Summer 2016

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ACFAP Quarterly

American College of Foot and Ankle Pediatrics

American College of Foot and Ankle Pediatrics

The American College of Foot & Ankle Pediatrics is excited and proud to announce its 3rd Annual ACFAP Pediatric Foot & Ankle Seminar. The Seminar will take place at Atlantic Oceanside Hotel & Conference Center in Bar Harbor, Maine on June 8-10, 2017.

This CME event will feature leading authorities on pediatric foot & ankle conditions. It will cover topics ranging from pediatric H&P, flatfoot, equinus, sports medicine, surgery, and rotational conditions. The meeting will be preceded on Thursday June 8 by a one day national park excursion.

Featured at this meeting will be spectacular Acadia National Park.

At the Conclusion of this meeting, the attendee shall be able to:

- Develop effective Protocols for treating the pediatric patient.
- Effectively evaluate surgical vs. non-surgical options for many common Pediatric foot & ankle pathologies.
- Improve patient outcomes in the pediatric patient for common conditions such as flatfeet, juvenile HAV, and Equinus.

For Conference details or to register online: please go to acfap.org/events.html

Approved for 11.75 CE Contact Hours

No commercial interest provided financial support for this continuing education activity

Lecture Schedule

Friday June 9

7:00-7:45 am	**Registration, Breakfast & Visit Exhibitors**
7:45-8:00 am	**Louis J. DeCaro, DPM** Welcome Address
8:00-8:35 am	**Louis J. DeCaro, DPM** Pediatric Foot Typing
8:35-9:10 am	**Paul Dayton, DPM** Juvenile HAV & Other Common Surgical Procedures for the Child
9:10-9:45 am	**Frank Santopietro, DPM** How the Foot Affects the Knee and Hip
9:45-10:20 am	**Russell Volpe, DPM** Pediatric Precursors of Posterior Tibial Dysfunction
10:20-10:50 am	**Visit Exhibitors**
10:50-11:25 am	**Patrick Agnew, DPM** Mettatarsus Adductus
11:25-12:00 pm	**Ed Harris, DPM** Polydactyly
12:00-12:35 pm	**Tracey Vlahovic, DPM** Plantar Warts, Onychomycosis , Ingrowns, Dermatology in Children
12:35-1:30 pm	**Lunch & Visit Exhibitors**
1:30-2:05 pm	**Nicholas Bolognini, DPM** The Clubfoot

Lecture Schedule (cont.)

Friday June 9 (cont.)

2:05-2:40 pm	**Patrick Deheer, DPM** The importance of Equinus in the Pediatric Foot
2:40-3:15 pm	**Jason Miller, DPM** Sports Injuries (Traveling Child) - Injuries Normally in Adults, Now in Kids
3:15-3:50 pm	**John Grady, DPM** Pediatric Sports Fractures
3:50-4:20 pm	**Break & Visit Exhibitors**
4:20-4:55 pm	**Marc Benard, DPM** Tendon Transfers Relative to Gait & Biomechanics
4:55-5:55 pm	**Patrick Deheer, DPM, Michael Graham, DPM & Panel** The Great Flatfoot Debate
5:55-6:35 pm	**All Speakers** Q&A

Not an ACFAP Member?

Becoming a member of ACFAP for $150 instantly saves $150 off the conference registration fee

Go to acfap.org/membership.html

Lecture Schedule (cont.)

Saturday June 10

7:00-7:45 am	**Breakfast & Visit Exhibitors**
7:45-8:45 am	**Jason Kraus, DPM** The Uniqueness of Treating The Child
8:45-9:45 am	**Louis J. DeCaro, DPM & Panel** Pediatric Practice Management
9:45-10:15 am	**Visit Exhibitors**
10:15-11:00 am	**Matt Werd, DPM & Panel** Taping of the Pediatric Athlete (Workshop)
11:00-11:45 am	**Nicholas Bolognini, DPM & Panel** Ponsetti Casting (Workshop)
11:45-12:30 pm	**Nick Pagano, DPM & Panel** Measuring the Child (Workshop)
12:30-1:30 pm	**Lunch & Visit Exhibitors**

This conference is intended for podiatric physicians and other medical specialties dealing with the pediatric lower extremity. No prerequisite levels of skill, knowledge, or experience required of learners.

This activity has been planned and implemented in accordance with the standards and requirements for approval of providers of continuing education in podiatric medicine through a joint provider agreement between the William L. Goldfarb Foundation as a provider of continuing education in podiatric medicine. The William L. Goldfarb Foundation has approved this activity for a maximum of 8 continuing education contact hours

In the event of cancellation ACFAP is unable to assume risk or responsability for the exhibitor's and/or registrants time or expenses should an act of God, government action, disaster, weather or other force beyond ACFAP's control make it inadvisable or impossible to conduct this event. The exhibitor and/or registrant may wish to consider purchasing personal travel insurance to insure their expenses.

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Presidents Message

My second year as president of ACFAP has been, once again, an exciting and rewarding experience. We have seen our paying membership triple (again), experienced significant corporate sponsorship growth, and recently completed our 2nd annual conference. As well, educational initiatives, such as a brand new website, corporate and membership resources, and school club support have strengthened our organization. Moving forward my promise to all of you is to not lose that momentum!

As you all know The American College of Foot & Ankle Pediatrics (ACFAP) hosted its Annual Conference at Tenaya Lodge, Yosemite National Park April 8-9, 2016. The conference featured a National Park outing combined with exceptional CME lectures.

I am extremely proud that once again approximately 100 podiatric physicians decided to join ACFAP in Yosemite. What they experienced was priceless: dedicated enthusiastic speakers, engaged attendees, supportive sponsors, and an overall sense of commitment to the advancement of pediatric foot and ankle education. I heard from so many of you at the meeting that the seminar was truly invaluable. The speaker surveys were virtually perfect with such positive and constructive suggestions for future conference topics. Vendors were also raving about their experience. In the weeks following, as word got out to other members, I received multiple emails from many of you (who didn't attend) "promising" not to miss next year's conference! Reading those responses was so gratifying.

I am NOW over the top excited to announce that we have secured a spot for ACFAP 2017 Annual Scientific Meeting. We are continuing the National Park "tradition" at the Atlantic Oceanside Resort, Acadia National Park, Bar Harbor, ME June 8-10 2017. Once again we will precede the meeting with a group outing in Acadia on the 8th. We have lined up a professional photographer who has conducted expeditions in Acadia over 20 times!

The scientific part of the conference will take place at Acadia National Park on Friday and Saturday June 9-10, 2017. This CME (11.75 CME's Proposed) event will feature leading authorities on pediatric foot and ankle conditions including Drs. Russel Volpe, Ed Harris, Tracey Vlahovic and many more! It will cover topics both conservative and surgical. As well the seminar will feature new and exciting panels and workshops. There will be a "Flatfoot Debate" consisting of a panel of docs representing surgical, orthotic, and conservative care point of views. Workshops and panels will include ponsetti casting, practice management, and how to guides to "measuring" the pediatric patient. Please go to our brand new website acfap.org for more information.

Each year the meeting is getting better and better. It really is the "Can't miss" meeting of the year!

Recently I had the honor of representing ACFAP at the World Congress of Podiatry Meeting, May 2016. Representing ACFAP and pediatric foot and ankle care on a world stage, in front of a "standing room only" crowd, was quite an honor. Upcoming, ACFAP will be present at APMA 2016 Annual Scientific Meeting (The National) in Philadelphia. We will have both a track as well as a booth. Please come visit the booth and bring your friends (who may not be members yet.)

I want to again welcome all past, future, and current members of the American College of Foot and Ankle pediatrics to this new era not only in this organization, but also in the education of pediatric foot and ankle medicine. Thank you to each and every one of you for making this all possible!

Louis J. DeCaro, DPM
President, ACFAP
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ACFAP
PODOPEDIATRICS
SEMINAR

June 8 - 10, 2017

ACFAP

American College of Foot and Ankle Pediatrics

is proud to present the

3rd Annual

ACFAP
INTERNATIONAL PEDIATRIC FOOT & ANKLE SEMINAR

to be held at

Acadia National Park
Atlantic Oceanside Hotel & Conference Center
Bar Harbor, ME

ACFAP Yosemite

2016 Conference

A New Look at Tibial Torsion: Measuring the Knee / Ankle Axis Relationship

Frank J. Santopietro, DPM

Many years ago as a young practitioner at Boston's Children's Hospital, I realized that my ability to properly evaluate leg torsion was flawed. After performing a full biomechanical exam on my patients including measuring the hip rotation, transmalleolar axis, and foot pronation and supination with accompanying adduction and abduction, I would calculate an expected angle of gait. My calculations did not correspond with the angle of gait I was observing.

The preferred method of measurement at that time to determine the relationship of the knee and ankle axes was to measure the transmalleolar axis and to align the tibial tubercle or femoral condyles to determine the ankle axis and the knee axis respectively. (Hazelwood et al. 2007, Lang and Volpe 1998, Ritter et al. 1976, Staheli and Engel 1972, Staheli et al. 1975). Using these methods the subsequent gait analysis did not correlate well with my exam. Obviously I needed to reevaluate my measuring technique to evaluate tibial torsion. The transmalleolar axis is defined by the two static boney structures on either side of the ankle. It does not necessarily dictate the axis of the ankle joint.

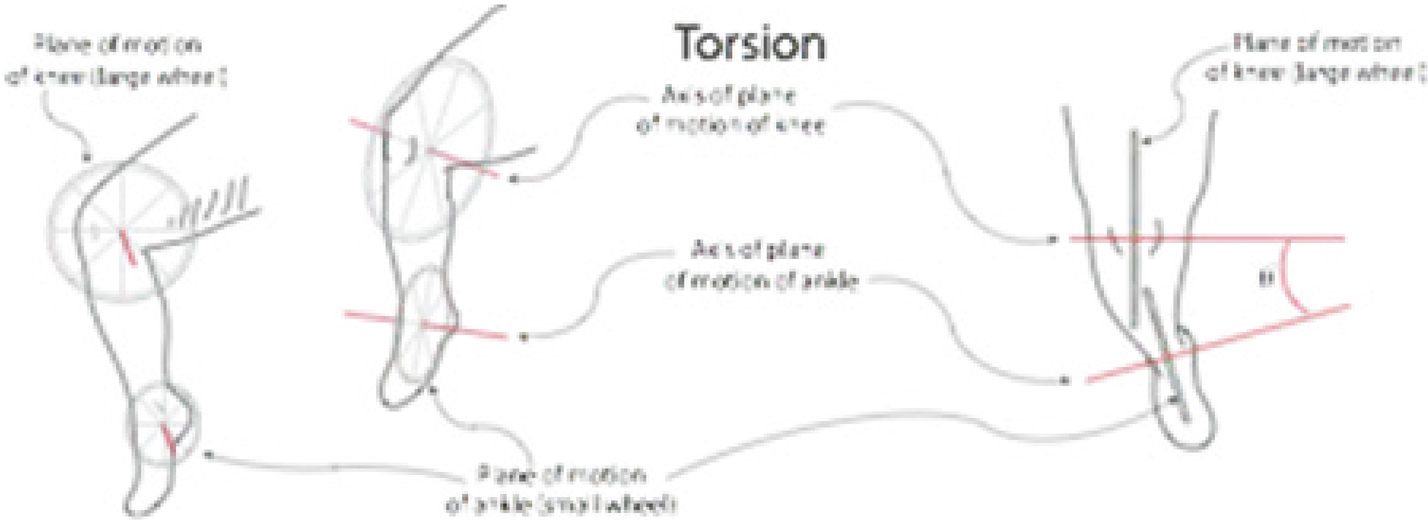
The real question is what are we trying to determine when we measure tibial torsion? From a clinical standpoint I am more interested in the direction the ankle joint is moving regardless of the relationship between the tibia or the tibial malleolus or fibula or fibular malleolus. So what I am really interested in is not tibial torsion, but how the knee joint and the ankle joint are moving relative to the entire lower extremity. Historically, torsion of the leg relative to the knee is measured by comparing the condyles of the femur or the tibial tubercle at the knee joint to the malleoli of the ankle joint (Hazelwood et al. 2007, Lang and Volpe 1998). The correlation is thought to be that the malleoli are about 18 to 23 degrees external to the axis of the knee joint which should place the ankle axis straight relative to the knee axis (Le Demany 1909). This in fact may sometimes be true but I have not found that relationship to be consistent. These methods do not directly measure a plane of motion, they only infer it.

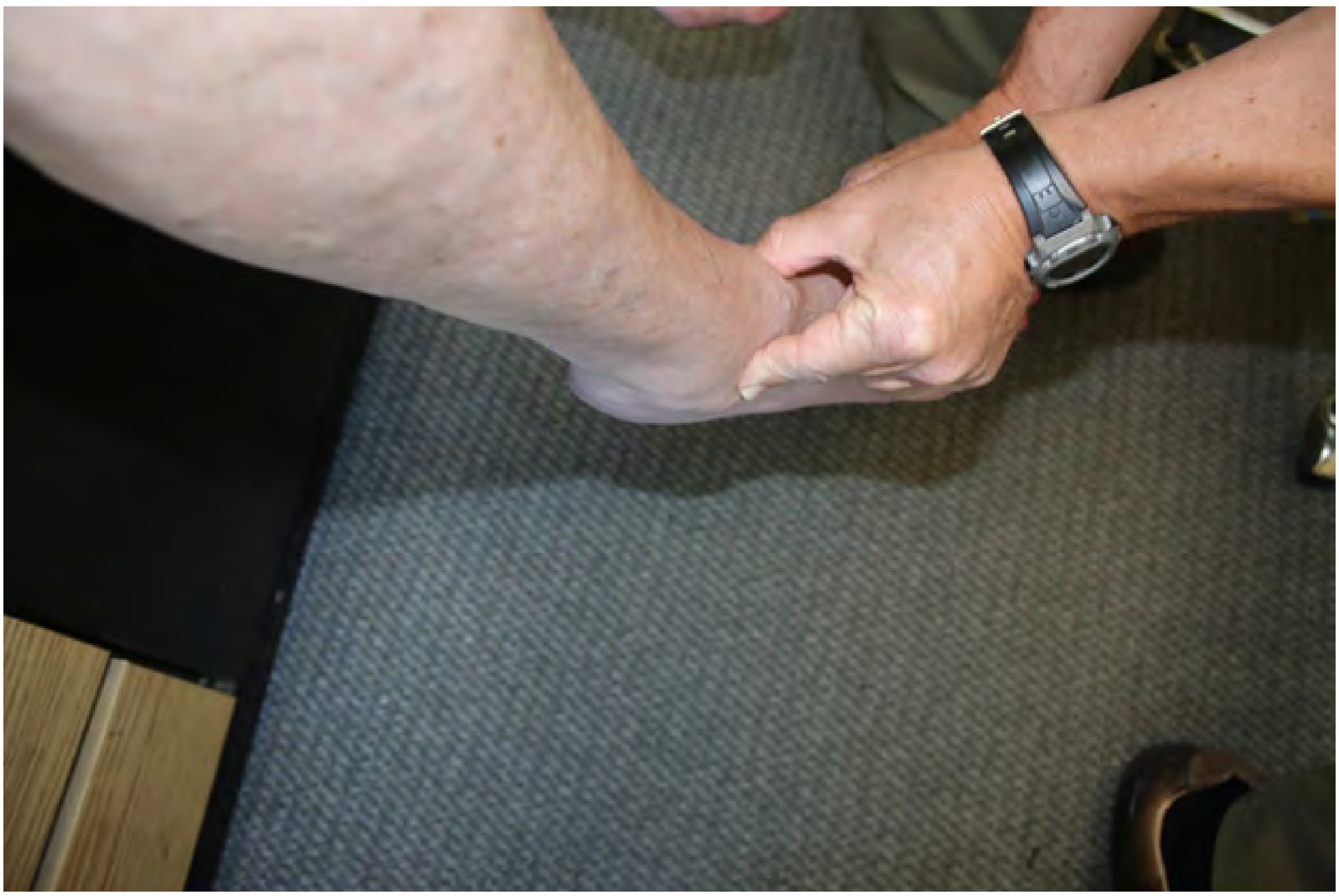
Other methods have been used to determine the axis of the ankle joint such as magnetic resonance imaging, computerized tomography and ultra sound, none of which use the actual motion of the joint to determine the axis (Lang and Volpe 1998, Milner et al. 1998). Most of these methods are not practical for everyday use in a clinical setting. When a child is in need of a corrective brace or cast it is necessary to be able to determine as accurately as possible what the knee to ankle axis relationship is and to measure its improvement with treatment.

Anatomy texts define the axis of a joint as the perpendicular to the plane of motion of a joint (Dorland 1974). The axle of a wheel is determined the same way. So rather than an indirect measurement of the joints, I prefer to move the joints through a range of motion, determine a plane of motion and take a line perpendicular to the plane of motion to calculate the axis of the joint. I refer to these planes of motion as the Knee Wheel and the Ankle Wheel.

With the patient sitting on the examining table facing the examiner, the knee joint is flexed and extended to full flexion and extension. The knee range of motion is determined by this flexion and extension and should be regarded as the Knee Wheel. The examiner can imagine extending the range of motion of the knee joint to a full circle, as is sometimes drawn in a cartoon character running. Once the plane of motion is visualized, a line perpendicular to it is marked by placing the arm of a goniometer along the knee axis or knee wheel axle. This wheel is then placed so the axle of the wheel (the axis of the joint) is parallel to the side of the table. With the patient still seated on the exam table, the practitioner moves the knee side to side by ADducting or ABducting the hip joint. This axis of the knee joint which is parallel to the examination table is now the benchmark for determining the Knee/Ankle Axis Relationship (KAAR).

Now that the knee joint axis is lined up with


Torsion
Plane of motion
of knee (large wheel)
Axis of plane
of motion of knee
Axis of plane
of motion of ankle
Plane of motion
of knee (large wheel)
Plane of motion
of ankle (small wheel)



the examination table, we can determine the axis of the ankle joint or the axle of the Ankle Wheel. This axis is a bit more complicated because in the process of dorsiflexing the foot about the ankle joint it is easy to dorsiflex the subtalar joint. Often it is easier to dorsiflex the subtalar joint than the ankle joint.

When the foot is dangling over the table, the subtalar joint and the talo-navicular joint are often in the neutral position. The talo-navicular joint and the subtalar joint can be palpated for congruency to ensure the neutral position. In order to obtain a true ankle joint axis or Ankle Wheel axle it is imperative that the neutral subtalar joint and talo-navicular joint are locked when dorsiflexing and plantar flexing the foot. To achieve this, the examiner should grasp the dorsum of the left foot firmly with her right hand while moving the foot up and down at the ankle joint without moving the subtalar or talo-navicular joints. By moving the foot through a full range of motion at the ankle, a plane of motion is visualized as was done in the knee. The line perpendicular to this plane of motion is the axis of the ankle (axle of the Ankle Wheel) and marked by the other arm of the same goniometer. The round portion of the goniometer is placed in the sinus tarsi area of the left foot with the left hand holding the goniometer at the lateral side of the foot. The vertex (the round end) of the goniometer is in the lateral foot area below the lateral malleolus/ sinus tarsi area.

The examiner now has a plane of motion of the knee and ankle and lines perpendicular to these planes representing the axes of the knee and ankle respectively. The examiner now should stand directly above the knee being measured. While still holding the goniometer at the ankle she sets up one arm in line with the Ankle Wheel axis and the other arm of the goniometer in line with the examination table (which represents the Knee Wheel axis). While looking from above downwards she measures the degree of difference between the two axes as they would be superimposed over one another on the same horizontal (transverse) plane. The examiner should hold or maintain the foot in its neutral foot position (STJ and TNJ) while taking this measurement.

I have found this technique to be very reliable in measuring both internal and external knee ankle axis relationship (KAAR) in the evaluation of my pediatric patients and my adult patients in assessing parameters for various surgical procedures and orthotic construction to estimate the need for compensatory flattening of the foot in those cases of internal and external torsion.

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Dr. Frank J. Santopietro has devoted over 40 years of clinical practice to the care of his patients in Brookline MA and formerly in the Providence RI area with an emphasis on a conservative biomechanical approach. Though Dr. Santopietro is a talented board-licensed podiatric surgeon, his philosophy has placed surgery as a measure of last resort. He holds two orthotic device patents and contributed to numerous industry wide shoe designs, including the first rear foot stabilizing heel counter, the first two density and the first three density progressive pronation midsoles for companies including Saucony and Stride Rite.

Dr. Santopietro served as the podiatrist for the New England Patriots for over 25 years and served as podiatric advisor to the Tennessee Titans and Los Angeles Rams NFL franchises as well as the Boston College Eagles, the Providence College Friars and the Boston Ballet. In addition, Dr. Santopietro is the former Chief of Podiatry at Children's Hospital and served as a Clinical Assistant Professor in Family Medicine at Brown University. He is a member of the American Podiatric Medical Association, the American Board of Podiatric Surgery and the Massachusetts Podiatric Medical Society.He continues to practice in Brookline, and is serving as Chief Medical Officer for the company he founded: EvenKeel | Advanced Custom Orthotics.

Pediatric Myth Busters

Roberta Nole, MA, PT, C.Ped

There is a lot of debate in the literature as whether to treat the asymptomatic (or symptomatic for that matter) pediatric flat foot with foot orthoses. What I have come to accept after 25 years of experience in the fields of pedorthics, biomechanics and physical therapy, is that when it comes to managing pediatric flat feet - there is no universal truth! Each situation needs to be carefully considered on a case by case basis when deciding if and how to treat each child.

In this article I will share what I fondly call my pediatric "Myth Busters"! Learning about common misconceptions related to children's feet can help a clinician overcome unwarranted fears about treating and managing pediatric flatfeet. This article will include easy to understand age specific assessment and treatment protocols for use of foot orthoses, and offer tools to help the practitioner learn how to market a pediatric program to expand their practice and become a pioneer in their community in the area of pediatric podiatry.

Myth Buster #1: "It's "Normal" For Children to Have Flat Feet"!

Yes, it is both true and quite normal for a young ambulator (ages of 1-6) to stand and walk with pronated arches and everted (valgus) heels [1,2,13]. This is partially due to the fact that at birth not all of the bones of the foot are fully present or ossified. The foot of a neuro-typical child requires further postnatal development before it will achieve a state of skeletal maturity sufficient enough to allow for standing and ambulation [2,13]. Also present at birth is a fat pad that fills up the space along the medial longitudinal arch of the foot that further accentuates its flatter appearance. This fat pad serves to protect the developing osseous structures of the foot from excessive load [11]. Over time this fat pad is fully reabsorbed by the body and the arch should appear "normal" by ages 4-5 [5,11].

Most children take their first steps around 9 to 15 months of age, but not all children grow and mature at the same rates. Some children may inherit skeletally deficient feet from their parents, and at times this can lead to delayed ambulation and postural deficits that can put them at risk for future disabilities. Children with developmental delays may take longer to begin ambulating, often 16-24 months or longer. In addition, consideration needs to be given with reference to epidemiology, flexibility, gender, weight and hypermobility [2].

Joseph C. D'Amico, DPM defined "Developmental Flatfoot" as an excessively pronated flexible flatfoot in the weightbearing pediatric population under 6 years of age; and describes it as a poorly functioning, posturally deficient foot that has the potential to cause future deformity and disability [1].

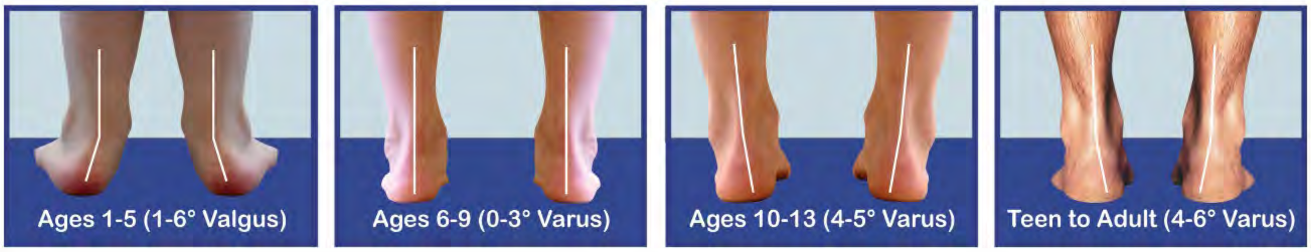
According to ACFAP president, Louis J. DeCaro (American College of Foot and Ankle Pediatrics), it is quite normal for a one-year-old child to stand in 7 degrees of heel valgus. According to DeCaro, the degree of heel valgus noted on weight bearing should progressively diminish with age. A good rule of thumb to follow when assessing the "appropriate level" of heel valgus for a child is 7 minus their age. For example, it would be normal for a 3-year-old child to stand with 4 degrees of heel valgus (7-4=3). By the time a child is 7 years of age their heels should assume a vertical alignment to the ground (7-7=0).

Dr. DeCaro also advises that aside from skeletal issues, there are many other factors that should be evaluated that could lead to, or negatively impact, gait. These factors may include: genetics, sensory processing disorders, gross motor delays, and low muscle tone.

DeCaro states: *"Overall there are 3 major factors that go into considering whether or not to treat pediatric flat foot: Genetics, the age specific degree of heel eversion, and functional impairments such as endurance, fatigue and poor posture".*

Age Specific Parameters for Pediatric Foot Development

- A child begins to walk around 10-14 months of age, at which time up to 6° heel valgus is considered normal
- Calcaneal valgus diminishes by 1° per year until age 6 at which time the heel should be vertical
- By age 13 a youths foot will take on its final adult form and the calcaneus will ideally be inverted 4-5°



As the author of this article, and based on my professional experiences, I have found the "ideal" adult heel to floor alignment to be approximately 4-6 degrees VARUS; and that this positional alignment should be attained by adolescence (approximately ages 9-12). This moderate varus heel alignment helps to lock the midfoot, stabilize the lateral column of the foot, and encourages an effective windlass mechanism.

Myth Buster # 2: "Growing Pains Are Normal"!

When are growing pains normal? After a rapid or excessive growth period of course! Parents and practitioners know and accept that growing pains will sometimes happen. So, how do we know when growing pains are NOT normal, or possibly excessive? [3,7,9]

First, consider the fact that growing pains in kids do not often occur in the foot. More commonly, growing pains occur in the thighs, knees, or calves. Also, true growing pains usually occur at rest, such as bedtime, as opposed to during physical activity. Children are not typically very good historians and often don't express themselves well. Some kids that are experiencing pain may simply avoid activity and become more sedentary, putting them at risk of childhood obesity issues. When examining the child be sure to take a good history from their parents. Include parental questions such as did your child crawl, stand, and walk on schedule? Does your child ask to be picked up and carried frequently? Does your child hop, skip, jump appropriately for their age?

Because the "growing pains" are not usually in the foot, it is often overlooked. Children with flat feet can experience postural deficits that make it much harder for them to function efficiently. An overly pronated foot causes the heels to evert in standing, the talus to plantarflex and adduct, and the tibia and femur to internally rotate. Pronated feet overstretch the posterior tibialis, the deltoid ligament, the plantar fascia, and many other deeper ligamentous structures. This creates a mechanical unstable foundation (foot), further compromising knee, hip, pelvic and back alignment.[12,14]

Children suffering from chronic, severe or frequent growing pains should be screened for foot pathology or overpronation. Implementing free pediatric foot screening in your clinics, at sporting events, or in school systems is a great way to promote foot health awareness and simultaneously market your business. Learning when and how to manage excessive childhood foot pronation could potentially prevent lifelong pathology and dysfunction.

Myth Buster # 3: "Children Outgrow Flat Feet"!

Many times parents are told to wait it out – After all kids outgrow flat feet right? Not always! Genetics plays a big role in that determination. If one or more of your parents has flat feet, you too may end up with flat feet, and may possibly pass this trait on to your children. We inherit all of our bodily features: hair color, eyes, cheek bone structure, body frame and as well – shape of our feet. So if you want to know if a

Side Tip: I love to take photos of family's feet: I call them family "Pho-toes".
It is both fun and interesting to share these images with families and point out that their children can look characteristically similar to one of their parents – just by looking at their feet! This exercise is engaging and interactive and gets the entire family involved.

child will outgrow their flat feet, then look at their parent's and sibling's feet. If there is a hereditary pattern in the family, it may be wise to consider orthotic intervention to prevent future disability, particularly if there is a familial history of foot or lower limb problems such as bunions, or other musculoskeletal conditions.

Myth Buster # 4: "Using Foot Orthoses Causes Dependency on Them"!

I often hear parents tell me they have their children walk barefooted in order to "strengthen" their ankles. Although there may be true benefit to a structured therapeutic exercise program under the direction of a trained physical therapist, athletic trainer or exercise physiologist; prolonged barefoot walking on an overpronated foot may at times exaggerate the deformity [4,12,14]. Flatfeet can lead to excessive muscle elongation of the foot supinators and can cause muscle spindle inhibition and increased production of sarcomeres. The change in muscle length alters the length-tension curve of a muscle and creates a "stretch weakness", or "positional weakness", that is associated with overuse injuries and postural dysfunction [6,8].

A pediatric foot orthosis is recommended when a child's foot pronation is deemed excessive for their age, especially when associated with a familial history of foot related conditions. The orthoses should include a deep heel cup (30mm), conservative medial rearfoot posting, a medial skive, and medial and lateral flanges [4]. Because of rapid growth it is not always possible, nor is it necessary, to use custom foot orthotics. Prefabricated orthotics that incorporate these features will often suffice and are a more affordable alternative for parents that may (because of genetics) have a gaggle of flatfooted kids to treat! Remember, when treating kids with orthoses you do not always have to achieve perfection. Medially post the rearfoot just enough to bring the foot back to the child's age related heel alignment. For example, remember that it is normal for a 5 year old child to stand in 2 degrees heel valgus (7-5=2). So, if you are treating a 5-year-old child that stands in 5 degrees' heel valgus, you need only post 3 degrees to bring them back to their age related 2 degrees' heel valgus position.

Russel Volpe, DPM and professor at the NY College of Podiatric Medicine offers the following guidelines to help ascertain the need to medically manage a child with a flatfoot [13]:

- Symptoms associated with abnormal foot posture
- A non-physiologic flatfoot at any age
- Abnormal weightbearing position of the foot based on age and associated abnormal foot posture
- Changes in dynamic function in gait associated with flatfoot

Summary: Foot pronation is often "normal" in younger children but should be outgrown by the age of 6 y.o. Excessive pronation in toddlers, or persisting flat footedness in preteens and adolescents, can perpetuate lifelong disability if left untreated; and can often be easily managed with OTC devices. Realigning the foot with an orthosis has many benefits including optimizing structural alignment to secure a stronger foundation for the body, facilitating better muscle functioning and strength, improving balance and coordination, and preventing present and future pathology.

For more immediate information:
please email: robertanstride@gmail.com;
or sign up for a webinar on "Pediatric Practice Pearls for Treating Developmental Flat Feet"
at: http://www.nolaro24.com/education.html

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A Retrospective Analysis of Tendo-Achilles Advancement in Comparison to Tendo-Achilles Lengthening in Cases of Pediatric Neurospastic Equinus

Charles C. Southerland DPM
Kieth B. Kashuk DPM
Gary L Dockery DPM
Adolfo Rocha MD
Brian Hutchinson DPM
Michael Sosinski PMS-IV

Statement of Purpose

Neurospastic equinus contracture is the most common deformity affecting the lower extremity of patients suffering from cerebral palsy (CP) and is the most common deformity requiring surgery in these patients [1,2]. A variety of surgical procedures have been described to correct the equinus deformity. The unifying theme of these procedures involves selectively lengthening and/or weakening the gastrocnemius alone or the gastroc-soleus complex together typically through tendo Achilles lengthening (TAL), tendo Achilles advancement (Murphy), or a combination of these procedures [2,3,4]. Surgical intervention is generally successful except in the actively growing child where there tends to be a high rate of recurrence of the equinus deformity. The authors describe a combination of modifications to the Murphy procedure on 50 limbs and compare the results to those of TAL in cases of pediatric neurospastic deformity secondary to CP induced equinus.

Methodology & Hypothesis

The authors reviewed the case reports from the Yucatan Crippled Children's Project compiled over a 16 year period (between 1998 and 2014). We found 48 cases of patients with spastic equinus secondary to CP who underwent a modified Murphy procedure. Of the 48 patients who underwent this procedure between 1998 and 2014, 32 were available for our study. The 16 non participants could not be contacted or did not present for more than one or two post-op evaluations and therefore no conclusive follow up data was available.

A retrospective review of 50 procedures on 32 patients was performed with a mean follow up of 31 months. Patient age, follow up time, and success rate were all analyzed. Success was defined by both subjective (pain/patient satisfaction) and objective (heel contact) data. To consider the procedure a success, the patient and or the patient's parents had to be satisfied with the surgical outcome, and the patient's heel had to contact the ground early in the stance phase of gait. Surgical interventions were performed to facilitate or improve a patient's gait, and so it was the gait that was evaluated for this study. A failure was defined as recurrence of equinus (toe-toe or toe-heel gait) or failure to satisfy one of the above qualifiers for a successful procedure. These results are compared to the results of TAL in cases of equinus secondary to CP presented in the literature.

Based on sound biomechanical principles, the hypothesis we propose is that the Murphy-Pierrot procedure and the modifications we describe offer superior resolution of neurospastic equinus compared to the traditional TAL in cases of pediatric CP.

Procedure

The modified Murphy-Pierrot procedure was performed on 50 limbs. The patient is placed prone and a 7-10 cm incision is made extending along the posteromedial or posterolateral aspect of the distal tendo

Achilles (TA), avoiding incisional placement directly on skin overlying the TA. In the course of dissection, the TA is identified at its insertion and is detached from the calcaneus as far distal as possible to preserve length, taking care not to damage the calcaneal apophysis in the pediatric patient. The upper surface of the calcaneus is exposed and Kager's fat pad divided to expose the posterior facet of the subtalar joint (STJ). The Flexor Hallucis Longus (FHL) tendon is identified and mobilized. The TA is passed anterior to the FHL tendon. A 0.5 cm deep trough receptacle running medial to lateral is formed by removing a wedge of bone the width of the TA on the superior aspect of the calcaneus immediately posterior to the Talo-Calcaneal joint. From the base of the trough, two drill holes are made, one infero medial and one infero lateral, exiting the lower medial and lateral aspects of the calcaneus. A Krakow suture is placed on the distal end of the TA using 0 or 00-gauge non-absorbable suture (Ethibond or Fiberwire). The two suture ends are "pullied" through drill holes on the medial and lateral aspect of the calcaneus pulling the distal end of the TA down into the trough receptacle via a "pully" type mechanism . The two ends are tied on the superior aspect of the calcaneus anterior to the TA. This trough is the new TA insertion point. Depending on the severity of the equinus contracture, if adequate dorsiflexion (foot 90° to lower leg) with anterior advancement of the TA could not be obtained (short TA), a fractional lengthening of the gastrocnemius would be performed to allow proper insertion immediately posterior to the STJ. However, this was only necessary in about 3 of the patients in our series (~ 6%). Generally, the additional length obtained from anterior advancement of the TA is satisfactory, and no additional lengthening is needed. Attempts are made to maintain or reattach the plantaris tendon to its original insertion point to tent the skin on the posterior aspect of the ankle joint. A layered closure is performed making sure to preserve the paratenon. The patient is placed in an above knee cast with the knee in 15° flexion and ankle in 0° Equinus.

Literature Review

TA advancement and TAL are well described in the literature for attempting to resolve equinus secondary to CP in the pediatric patient [1-13]. Generally the information presented in favor of TAL for these patients claims similar results to TA advancement with "simpler heel cord lengthening" procedures[2], while information presented in favor of TA advancement describes less recurrence of equinus while also eliminating the need for post-op bracing [1,5,6,8]. The success rates published in the literature for these two procedures vary depending on surgical technique, number of patients included in the study, and follow-up time. Numerous variations of TAL used in correcting equinus are described in the literature [3]. The majority of research surrounding TA advancement involves the analysis of clinical outcomes after performing the procedure as described by Murphy in 1959. Variations to the Murphy procedure are also described.

Murphy and Pierrot (M&P) were dissatisfied with the existing approaches to spastic equinus deformity and refined the procedure of TA advancement in 1959, stating that this is the only operation that alters the mechanical advantage of the spastic gastroc-soleus complex. They originally described routing the TA anterior to the FHL tendon warning that "the tendon will return to its original insertion in a high percentage of cases if it is not routed anterior to FHL." Their description of the procedure also utilizes a drill hole through the calcaneus from superior to inferior to serve as the new TA insertion point. The distal end of the TA is pulled into the drill hole and anchored to an externally placed plastic heel plate or foam covered button on the plantar aspect of the foot. M&P retrospectively reviewed the results of their procedure and compared them to the results of TAL in cases of pediatric equinus secondary to CP. They also evaluated the use of braces post-operatively after these two procedures. 23 patients with 32 TA advancements and 18 patients with 22 TAL were included in their study. The mean age was 6.5 years. Mean follow-up of 6 years, 7 months was performed. A successful result was defined as heel-toe gait or flat foot gait while failure was defined as toe-heel gait (under correction) or calcaneus gait (overcorrection). Utilizing their procedure, an 81% success rate was obtained while only a 54.5% success rate was obtained in the TAL group. They also determined that there is a lower failure rate in cases of TA advancement when braces are not utilized postoperatively. M&P concluded that TA advancement results in less recurrence of equinus in the growing spastic child and requires minimal bracing post operatively in comparison to similar patients who underwent TAL [1].

Throop, et al published results on 79 limbs in 48 patients with spastic equinus secondary to CP who underwent TA advancement. Mean follow-up was 1-4 years. These patients underwent the procedure described by M&P but with the added modification of "dog ears" cut into the TA to increase its functional length to allow for proper insertion of the tendon immediately posterior to the STJ in patients with structurally shortened TA. Utilizing the criteria developed by M&P for grading the clinical outcome of a given procedure, Throop obtained an 89.9% success rate utilizing TA advancement [5].

Strecker, et al retrospectively reviewed the operative results in 161 limbs of 100 patients picked at random living with spastic equinus secondary to CP who underwent TA advancement. The average follow-up was 54 months (30-76). The mean age at operation was 6.5 years (1-10). The procedure was performed as described by M&P but if neutral dorsiflexion could not be obtained with TA advancement, a fractional lengthening of the gastrocnemius was performed by the Vulpius technique. Using the criteria determined by M&P for determining the success or failure of a procedure, 98% of their patients demonstrated successful outcomes and resolution of equinus without the need for prolonged bracing post-operatively. Strecker stresses that lengthening of the gastrocnemius is needed in selected cases to achieve full correction of the deformity [6].

Yoshimoto, et al also combined TA advancement according to M&P with Vulpius lengthening of the Gastrocnemius. 20 limbs of 17 patients with spastic equinus deformities secondary to CP were treated with this technique, and satisfactory midterm postoperative results were obtained. The mean age of the patients at surgery was 10 years, and the mean duration of follow up after surgery was 8 years. The combination of heel cord advancement and the Vulpius technique did not result in a calcaneal gait or decrease in walking ability. There was no recurrence of equinus among patients at the short-term and midterm evaluations. Utilizing the Vulpius technique with TA advancement enabled a favorable corrected position to be obtained even in patients with severe equinus deformity [7].

Walker et al, retrospectively reviewed 122 limbs of 90 children who underwent TA advancement. These operations were performed exactly as described by M&P without any modifications to their original description of the procedure. Mean follow-up was 9.7 years. The results were graded according to the system devised by M&P. Analysis revealed a 65% success rate for TA advancement. Walker states that since they obtained comparable results with "simpler heel cord lengthening", they no longer perform TA advancement procedures [2].

Borton, et al reviewed 195 procedures in 134 children with spastic equinus secondary to CP who underwent TAL (as opposed to TA Advancement). The mean age at surgery was 7.6 years. The mean follow-up was 6.9 years. At follow-up, 42% had satisfactory calf length, 22% had recurrent equinus and 36% developed calcaneus deformity (58% failure). Borton went on to claim that TAL had few, if any indications in the growing child [11]. Dietz, et al claims that TAL procedures generally tend to have a high rate of failure with over correction resulting in calcaneus deformity as defined by the need for post-operative bracing or under correction resulting in recurrence of equinus especially in the growing pediatric patient [1, 10, 12].

McGlamry and Downey described a new technique for reinsertion of the TA on the dorsum of the calcaneus. Their modified internal reattachment of the anteriorly advanced TA utilizing a "pulley mechanism" eliminated the need for the plantar heel plate/button described by M&P. McGlamry reasoned that in patients with a spastic gastroc soleus complex, continued spasm of the musculature will create excessive pressure on an externally placed fixation device. Their modification was devised to prevent possible pressure ulceration and subsequent infection. Mcglamry also pointed out an adverse residual effect after TA advancement. With the resultant change in leg contour resulting from anteriorly advancing the TA insertion, the posterior dorsal aspect of the patient's calcaneus will be much more prominent and irritation may occur with normal shoe wear. They recommended placing a heel lift in the child's shoe to deal with this issue [8].

Results

Of the 32 patients we studied, the average age was 8 years. Of the 50 limbs operated on, the overall success rate was 90% (45 limbs) with an average follow-up of 31 months (3 months-20 years). The 5 failed procedures occurred in 3 patients (2 bilateral cases, 1 unilateral case). The failed procedures were the result of overcorrection of the deformity. Neither of these actually resulted in Calcaneus gait, but did cause a noticeable pes plano valgus. Equinus was resolved in all cases and there was no recurrence of the deformity following any of the cases.

Analysis & Discussion

We report on a technique for TA advancement consisting of a combination of modifications to the original Murphy procedure. The surgeon selected the combination of modifications based on evidence presented in the literature and what they felt would produce the most successful result in resolving pediatric neurospastic equinus secondary to CP. This "modified Murphy" procedure was performed in all 32 patients in the case reports we reviewed.

Routing the TA anterior to FHL prevents the TA from returning to its original insertion. Internal reattachment of the TA to its new insertion point eliminates the need for the externally placed heel plate/button therefore eliminating any plantar wounds and minimizing subsequent infection of those wounds. Performing a fractional lengthening procedure of the spastic gastrocnemius in selected cases in which a full correction of the deformity could not be attained with TA advancement alone, enabled resolution of equinus even in patients with severe deformity. This technique preserves the soleus which is an important stance phase muscle. Notably, this was done on 2 of the 3 cases that were considered "failures" resulting in pes plano valgus. In the majority of patients, the fractional lengthening was not necessary. Reattaching the Plantaris tendon to its original insertion limits "boat tailing" by tenting skin on the posterior aspect of the ankle which decreases irritation from shoe wear postoperatively due to the change in leg contour resulting from changing the insertion point of the TA.

With an encompassing disease like CP, not all patients are alike in their deformity. The degree of spasticity has a great deal to do with the success rate of the surgery. Surgery should not be performed on any child without the potential for locomotion.

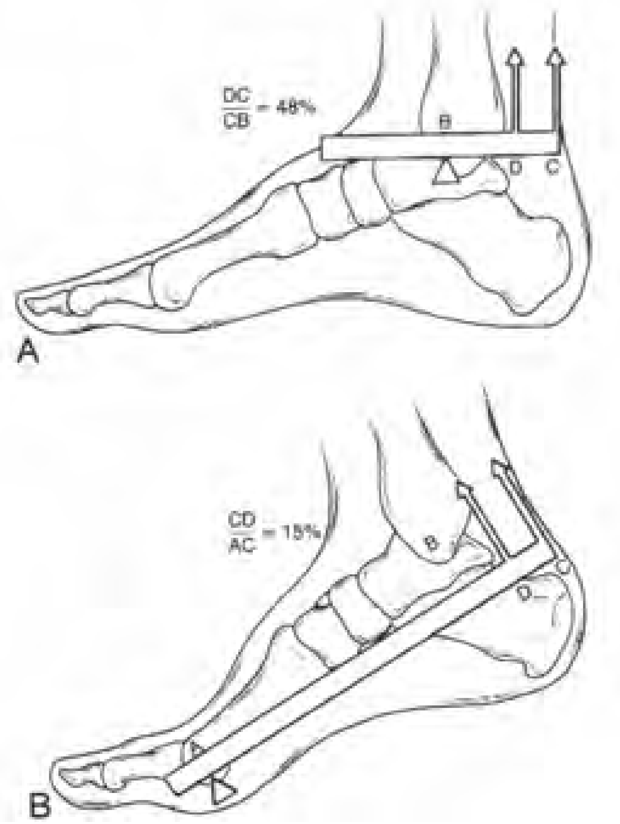
In the case reports studied, success rate was 90% in 50 limbs operated on with an average follow-up of 31 months. There were 5 instances of overcorrection to pes valgus (none to Talipes Calcaneus) and zero cases of recurrent equinus. Table 1 shows success rate, number of surgeries, follow-up time, and summary of the failed procedures of the comparative studies.

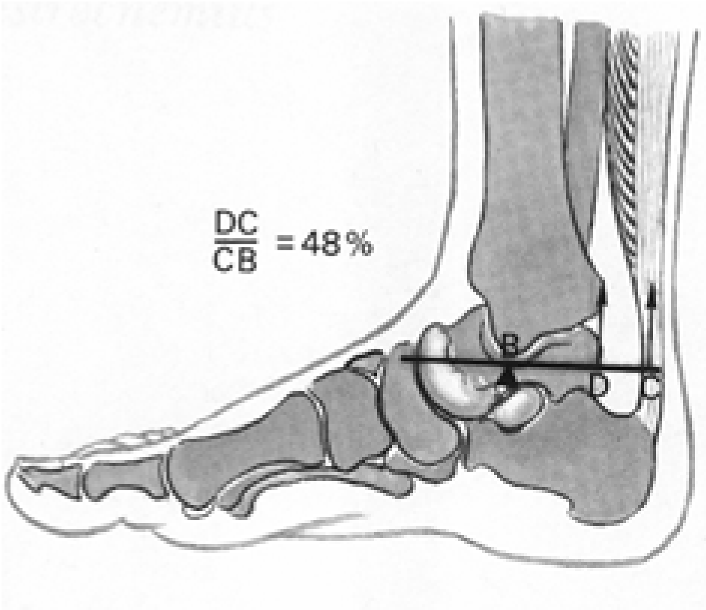
In the pediatric patient with spasticity secondary to CP, the success rates of TA advancement along with the failure rates of TAL have a biomechanical ex-

	Procedure	% Success	Patients	Follow-up	Failure Summary
Murphy	TAA*	81%	23 patients 32 procedures	6.8 years	All failures due to calcaneus gait.
Walker	TAA*	65%	90 patients 122 procedures	9.7 years	40 cases of recurrent equinus. 3 cases of calcaneus gait.
Strecker	TAA*	98%	100 patients 161 procedures	4.5 years	2 cases of toe-toe gait. Believed to be incompletely corrected at surgery.
Throop	TAA*	89%	48 patients 79 procedures	1-4 years	1 case of calcaneus gait, 1 case incompletely corrected at surgery, 6 cases of tendon pull-out.
Murphy	TAL**	54%	18 patients 22 procedures	6.1 years	All failures due to recurrent equinus.
Borton	TAL**	42%	134 patients 195 procedures	6.9 years	22% developed recurrent equinus, 36% developed calcaneus deformity.

Table 1

planation. The technique of TA advancement consists of moving the insertion of the TA anteriorly along the dorsum of the calcaneus to a point just posterior to the talo-calcaneal joint. This procedure is designed to alter mechanical advantage of the spastic gastroc-soleus complex. Transferring the insertion point of the TA closer to the axis of the ankle joint (fulcrum), weakens the gastroc-soleus complex by shortening its lever arm. Mechanically, this may be expressed by the following diagram, which describes a 48% reduction in mechanical advantage over the TA insertion:





Of some concern is the capacity for the heel to raise up at all, given this apparent lever arm length discrepancy. Because the foot lifts off the ground at, essentially the metatarsophalangeal joints (MTPJ), another feature of mechanical advantage is the relative length of the lever arm between the MTPJ and the insertion of the Achilles Tendon. Essentially, this reverses the lever orientation from a type two lever (Effort-Fulcrum-Resistance) to a type three lever (Fulcrum-Resistance-Effort). In resolving the fulcral change from ankle joint to MTPJ, the final effect on heel lift is about a 15% reduction in mechanical advantage on gait, while effecting a 48% mechanical advantage compromise between the insertion of the Achilles tendon and the ankle joint fulcrum [1, 4].

Because the resting length of the muscle is not changed in TA advancement as it is in TAL, the results should not be affected by growth of the patient. This is an important concept to understand when operating on actively growing children. Of the 50 patients studied, 5 had previous TALs but presented with recurrent equinus. Children tend to outgrow their TAL and therefore redevelop the equinus deformity. To overcome recurrence of equinus after TAL, the child needs to be braced post-operatively until they are skeletally mature which is expensive and burdensome to the patient and their family [1, 10].

Although the child will never be completely normal, the goal of this procedure is to improve their quality of life. It has been shown that the motor handicap these patients have to live with can be substantially improved with TA advancement surgery. Utilization of the modified Murphy procedure has been shown to be successful in the neurospastic patient. We feel that TA advancement along with the described modifications is superior to TAL in resolving neurospastic equinus in the pediatric patient secondary to CP.

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