> Even in children for whom in-toeing resolves incompletely, no functional or other untoward sequelae usually result.<sup>7,9,10</sup> One study has even suggested that internal tibial torsion may confer an advantage to running athletes.<sup>11</sup>

Children with in-toeing often present to a physician because of a parental concern about falls, the child’s future ability to participate in sports, cosmetic appearance, or the perception of others. The historical but now discontinued treatment for these rotational deformities has been bracing, corrective footwear, and other mechanical devices.<sup>6</sup> The difference between historical treatments and current recommendations can place young parents between their older relatives and well-read pediatricians.

To our knowledge, the prevalence of children referred for in-toeing indicated for active treatment in the United States has not been examined since the guidelines for referral to the pediatric surgical specialist were published in 2002.<sup>3,12-16</sup> In Scotland, Blackmur et al<sup>2</sup> reported in 2010 that 3% of patients with in-toeing referred to the pediatric orthopedic surgeon were indicated for active treatment. Children treated included 4 referred to physical therapy, 1 referred for orthotics, and 1 recommended for diet and weight loss counseling. No case was indicated for surgery. The purpose of the current study is to review in-toeing consults in the current era and to identify the proportions among whom follow-up and treatment are indicated, referral and final diagnosis differ, and management could be performed by a primary care physician. A discussion of the important terminology, history, physical examination, and indications for referral to the pediatric orthopedic surgeon are also presented to support the pediatrician’s role in the management of the patient with in-toeing.

### Methods

The College of Medicine Institutional Review Board approved this study. A prospective registry was created for 143 consecutive patients referred to the pediatric orthopedic clinic with the complaint of “in-toeing” or “feet turning in.” The patients were identified by the nurse manager of the pediatric orthopedic clinic who flagged the chart for review. We recorded the

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**Table.** Physical examination rotational profile of the study sample

	Mean	Range
Foot progression angle	-16.5°	-35°-0°
Thigh-foot angle	-14.4°	-30°-0°
Hip external rotation	43.3°	15°-80°
Hip internal rotation	67.5°	20°-90°

Negative angles indicate in-toeing as applied to the foot progression angle and the thigh-foot angle.

final diagnoses, treatment offered, follow-up visit results, and the source of the referral. Active treatment was defined as casting for rigid metatarsus adductus in infants and surgical intervention (rotational osteotomy) for internal tibial torsion or femoral anteversion. Bracing was not considered as active treatment. Each patient underwent a careful history and physical examination to exclude neurologic disorders, osseous malformations, or inflammatory conditions. A rotational profile was documented for each child. At each visit, an explanation of the natural history of the disorder and a handout about the disorder was provided to the child's parents or guardian. For some parents/guardians displaying overabundant anxiety, a follow-up evaluation was arranged for family reassurance and to minimize detrimental patient satisfaction scores. Descriptive statistics were performed.

## Results

After pediatric orthopedic evaluation, 121 of 143 patients (85%) referred were confirmed with a diagnosis of in-toeing. Of those patients with a final diagnosis of in-toeing, 23 (19%) demonstrated femoral anteversion, 61 (50%) demonstrated internal tibial torsion, 12 (10%) demonstrated metatarsus adductus, and 25 (21%) demonstrated a combination of these 3 diagnoses. Of the 22 patients (15%) with a final diagnosis other than in-toeing, 12 (55%) had flexible flat feet, 2 had physiologic genu varum, 3 had tight heel cords and cerebral palsy, 1 had hallux valgus, and 4 had normal examinations.

The average age was 3.8 years (median, 2.5; range, 2 months-13 years), with a 25th percentile of 1.6 years, and a 75th percentile of 5.0 years. Eighty-five patients (59%) were female and 58 (41%) were male. One hundred twenty-six referrals (88%) were from primary care physicians, 9 (6%) were from a general orthopedic surgeon seeking a second opinion, and 8 (6%) were self-referred. The rotational profile of all patients reviewed is in the **Table**. Among the patients referred, 106 (74%) were discharged from care after the initial consultation, 26 (18%) were discharged from care after the first follow-up visit, and 11 (8%) had >2 visits. No patient had in-toeing that was indicated for treatment by casting or surgery.

## Discussion

Our data reinforce that in-toeing is most often a set of benign conditions that rarely require treatment beyond education,

reassurance, and the offer of follow-up visits. Despite the knowledge that management of in-toeing is largely observational, no specific guidelines exist to help primary care physicians decide when referral to a pediatric orthopedic surgeon is necessary.

The AAP guidelines for referral to surgical specialists include “infants with malformations of the limbs (eg, idiopathic club-foot, congenital limb deficiency),” “children and adolescents with significant limb deformity secondary to metabolic bone disease or other types of growth arrest or with significant limb length discrepancy,” and “infants, children, and adolescents with disability, deformity, or gait abnormality secondary to neuromuscular conditions (eg, cerebral palsy, spina bifida, muscular dystrophy, spinal muscular atrophy).”<sup>5</sup> In-toeing in an otherwise healthy child does not fall into any of these categories, and therein lies the challenge for many primary care providers.

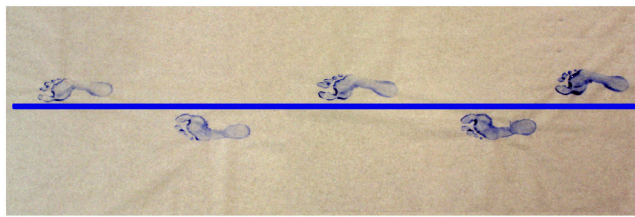
Studies have found that pediatrics residents often rate their comfort in managing musculoskeletal problems lower than all other areas of pediatric medicine.<sup>17</sup> Because no clear guidelines for in-toeing referral exist and parents are often overly concerned, pediatricians may feel unable to provide complete reassurance. In this setting, referrals for in-toeing are completely understandable and appropriate. However, in-toeing is a concern managed best by primary care physicians. As such, the vast majority of in-toeing cases should be overseen by the primary care physician and not referred to a pediatric orthopedic surgeon.

Considering the large number of pediatric orthopedic referrals and the shortage of pediatric orthopedic resources, steps should be taken to assist pediatricians in managing cases of in-toeing for which referral is unnecessary.<sup>18</sup> Pediatricians are uniquely equipped to provide education, reassurance, and follow-up on in-toeing over time, thus saving referrals for the most challenging cases. We suggest that the AAP develop unambiguous guidelines regarding in-toeing.

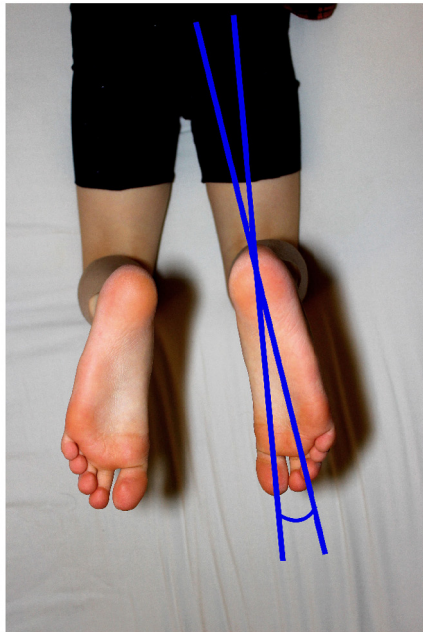
Based on the current study and review of the literature, we present here a brief, practical guide to pediatricians and family practice physicians for the assessment of in-toeing, indications for referral to the pediatric orthopedic surgeon, and/or indications for a radiographic study. The history of in-toeing is typically one when the patient presents as young child after parents or other caregivers observe physical deformity or clumsiness. As noted, parents are often concerned about falls, future ability to participate in sports, cosmetic appearance, and the perception of others. Young parents may feel pressured to seek medical advice at the urging of older friends and relatives who remember now discounted interventions such as “Forrest Gump braces.”

Metatarsus adductus is most common from birth to 1 year, increased tibial torsion from ages 1-3 years, and increased femoral anteversion after 3 years of age.<sup>8</sup> Physical examination should include a rotational profile from hip to toes composed of 4 measurements. These measurements include foot progression angle, thigh-foot angle, and hip internal/external rotation.

Metatarsus adductus describes a deformity in which the toes and forefoot are deviated medially to the expected midline of the foot. This deformity is thought to be due to intrauterine positioning and can be associated with mild hindfoot valgus.<sup>3,8</sup>



A



B

**Figure 1.** **A**, Normal foot progression angle and a normal gait. The foot progression angle is formed between the long axis of the foot and the path of motion as the child walks in a straight line. **B**, The thigh-foot angle is formed between the long axes of the foot and the femur as observed with the child prone on the examination table, one knee flexed to 90°, with the examiner looking down the long axis of the tibia.

The heel cord is not tight in metatarsus adductus, which differentiates this condition from clubfoot.<sup>19</sup> The deformity can be flexible or rigid. A flexible deformity can be passively corrected by stretching. The physical examination should include the foot progression angle (**Figure 1**, A). Normal values range from  $-3^{\circ}$ - $20^{\circ}$  with negative angles deviating to the midline and positive angles pointing away from the midline.<sup>7</sup> Metatarsus adductus typically resolves during the first year of life. Referral to a pediatric orthopedic surgeon should be made in the setting of rigid deformity.<sup>8</sup> In this case, the disorder is treated with early casting with 95% success.<sup>15</sup> Surgery is reserved for children with severe rigid deformities who fail casting.<sup>20</sup> In the current study, no case required casting or surgery. Metatarsus adductus is not associated with osteoarthritis in adulthood.<sup>3</sup> Radiographs for metatarsus adductus are rarely indicated.<sup>8</sup>

Internal tibial torsion is defined as an internal rotation of the tibia. Internal tibial torsion can result from intrauterine positioning or crowding.<sup>3,6,8</sup> Children are generally born with



**Figure 2.** “W-sitting” occurs with increased femoral anteversion.

$5^{\circ}$  of internal tibial rotation that gradually rotates to the adult  $10^{\circ}$  of external rotation of by 8 years of age.<sup>8</sup> An abnormally rotated tibia is typically observed around 2 years of age and corrects by 4 years of age.<sup>8</sup> The examination should focus on the thigh-foot angle (**Figure 1**, B) and foot progression angle. Normal thigh-foot angle values range from  $-5^{\circ}$ - $30^{\circ}$  with negative angles deviating to the midline and positive angles pointing away from the midline.<sup>7</sup> In the setting of a thigh foot angle of  $<-10^{\circ}$  that fails to correct by 8 years of age, a referral to a pediatric orthopedic surgeon should be made and radiographs should be considered.<sup>7,8</sup> Pain, asymmetry, unequal leg lengths, and unrelenting parental overconcern despite appropriate counseling by the pediatrician are also indications for referral. Osteotomy is indicated in rare cases of severe persistent tibial torsion, as measured by a thigh foot angle of  $<-15^{\circ}$ , after 8 years of age that causes functional difficulty.<sup>2,8,20</sup> In the current study, no case required surgery. Internal tibial torsion is not a risk factor for osteoarthritis.<sup>2,8,21</sup>

Femoral anteversion is defined as internal rotation of the shaft of the femur. As with tibial torsion, the femur naturally rotates during development. At birth, normal anteversion is  $30^{\circ}$ - $40^{\circ}$  with a gradual derotation to  $15^{\circ}$  by maturity.<sup>7,8</sup> Increased internal femoral anteversion is typically observed in 3-6-year-old children and resolves by 8 years of age.<sup>8</sup> Classically, parents report that their child prefers to sit with their legs internally rotated in the “W” position rather than “cross-legged” (**Figure 2**).<sup>8</sup> The physical examination should focus on hip internal and external rotation (**Figure 3**). Internal rotation of  $30^{\circ}$ - $60^{\circ}$  is considered normal and external rotation from  $30^{\circ}$ - $60^{\circ}$  is considered normal.<sup>7,8</sup> In the setting of excessive femoral anteversion, as assessed with a hip range of motion  $>80^{\circ}$  of internal rotation that persists after 10 years of age, a referral to a pediatric orthopedic surgeon should be made and



**Figure 3.** Rotation is examined with the child prone on the examination table with the knees held together and flexed to approximately 90°. In each instance, the angle of each tibia is measured relative to neutral (a line perpendicular to the examination table). **A**, To measure hip internal rotation, the feet are moved from midline until the end of the comfortable range of motion is reached. This image shows 80° of internal rotation. **B**, To measure hip external rotation, the feet are moved across the midline such that the shins cross until the end of the comfortable range of motion is reached. The image shows 20° of external rotation.

radiographs should be considered.<sup>3,7,8</sup> Pain and asymmetry are also indications for referral. Osteotomy is indicated in rare cases of severe persistent femoral anteversion after 8 years of age that causes functional difficulty such as excessive tripping.<sup>8</sup> In the current study, no case required surgery. To our knowledge, no studies have been performed that show increased femoral anteversion leads to an increased risk of osteoarthritis.

Limitations of the present study include a study sample that is a product of sequential referrals. This group may not represent the typical patient who presents to a primary care physician. In addition, this study is cross-sectional in nature and the sample is relatively young and may return at an older age with indications for treatment.

Overall, most cases of in-toeing are a normal variation of development for in which counseling and patient observation is the appropriate intervention. Almost all cases of in-toeing can be managed by the primary care physician alone. Although there are many historical treatments, such as bracing and special footwear, evidence-based literature does not support these measures.

Any surgical correction for in-toeing procedures should be approached with caution owing to the high rates of complication such as avascular necrosis, osteomyelitis, and overcorrection.<sup>2,22-24</sup> Intervention for in-toeing is rare and in the present study no child required casting or surgery. We recommend that the AAP develop unambiguous guidelines for referral for in-toeing. ■

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