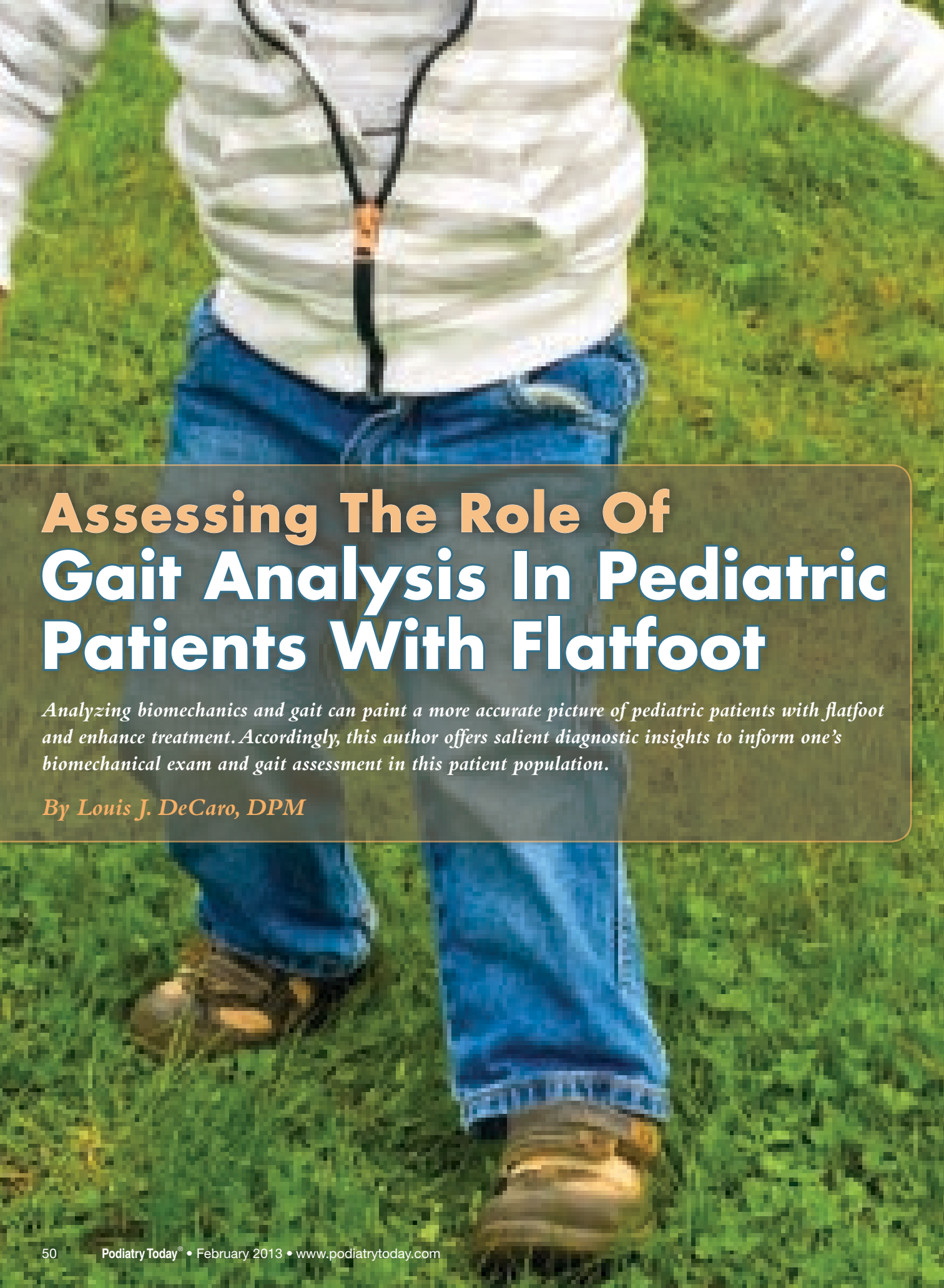

Assessing The Role Of Gait Analysis In Pediatric Patients With Flatfoot

Analyzing biomechanics and gait can paint a more accurate picture of pediatric patients with flatfoot and enhance treatment. Accordingly, this author offers salient diagnostic insights to inform one's biomechanical exam and gait assessment in this patient population.

By Louis J. DeCaro, DPM

The identification and successful treatment of the pediatric flatfoot at an early age is of utmost importance in 21st century podopediatrics. My personal podiatric mantra is "prevention begets correction." A majority of the patients in my private practice — and I expect in yours as well — are seeking treatment not only for "foot problems" but for associated ankle, knee, hip and back pain/dysfunction. It is for this reason that I spend a considerable amount of time with each patient educating him or her about their feet and the foot's influence on the entire kinetic chain.

Let's take some time to review not only the essentials of age-specific treatments of podopediatric flat feet but the numerous varieties of flat feet that exist in our pediatric patient population.

Identification of a patient's "foot type," coupled with successful orthotic intervention, can mitigate or eliminate many orthopedic conditions that would otherwise affect patients throughout their lives. It is important to keep in mind that children are often asymptomatic despite poor foot mechanics. However, this does not mean that the dysfunction should go untreated. Pain should not be the sole indicator of intervention with children. It is paramount that we understand the impact of poor foot biomechanics and proper growth and development.

A Closer Look At The Major Flatfoot Types

I can attest to the fact that there are six major foot types (six variations of "normal") that occur in the general population (see http://www.decaropodiatry.com/). Two of these six are typically defined as "flat feet," the "bread and butter" of a podiatrist's practice. These two foot types are referred to as the "D and F" foot types. Let us begin with a review of these two common varieties of flat feet and their impact on the kinetic chain.

The D foot type, or what we politely refer to as the "Fred Flintstone" foot, is the wide, splayed flatfoot variety. It is the result of a compensated rearfoot varus in which the subtalar joint allows the heel to evert/pronate to a vertical alignment that facilitates unlocking of the midtarsal joint. The hypermobility of this foot type leads to numerous conditions of the foot (think of this foot as a "loose bag of bones").

The D foot type is the result of a compensated rearfoot varus in which the subtalar joint allows the heel to evert/pronate to a vertical alignment that facilitates unlocking of the midtarsal joint.

The F foot is the classic pes planovalgus foot type. It is the combination of a compensated rearfoot (like the D) coupled with a forefoot varus/supinatus.

As the heel everts, the midtarsal joints unlock, leading to peroneal insufficiency and first ray instability. Propulsion then transfers to the second and third metatarsals with associated reversal of the transverse metatarsal arch. The loss of the first ray inclination angle results in an impaired windlass mechanism and may lead to hallux limitus/rigidus. Continuing "up the chain," the rearfoot pro-

Photo courtesy of Laurence DiDomenico, DPM

This X-ray shows pediatric flatfoot. Naturally occurring hypermobile flat feet result in instability, poor trunk strength and stability, and a resultant sedentary lifestyle.

nation leads to excessive internal tibial rotation and knee flexion.

Typical conditions that can arise from this foot type are plantar fasciitis, callusing beneath the second and third metatarsal heads, hallux limitus, metatarsalgia and patellofemoral pain. The gait cycle is dominated by hypermobility as the foot typically remains unlocked through most of the stance phase and often fails to become that rigid lever in the propulsive phase of gait. This hypermobility leads to muscular overuse, fatigue, low endurance and poor core trunk strength.

The F foot is the classic pes planovalgus foot type. It is the combination of a compensated rearfoot (like the D type) coupled with a forefoot varus/supinatus. The name of the game in gait is that we will attempt to load the medial column at all costs no matter how the foot hits the floor. At foot flat, the heel has already everted to vertical (compensated rearfoot), unlocking the midtarsal joint. In this case, however, pronation continues through midstance and into propulsion as further pronation is required to compensate for the forefoot varus. Pronation will continue until the medial column loads. Accordingly, this foot type typically remains unlocked throughout the stance phase and into propulsion.

The abducted forefoot (abductory twist), as a result of the forefoot varus/supinatus, lends to the severity of this "deformity." The resultant posterior tibial tendon dysfunction often necessitates surgical procedures such as triple arthrodesis and ankle fusions. Conditions in this foot may be similar to those of the D quad but may also include tarsal tunnel syndrome, subfibular impingement and neuromas. The progression angle of gait often appears "toe out" but that is often an illusion. Limb alignment from the hip is often neutral to mild toe out but the forefoot abduction creates an illusion of a larger toe out gait (abductory twist).

Getting A Clearer Clinical Picture Of The Pediatric Patient

Now that we have reviewed the two major flatfoot types, let us talk about how we can incorporate this information into our age-specific analysis of the typical flatfooted podopediatric patient.

One of the first questions I ask my pediatric patients (and their parents) is "What sports do you like to play?" Not playing sports or a lack of enjoyment of sports/physical activity is a red flag. Have the patients always been inactive? Is it because they are slower than or not as coordinated as their peers? Are they self-conscious because of how they run or how poorly they compete? I feel a lot of choices these children make regarding athletics and other physical activities are a direct result of their underlying foot types. You will be surprised. Take the time to talk to your pediatric patients about the things they like to do (or do not like to do). You will start to see patterns.

There have been a few studies indicating an abnormally high percentage of flatfooted children who are overweight, showing a correlation between arch height and childhood obesity.[1-3] I personally do not believe that obesity in children causes flat feet but the other way around. Naturally occurring hypermobile flat feet result in instability, poor trunk strength and stability, and a resultant sedentary lifestyle.

There are several things to consider when treating biomechanical issues of the foot, regardless of the patient's age. First, we need to understand the normal ranges of rearfoot and forefoot varus/valgus from infancy through adulthood. Forefoot varus is traditionally not something we treat until children are at least 6 to 7 years of age. It is necessary to allow the forefoot to derotate and encourage a proper inclination angle of the first ray so one does not typically use extrinsic forefoot posting at this young age.

Identification of a significant forefoot varus in young children is important. However, we are not necessarily treating it but just monitoring the condition. The general rule of forefoot varus is that the child loses about 2 degrees of forefoot varus every year up until about the age of 6. At birth, if you were able to measure it, 12 to 15 degrees of forefoot varus is average with derotation of the varus ideally completed by the age of 6 or 7. Compensation for a forefoot varus requires calcaneal eversion beyond vertical. Forefoot varus conditions are very destructive at an early age and result in severe hyperpronation. Any residual forefoot varus after the age of 7 or 8 may need specific orthotic correction/posting, either intrinsic or extrinsic.

In regard to rearfoot alignment, normal development begins with a typical 1-year-old child having about 6 degrees of calcaneal eversion. Calcaneal eversion should resolve by approximately 1 degree every year up until about the age of 7. A 2-year-old should have about 5 degrees of eversion, a 3-year-old has 4 degrees, etc. By the age of 6 or 7, the child should have a fairly neutral foot alignment with the calcaneus close to vertical. Any calcaneal alignment deviating by 4 degrees or more from vertical at this age may be a significant problem and one should treat it.

Muscle strength and function can be compromised based on foot type. Hypermobile flat feet are perpetually mobile adaptors and are typically unable to lock the midtarsal joint in a timely fashion to

prepare for the propulsive phase of gait. This unstable foundation makes it very challenging to develop lower extremity stability and, in turn, core trunk strength. Just imagine walking barefoot in the soft sand of a beach all day. It takes a lot of work and is rather exhausting.

We also need to keep in mind the genetic component of foot types. We can inherit our underlying foot structure much like we may inherit our eye and hair color among other things. When treating pediatric patients, question the parents about their feet, siblings' feet, grandparents' feet, etc. It should be of no surprise to see patterns quickly develop. This always leads to more referrals.

Postural assessment above the foot is no less important than the actual foot assessment. We would be doing a disservice to our patients if we did not pay close attention to the upper kinetic chain. We need to understand the difference between structural and functional asymmetries, functional versus structural leg length discrepancies, and recognizing how the foot type can affect a patient's center of gravity. As we all know, there are many factors to consider when assessing leg length such as pelvic obliquities/torsions, scoliosis, foot disparities, etc. I am a firm believer that as much as 80 percent of limb length disparities are functional, not structural.

Dispensing a heel lift should take careful consideration, particularly if a foot disparity is present. Equalizing the feet from left to right with foot orthoses as well as physical therapy to address muscle imbalances will often reduce or correct most "apparent" limb length disparities. When I do dispense a heel lift with foot orthoses, I usually provide it as a detached heel lift so patients may easily remove it from shoes.

A Protocol For First-Time Evaluation Of The Pediatric Patient

Accordingly, when evaluating a patient for the first time, there are several factors one needs to examine. First, I obtain an extensive patient history. I find out about the patient's medical history, family history, chief podiatric complaints, interests/activities and his or her overall well-being.

Then I perform my biomechanical foot evaluation. I take my rearfoot and forefoot measurements (rearfoot varus, forefoot varus or valgus) with the patient in a prone position. I also observe the feet while they hang down from the examining chair. In addition, I notate callus patterns, bunions and other toe deformities, muscular tightness, etc. I then have the patient stand for me. It is important to have patients march in place for a moment and have them relax in their natural stance.

I will then perform an overall postural assessment from head to toe, first looking for obvious asymmetries and then subtle ones. I notice the alignment of the knees and hips. Are they in alignment with each other or rotated differently? Are the hips and pelvis equal in height? Are the shoulders even in height? Is one knee more flexed than the other? Is one foot turned in or out more than the other? Are the arch heights similar? Are there orthopedic differences that are noticeable (i.e., a bunion on one foot but not the other)? I ask the patient specific questions based on what I am seeing. For example, I may ask if anyone has ever told the patient he has a limb length discrepancy or if one knee or hip bothers him more.

Then I finally ask the patient to walk down a hallway for me. I have patients do this several times as I observe their hips, knees, ankles and feet, and how they are aligned with each other during the gait cycle. I look for heel whipping or circumduction. I try to notice any differences in the gait from the left side versus the right. When I tie all of this together, I determine the patient's foot type and can begin to predict future problems. This is when I often learn of orthopedic problems that run in the family, even though I have tried to elicit this information previously.

When Emphasizing Patient Education Leads To Referrals

Once I have determined the patient has flat feet, whether he or she has the D or F foot type, the education begins. I spend a considerable amount of time during the visit educating the patient and family about the foot type and the impact on the body. I inquire about family, including parents, siblings, children and grandchildren if appropriate, etc. I typically demonstrate an exaggerated version of the patient's gait so the parents may understand how the child is walking and how this relates to his or her symptoms or dysfunction.

Typically, parents and older pediatric patients are more than pleased as they have gotten more than they bargained for. They have had evaluation and treatment but also a thorough education on their foot type, its impact on their lives and where to go to learn more about their foot type.

Keep in mind that older patients you are treating surgically and non-surgically with foot orthoses often have offspring. You have to start thinking about them. It is amazing how appreciative patients will be because you ask about their children and/or grandchildren. They will gladly bring them in for a screening. ■

Dr. DeCaro specializes in pediatrics with a special interest in sports medicine and biomechanics for both adults and pediatrics. He is the Vice President of the American College of Foot and Ankle Pediatrics. Dr. DeCaro is currently in private practice with an office in West Hatfield, Mass. He is a member of the surgical and medical staff at Franklin Medical Center and Holyoke Hospital in Holyoke, Mass. Dr. DeCaro is the Director and originator of the biweekly Adult Gait Labs Biomechanics Clinic and directs a weekly Lower Extremity Podo-Orthopedic Clinic.

The author offers special thanks to Joe Coletta, CPed, and Kay Brooke-Willbanks, PMA, for their contributions.

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Editor's note: For related articles, see "How To Address Conditions That Affect Pediatric Gait" in the October 2007 issue of Podiatry Today, "Key Insights On Assessing Pediatric Gait" in the June 2009 issue, "Pediatric Flatfoot: When Do You Treat It?" in the January 2012 issue and the June 2010 DPM Blog "Why Treating Equinus Is The Key To Treating Pediatric Flatfoot."

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