

# Pediatric Podiatry

The foot is one of the more complicated parts of the body due to the ligaments, muscles, blood vessels, nerves and 26 bones. Abnormal pressure can cause deformities because the foot is so soft and pliable. According to DuPage Podiatry Medical Group, podiatrists consider the first year of life to be the most important.

Bone formation (osteogenesis) begins during the prenatal development of the fetus. Week 6 of gestation; Week 8 of pregnancy

1. The arms and legs have grown longer, and foot and hand areas can be distinguished.
2. The hands and feet have fingers and toes (digits), but may still be webbed.

This growth continues throughout adulthood to approximately 18-23 years of age. Infants and children have softer bones because they have not yet ossified. Ossification is when cartilage is synthesized into bone.

There are two ways osteogenesis occurs, and both types form by replacing existing cartilage:

1. Intramembranous Ossification: Osteoblasts specialized cells in bone tissue that deposit calcium into the protein matrix of the bone (collagen).
2. Endochondral Ossification: Osteoclasts dissolve calcium previously stored away in bone and carry it to tissue when it's needed.

One third of a bone's components are collagen, which is a flexible, gelatin-like matrix. Bones formed during intramembranous period are called membranous bones, or dermal bone. These formations usually occur in

bones such as cranial bones. Bones formed during the endochondral period are called cartilage bone, as in the formation of the long bones.

Periosteal is the formation of successive thin layers of bone by osteoblasts between the underlying bone or cartilage. Periosteum is the cellular and fibrous layer that covers the forming bone. This is also called subperiosteal ossification.

One of the most widely accepted myths is that bone is dead, unchanged matter. In reality, bone is constantly changing every second as the new bone cells replace old cells.

**Intramembranous Ossification** - seen under a microscope, the membranous bones appear flat, and membrane like layers are of early connective tissue. These layers are provided a constant supply of nutrient blood by networks of blood vessels that are formed between these layers. The osteoblasts then remove calcium from the blood and deposit it in the bone matrix (the cartilage). This creates layers of spongy bone around the original cartilage. In later development, the bone matrix fills the spaces of the spongy bone to become compact bone.

Osteoblasts continue to deposit calcium supplements into the matrix until it is completely surrounded. After this occurs, the osteoblasts are considered to be encased in a lacunae (meaning space occupied by cells of calcified tissue) and are now called osteocytes.

The original connective cells first formed around the network of blood vessels is now called the periosteum.

**Endochondral Ossification** - forms the bone by replacing a cartilaginous model or precursor that appeared in early embryonic development. Cartilaginous models undergo quick changes as connective tissue cells begin to enlarge, and in turn destroy the surrounding matrix. Not long after the

connective tissue cells die and disintegrate, a periosteum is formed outside the developing structure.

Centers of ossification can be seen in embryonic development, and can even be seen in the feet. Growth in the length of bone continues until about the age of 25. This is possible because of the epiphyseal disk.

The epiphyseal disk is found on a portion of the bone that remains cartilaginous. This portion of the bone is called the epiphysis, and is at both ends of the bone that continues to grow throughout development. The centers of premature bones undergo ossification. The full length of bone is attained by the deposition of calcium on the epiphyses.

Today's children face something that attacks their feet more than ever and it's called "Screen Time", which can cause foot pain. It is blamed on watching too much television, playing video games, too much computer time, even iPods and videos are included in this new phenomenon.

Studies have shown that "screen time" has increased, and as it increases so does a child's weight. Not only can childhood obesity develop from "screen time", but it increases the chance from the obesity to develop into diabetes. Childhood obesity has been related to foot pain. According to a study in *Pediatrics*, published in April, 2010, obese children have more foot and ankle injuries than similarly aged children of a healthier weight.

Tips for helping normal foot development:

1. Have the baby lying uncovered to provide exercise by kicking and moving feet to prepare for weight bearing.
2. Several times a day change the baby's position

3. Look at the baby's feet often to look for something that does not look normal, bring this to your physician or podiatrist's attention. A baby foot grows rapidly during the first year.
4. Always cover the baby's feet loosely; tight covers restrict movement.

Remember to start early when it comes to taking care of your children's feet, it could prevent adulthood issues.

## Clubfoot or Talipes Equinovarus

Clubfoot is a congenital (present at birth) foot deformity. Clubfoot is one of the most common of the congenital deformities. Talipes means any of several deformities of the foot; of those that are congenital foot deformities, but not a traumatic deviation explained by the direction of one or two of the four lines of movement. Equinovarus is a combination of talipes equines and talipes valgus. Equinovarus means walking without touching the heel to the ground and the sole having turned inward.

Experts in this field believe that when a child is born with clubfoot, it does not cause them pain. However, if this condition is not treated, it will lead to pain and possibly many kinds of physical difficulties later on in a child's life. One complication is arthritis, which will cause joint inflammation, swelling, stiffness, deformity and pain.

Clubfoot has four deformities:

1. Cavus: Talipes arcatus
2. Adductus: Brought toward

3. Varus: Angled or turned inward
4. Equinus: Plantar declination of the foot

Clubfoot can be classified as postural (affected by position) or positional (affected by posture). Postural or positional clubfeet are not considered to be a true “clubfoot”. Clubfoot can also be a fixed (position established) or rigid (still, hard, unyielding). Fixed or rigid clubfeet are either “flexible”- which can be corrected without surgery-or “resistant” which require surgical release in most cases. In the rigid type of clubfoot, the only bone deformity at birth is the talus. The talus is the ankle bone and articulates with the tibia, fibula, calcaneus (heel bone) and the navicular bone (scaphoid bones in the tarsus/ankle). The talus saddles the tibia to form the main ankle joint.

In clubfoot, the osseous columns of the foot are modified in length and shape. The talo-calcaneo-navicular joint is severely altered; The Talus is externally rotated and the talar head is subluxated (creating a partial or incomplete dislocation) from the acetabulum (a cavity or depression on the lateral surface of the in nominate bone) pedis.

The cause of clubfoot has been studied as a condition since the 1800s. According to the Journal of Children’s Orthopedics, some scientific investigators have concluded that this condition is caused by the malformation of bones, abnormalities of muscle, joint or vascular lesions and/or abnormal ligaments and tendons.

Other views include the possibility that the foot arrested (condition of growth being stopped) during development around the eighth through tenth week, of the embryonic foot. This is when the foot goes through a stage of equines and inversion (to turn inward). If this occurs in this stage it usually leads to a rigid type of clubfoot. If clubfoot occurs later in development, it is felt it is a possible as a result of malposition and

abnormal intrauterine pressures. Along with this later in development abnormality, it is felt the type of deformity is more “flexible” and involves the joint tissue instead of bone.

Since the etiology of clubfoot is still unknown, several theories have been put together on possible reasons for clubfoot:

**A: Development Arrest Theory (Böhm):** The Morphogenic stages of development of a lower limb show a period of physiologic equino-varus foot. Many investigators have shown that equines, varus, and adduction normally occur at the end of limb morphogenesis. An arrest of development at this stage can lead to a clubfoot.

**B. Genetic Theory:** Familial clubfeet do exist and a polygenic multifactorial transmission is proposed.

**C. Primary Germ Plasm Defect:** Irani and Sherman have suggested that the deformity probably resulted from a primary germ plasm defect affecting the head and the neck of the talus. This theory is based on dissections of stillbirth’s feet.

**D. Mechanical Factors in Utero:** Portural theories are no longer available because ultrasonography has shown clubfeet at 12 weeks when the embryo is floating in amniotic fluid.

**E. Neurogenic theory:** Many histochemical and electron microscopic studies of the extrinsic muscles of the clubfoot report anomalies that can be explained by a neurologic lesion. It is sometimes difficult to determine if these anomalies are primary or acquired secondarily.

**F. Myogenic theory:** muscle anomalies are also reported and an initial muscle disease can be proposed.

**G. Retracting Fibrosis theory:** The Ponsetti Theory.

Studies of pooled data from several birth defects surveillance programs approximately 6139 cases of clubfoot showed the prevalence of clubfoot was 1.29 per 1,000 live births. Clubfoot occurs 1 per 1,000 in the United States versus 75 cases per 1,000 in Polynesian islands particularly Tonga. Maternal age, parity (having borne offspring), education, marital statuses were significantly associated with cases of clubfoot as well as maternal smoking and diabetes. The male-to-female ratio is 2:1. Bilateral involvement is found in 30-35% of cases. There is also a 10% chance of a sibling being affected if the parents already have a child with clubfoot, per [medicine.medscape.com](http://medicine.medscape.com).

According to the March of Dimes, scientists believe environmental and genetic factors contribute to the development of clubfoot. When clubfoot develops in the second trimester of pregnancy, it may be caused by drugs, cigarette smoking, infection or other uterine exposures.

Etiology of congenital clubfoot and most infants who have clubfoot have no identifiable genetic or syndromal extrinsic causes. However per [ehow.com](http://ehow.com), a genetic study funded by SPARKS, a children's medical research charity organization, and Linda Sharp, epidemiologist, discovered for the first time, that a variation in the gene that processes folate may be part of the cause of clubfoot. It was determined that those infants who possessed the less common variant of C677T variant, in the gene called MTHFR or methyltetrahydrofolate reductase, were more apt to be born with clubfoot than those who did not.

Most infants born with clubfoot usually do not have any other defects. Clubfoot, however, can be connected with other birth defects such as spina bifida or infants who have an open spine. With spina bifida, there may be no evidence of foot problems at birth; however with muscle or nerve disease from these birth defects, a foot or both feet could become twisted as the child becomes older.

## Classification of Clubfoot:

The classification score allows easy assessment and makes treatment strategies more clear. This process allows the ability to predict the impact of functional treatment, its progress, and establish the most beneficial surgical treatment.

**Grade I:** Benign with discrete involvement includes 20% of all clubfeet. This grade is termed “soft-soft” feet, and has a score from 0 to 5 and is 90% reducible. All of these feet are healed by consecutive functional treatment and normal conditions are achieved. These types of feet should not be included into statistics of clubfeet.

**Grade II:** Benign with discrete involvement includes 33% of all clubfeet. This grade is termed “soft-stiff” feet, and has a score of 5 to 10 and is reducible but partially resistant. Since treatment has very good chances of being effective in this category and surgery can also be avoided, such feet must be recognized.

**Grade III:** Severe feet with a score of 10 to 15 and includes 35% of all clubfeet. This grade is termed “stiff-soft” feet. These feet are resistive and partly reducible. This is the most common category, and resistance is much greater than reducibility.

**Grade IV:** Very severe, stiff feet, involvement is 12% of all clubfeet. This grade is termed “stiff-stiff” feet, and has a score of 15 to 20. These feet are almost irreducible. This category is rare, and is a type of pseudoarthrogryposic feet.

Arthrogryposis: arthro (joint) + gryposis (crooking) is a Greek term for “curved joint” children diagnosed with arthrogryposis, developed joint contractures before birth; then are born with a limited range of motion. These children other than stiff joints and muscle weakness are usually

medically healthy. This occurs in about one in every 3,000 births. It must have one of the three characteristics:

1. Congenital: a condition at birth.
2. Non-progressive: does not worsen with age.
3. Includes multiple joint contractures: the motion of two or more joints is limited.

#### Types of arthrogryposis

1. Distal arthrogryposis - affects only a few joints, usually in the hands and feet mildly limiting range of motion.
2. Classic arthrogryposis - affects feet, knees, hands, wrists, elbows and shoulders to a varying degree. In the most severe cases nearly all joints in the body can be involved including the back and the jaw. Joint contractures are often involving further limiting movement and muscle weakness.
3. Syndromic arthrogryposis - affects internal organs and the muscle/joint system. Internal organ involvement can include breathing problems, feeding/eating problems, speech disorders and possible mental retardation.

Children who have clubfoot left untreated will have a problem with gait. Gait is a manner of walking. In general, problems with gait cause an increased risk of falling, which is a greater problem later in life. The fact that a clubfoot does not look “normal” and problems with walking because of the clubfoot; may create a body image problem as the child gets older.

Treatment for clubfoot depends on the deformity. Nonsurgical management is the common procedure to initiate the treatment of the

clubfoot. Then first step when possible is called Ponseti, named after Dr. Ponseti. Ponseti is a stretching method achieved by casting a child's foot. The cast is changed frequently over several weeks to gradually stretch the affected foot in the right direction. Once the foot has been corrected, the doctor then released the heel cord on the foot and applies another cast for several weeks.

A complication of manipulation treatment is rockerbottom foot.

Included is the information from Dr. Ponseti's international website. [www.Ponseti.info](http://www.Ponseti.info) .

If the Ponseti method does not work, the next step is surgery. Surgery occurs between nine to twelve months old, and will usually result in a stiff foot. Surgery is performed to do a posteromedial release of the clubfoot. The surgical foot will be less mobile and have less flexibility.

After the surgery is complete, the foot or feet are put into a brace for an extended period of time. The affected foot will try to revert back to its original position even with surgery. After the braces, a child may need orthopedic shoes to prevent the foot from turning inward. Even with surgery, the clubfoot will not be completely normal; however it will be more functional. Usually the affected foot will be smaller than the non-affected foot if clubfoot is not bi-lateral.

Immediate complications in management of Idiopathic clubfoot; is hypercorrection that could lead to skin problems during conservative treatment. Post-surgical vascular problems fall into this category. Late complications would show up as under or over corrections with patient having rocker-bottom feet.

Cutting Edge Nursing Education would like to give a special **Thank You** to Iowa City University. Iowa City University has allowed us to include their web site information about clubfoot for our course.

Iowa City University is extremely proud of Maria Miller Clinic Nurse Coordinator, Maria-Miller@uiowa.edu. Maria worked alongside Dr. Ponseti for many years and is an expert in this field with a published paper discussing it. Maria is a wealth of knowledge for nurses who are dealing with parents of patients who suffer from clubfoot. This process takes years, intertwining parents and nurses who form a support system. Maria has information and ideas on how to deal with this long term issue, and can be reached at the e-mail address above.

Below is the Iowa City University web site for Dr. Ponseti.

Dr Ponseti:



Ignacio Ponseti was born in 1914 on the Spanish Island of Menorca. As a teenager he worked at his father's watch repair workshop where he learned training and precision. At the age of 16 he began attending the University of Barcelona where he earned a degree in biology as well as an MD.

Following graduation in 1936, Ponseti served as a medic during the Spanish Civil War, treating hundreds of orthopaedic wounds.

In 1941, Dr. Ponseti came to the University of Iowa to finish his residency and went on to join the faculty of orthopaedic medicine in 1944. Dr. Arthur Steindler, the head of the department at the time, asked Ponseti to review the results of clubfoot surgeries being performed at the University of Iowa, and what he learned was not encouraging. He found that, in adulthood, former surgical patients often experienced foot stiffness, pain, arthritis, and limited mobility, and in many cases required additional surgery.

By studying the anatomy and functions of a baby's foot, Dr. Ponseti developed a non-surgical method to correct clubfoot in infants through gentle manipulation of the feet followed by the application of plaster casts. The success of the "Ponseti Method" has been well documented through patient studies and research articles.

### **A letter from Dr. Ponseti to his patients and friends**

I just want to let you know that now since I turned 95, I feel grateful that I was given the opportunity to have been of assistance to you and your family. Nothing delights more than to treat a clubfoot baby and restore its tiny feet to normalcy. This has been the passion of my life and I am fortunate that I was inspired to devise a non-surgical method to successfully treat this foot disorder.

I am also pleased that many efforts are being made to export the Ponseti Method throughout the world. Dr. Jose Morcuende has been diligent in conducting seminars and training sessions in scores of countries. Hundreds of physicians and health care providers have been trained on the Ponseti Method abroad and in Iowa City where they have come to see how it is done.

I also want you to know that my hip has healed completely. I thank you from the bottom of my heart for your good wishes and prayers. Your support and affection have helped me during my recovery.

I am looking forward to the Ponseti Symposium, as well as the Ponseti Run, that will be held in Iowa City on October 16-17, 2009, where we will see each other again.

Thank you for your greetings and warm wishes.

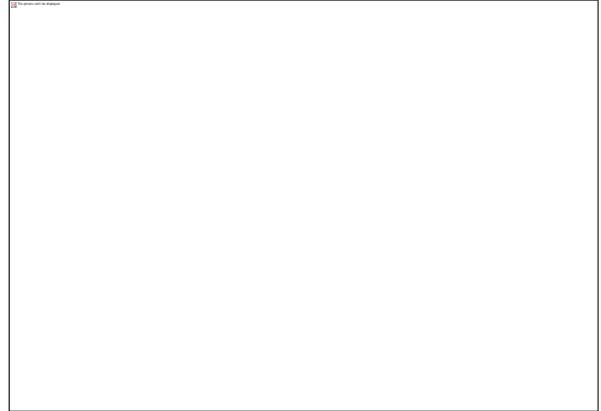
Ignacio Ponseti, M.D.

Method explained by Dr. Ponseti

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Treatment of Congenital Clubfoot

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Professor  
Department of Orthopaedic Surgery  
The University of Iowa  
Peer Review Status: Externally Peer  
Reviewed  
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Most orthopaedic surgeons agree that the initial treatment of congenital club foot should be nonoperative, beginning in the first days of life so as to take advantage of the favorable fibroelastic properties of the connective tissue which forms the ligaments, joint capsules and tendons. Early operation induces fibrosis, scarring and stiffness [4, 5]. It must be delayed until the child is at least three months old. These first three months offer the skilled and knowledgeable surgeon a golden opportunity to correct the deformity by manipulation and casting. Proper manipulative techniques followed by applications of well moulded plaster casts offer the best and safest correction of most clubfeet in infants [11, 20].

Failures of manipulative treatment usually occur when the surgeon lacks a thorough knowledge of the kinematics and pathological anatomy of the deformity. The kinematics of clubfoot were clearly described by Farabeuf in 1892 [6] and Brockman in 1930 [2]. In 1963, when presenting our results of fifteen years of treatment, we explained that to correct the deformity all of the

foot distal to the talus must be made to rotate laterally, i. e. abduct, underneath the talus which is fixed in the ankle mortice [10]. In a recent review of our patients treated 25 to 42 years ago [3], it was found that although the treated clubfeet were less supple than the normal foot, there were no significant difference in function or performance compared to a population of a similar age born with normal feet.

Our treatment is easy to learn. An interested resident is proficient in the technique after correcting two or three clubfeet. The main stages of the correction are illustrated in Figs. 1 to 9 using a facsimile of a clubfoot made of plastic bones and elastic strings.

First, the resident learns to identify by palpation the position of the main bones of the foot in relation to the malleoli and to the head of the talus. In the clubfoot the calcaneus, the navicular and the cuboid are rotated medially in relation to the talus, and are firmly held in adduction and inversion by very tight ligaments and tendons (Fig. 1 ). Although the whole foot is in extreme supination, the forefoot is pronated in relation to the hindfoot and this causes the cavus, the first metatarsal being in more plantar flexion than the lateral metatarsals (Fig. 2). The resident feels the distance between the medial malleolus and the tuberosity of the navicular. The shorter this distance the worse is the clubfoot (Fig. 1 ). When abducting the foot he must estimate the degree of resistance of the navicular to be moved away from the medial malleolus. This resistance correlates with the severity of the deformity.

To correct the clubfoot, the cavus is corrected first by supinating the forefoot and dorsiflexing the first metatarsal (Figure 3 and Figure 4 ). The forefoot must

never be pronated.

To correct the varus and adduction, the foot in supination is abducted while counterpressure is applied with the thumb against the head of the talus the thum against the head of the talus (Figures 5, 6,7 ). The index finger of the same hand rests over the posterior surface of the lateral malleolus. The heel must not be touched (Fig 11 ). The calcaneus abducts by rotating and sliding under the talus (Fig. 8 ). As the calcaneus abducts it simultaneously extends and everts, and thus the heel varus is corrected (Figs. 8, 9,10, 11 ). The calcaneus cannot evert unless it is abducted [7]. The improvement obtained by manipulation is maintained by immobilizing the foot in a plaster cast for five to seven days. With immobilization, the tight medial and posterior tarsal ligaments tend to yield. The deformity can be gradually corrected with further manipulations and five or six changes of cast. To fully stretch the medial tarsal ligaments in the later casts, the foot in front of the talus must be severely abducted to an angle of about 60 degrees (Fig. 8 ).

The equinus is corrected by dorsiflexing the fully abducted foot. A percutaneous tenotomy of the Achillis tendon is often necessary to completely correct the equinus [11].

Many degrees of severity and rigidity of clubfoot are found at birth. Failures in treatment are related more often to faulty techniques of manipulation and application of the cast than to the severity of the deformity. Our experience of 50 years indicates that most clubfeet, when treated shortly after birth, can be easily corrected by manipulation and five or six applications of plaster casts. A small number of infants with very severe, short, fat feet with stiff ligaments

unyielding to stretching require special treatment and may need surgical correction. Long term function and the results of our patients treated in infancy indicate that the well treated clubfoot is not a handicap and is compatible with a normal active life [3].

The common errors in the treatment of the clubfoot and how to avoid them are:

1. Having the parents remove the plaster cast at home the day before the cast change. Much correction is lost while the foot is out of the cast. The cast should not be removed more than an hour before the new cast is applied.
2. Pronation or eversion of the foot (Figure 12 and Figure 13 ). The wrong assumption is made that the severe supination in the clubfoot will correct by pronating or everting the foot. Pronation of the foot will make the deformity worse by increasing the cavus and locking the adducted calcaneus under the talus, while the midfoot and forefoot are twisted into eversion [12]. Supination of the foot and heel varus are corrected by abducting the supinated foot under the talus(Figure 15 ).
3. External rotation of the foot to correct adduction while the calcaneus is in varus (Figure 14 ). This causes a posterior displacement of the lateral malleolus by externally rotating the talus in the ankle mortice. The posteriorly displaced lateral malleolus, seen in poorly treated clubfoot, is

an iatrogenic deformity [ 12]. It does not occur when the foot is abducted in flexion and slight supination to stretch the medial tarsal ligaments, with counter pressure applied on the lateral aspect of the head of the talus, thus allowing the calcaneus to abduct under the talus with correction of the heel varus (F igure 15 ).

4. Abducting the foot at the midtarsal joints with the thumb pressing on the lateral side of the foot near the calcaneocuboid joint, arching the foot as if straightening a bent wire. This was taught by Kite and is a major error [8]. By abducting the foot against pressure at the calcaneocuboid joint the abduction of the calcaneus is blocked, thereby interfering with correction of the heel varus (Figure 11 ). Kite wrongly believed that the heel varus would correct simply by everting the calcaneus. He did not realize that the calcaneus can evert only when it is abducted, i. e. laterally rotated, under the talus. This error in the Kite technique had a major negative impact on the manipulative treatment of clubfoot. Kite was able to correct the deformity after many manipulations and changes of cast. His less patient followers, with some notable exceptions, have resorted to surgery.
5. Frequent manipulations not followed by immobilization. The foot should be immobilized with the contracted ligaments at the maximum stretch obtained after each manipulation. Plaster casts applied between manipulations serve to keep the ligaments stretched, and to loosen them

sufficiently to facilitate further stretching in the manipulations following at intervals of five to seven days [11]. The tarsal joints and bones remodel due to the changes in the direction of mechanical loading of fast growing tissues.

5. Application of below knee instead of toe to groin casts. The longer plasters are needed to prevent the ankle and talus from rotating. Since the foot must be held in abduction under the talus, the talus must not rotate, otherwise the correction obtained by manipulation is lost.
7. Attempts to correct the equinus before the heel varus and foot supination are corrected will result in a rocker bottom deformity.
3. Failure to use shoes or molded orthotics attached to a bar in external rotation for three months full-time and at night for two to four years. These splints are necessary to counter the tendency of the ligaments to tighten, causing relapses. The ankles and knees are free to move and the leg and thigh muscles gain strength [11].
9. Attempts to obtain a perfect anatomical correction. It is wrong to assume that early alignment of the displaced skeletal elements results in a normal anatomy and good long term function of the clubfoot. We found no correlation between the radiographic appearance of the foot and long-term function [3]. In severe clubfoot, complete reduction of the extreme medial displacement of the navicular may not be possible by manipulation.

The medial tarsal ligaments cannot be stretched sufficiently to properly position the navicular in front of the head of the talus. Since the joint capsules and ligaments play a crucial role in the kinematics of the tarsal joints [7], they cannot be stripped away with impunity. In infants, the medial ligaments should be gradually stretched as much as they will yield rather than cut, regardless of whether a perfect anatomical reduction is obtained or not [11].

With a partially reduced navicular, the forefoot can be brought into proper alignment with the hindfoot because the ligaments in front of the navicular and the bifurcate ligaments will yield, allowing lateral displacement and lateral angulation of the cuneiforms and of the cuboid with proper positioning of the metatarsals. The calcaneus can be abducted sufficiently to bring the heel into a normal neutral position. This anatomically imperfect correction will provide good functional and cosmetic results for at least four decades, avoiding many of the complications of operative tarsal release.

Relapses are common in severe clubfeet and are probably caused by the same pathology that initiated the deformity, but they may easily be corrected by manipulation and two to three plaster casts. When a second relapse occurs and the tibialis anterior muscle has a strong supinatory action, the tendon must be transferred to the third cuneiform. This transfer prevents further relapse and corrects the anteroposterior talocalcaneal angle, thereby greatly reducing the need for tarsal release [9, 10].

Surgeons with limited experience in the treatment of clubfoot should not

attempt to correct the deformity with manipulation and plaster casts. They may succeed in correcting mild clubfeet, but the severe cases require experienced hands. It is easy to compound the deformity, making further treatment difficult or impossible. No more than two or three changes of cast should be undertaken if correction is not being achieved. Referral to a centre with expertise in the management of clubfoot should then be made so that more skilled manipulations can be done before tarsal release operation is considered [13-20]. The functional results are always better if this type of surgery can be avoided [1].

# Treatment of Congenital Clubfoot

## Index of Images

**Ignacio Ponseti, MD**

Peer Review Status: Externally Peer Reviewed

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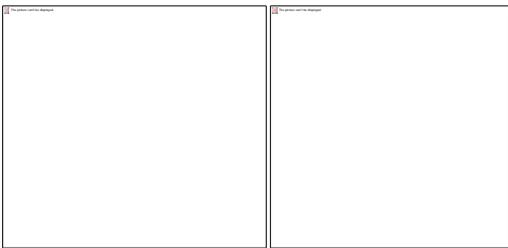


Figure 1

Figure 2 and 3



Figure 4 and 5



Figure 6

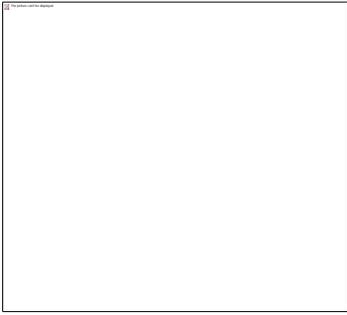


Figure 7

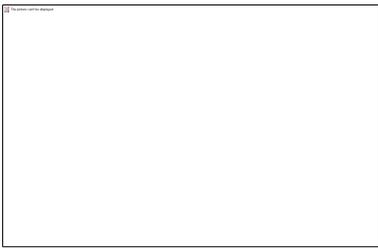


Figure 8

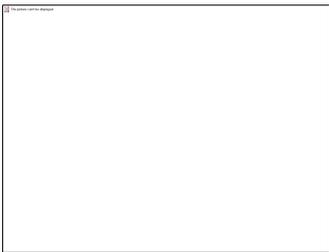


Figure 9

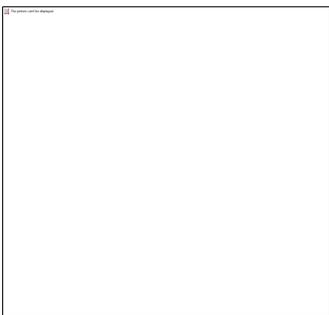


Figure 10 and 11

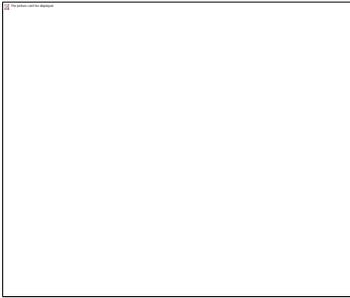


Figure 12

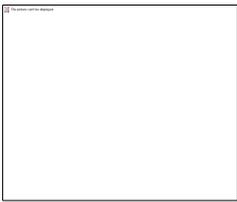


Figure 13 and 14



Figure 15

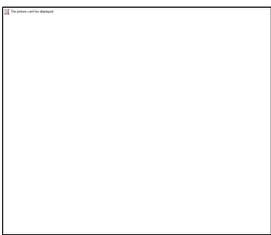


Figure 16

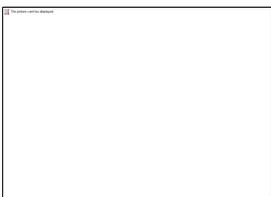


Figure 17

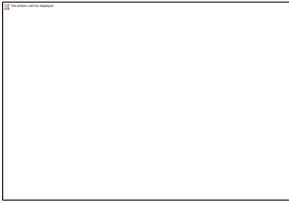


Figure 18



Figure 19



Figure 20



Figure 21



Figure 22

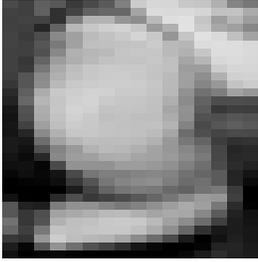


Figure 23



Figure 24

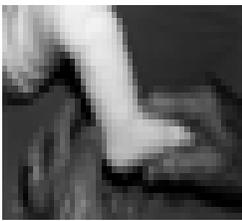


Figure 25

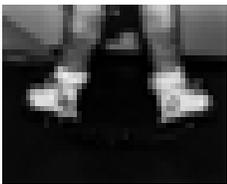


Figure 26



Figure 27

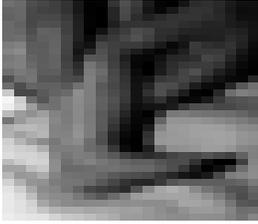


Figure 28

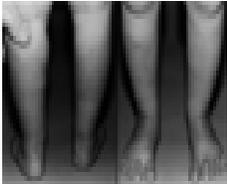


Figure 29



Figure 30

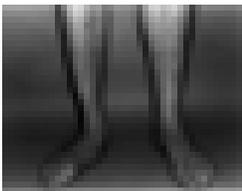


Figure 31



Figure 32

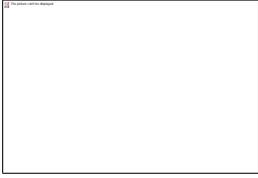


Figure 33

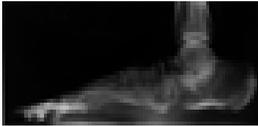


Figure 34

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## About Us

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This image was provided by  
Melissa Dieterich Photography

**VISION**

A world free of untreated clubfoot.

## MISSION

To prevent disability, ill health, and poverty in children born with clubfoot by globally implementing comprehensive programs of Ponseti training, ongoing support, and public awareness.

The Ponseti International Association (PIA) is committed to treating children around the world with clubfoot. No child deserves the pain and suffering caused by untreated or poorly treated clubfoot. With the help of dedicated parents, PIA aims to reach that goal.

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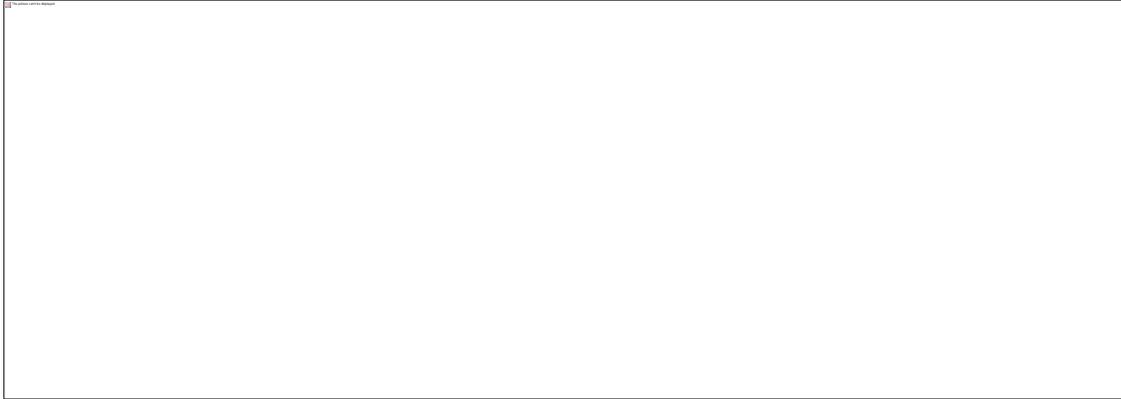
*"Through this association and the partnerships it will foster, our goal is to make Dr. Ponseti's clubfoot treatment available to any child, born anywhere in the world, with this condition."*

*Jean E. Robillard, MD*

*Vice President for Medical Affairs*

*University of Iowa*

About Clubfoot:



## What is Clubfoot?

Clubfoot, or talipes equinovarus, is a treatable birth defect that affects approximately 150,000-200,000 children each year. When clubfoot occurs the foot is twisted inward and down, and this condition occurs during development in the womb. Physicians have observed that fetuses that develop clubfoot start with a normal foot and then the foot begins to turn inward around the third month. Most children born with clubfoot are not missing any bones, muscles, or connective tissue. It is a congenital condition, meaning that when it occurs it is always present at birth. It is one of the most common congenital deformities. One or both feet may be affected and the affected feet can range from relatively flexible to stiff and rigid. The condition is not painful for the new born, though when a child gets to walking age, walking with an uncorrected clubfoot can be very painful and difficult, if not impossible.

When will you know?:

Parents will know at birth if their child has clubfoot because the foot will be twisted inward. Some cases are diagnosed during a routine ultrasound. If you are wondering if your child has clubfoot, contact a physician who has experience in diagnosing this condition (not all pediatricians know how to diagnose clubfoot).

Causes:

Researchers do not know exactly what causes clubfoot. However, if either of the parents were born with clubfoot, their children are more likely to have it.

Treatment:

For years clubfoot has been treated by casting and/or surgery. Over fifty years ago Dr. Ignacio Ponseti developed a method for treating clubfoot that requires the use of over the knee casts and special protocol. The method consists of using a series of casts, gentle manipulation and the use of a special brace. This treatment is 95+% effective and it is the most cost effective treatment with no side effects. Treatment should start soon after birth.

Older Children:

Recent research has shown that the Ponseti Method is effective for

children as old as ten, even in cases of failed surgery. Check out the PIA sponsored Philippines website to learn more about success stories of older children treated with clubfoot. You can also read stories written by parents of older children treated by the Ponseti method.

Clubfoot in developing countries:

Clubfoot is a serious problem in many developing countries. The majority of cases of clubfoot occur in these areas, about 80%, and there are high incidences of neglected clubfoot. Neglected clubfoot limits the prospects of those living in developing countries as they often are unable to walk without great pain and do not have many job opportunities or the ability to carry out many daily tasks. The Ponseti method is very cost effective and various healthcare providers can perform the treatment making the Ponseti method a practical option for eradicating clubfoot around the world.

Commonly Asked Questions about Clubfoot Treatment

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To Parents of Children Born with Clubfeet

Commonly Asked Questions on Clubfoot Treatment

Ignacio Ponseti, MD

Department of Orthopaedic Surgery, University of Iowa Hospitals and

Clinics

Last Revised: March 2004

Peer Review Status: Internally Peer Reviewed

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Does surgery "cure" clubfoot?

Surgery does not "cure" clubfoot. It improves the appearance of the foot but diminished the strength of the muscles in the foot and leg, causes stiffness in the second and third decade of life, if not earlier, limits the motions of the foot joints, and the foot becomes often painful at midlife. Surgery does not prevent the recurrence of the deformity in a number of cases. To my knowledge not followup studies of operated patients older than 16 years of age has been published to date. Therefore, orthopaedic surgeons are ignorant of the results of their surgeries.

Foot and ankle surgeons, however, who treat adult patients have noticed that those surgically treated for congenital clubfoot in infancy have weak, stiff and often very painful feet.

How long has clubfoot been treated in this manner?

Clubfeet have been treated with manipulations, bandages, braces, and plaster casts for centuries. The practice of heel-cord tenotomy

was started in the middle of the 19th century; extensive ligament release surgery has become the fashion in the past 50 years.

When should a baby with clubfoot begin the Ponseti Method?

When a baby is born with clubfeet, an orthopaedic surgeon with expertise in the manipulation and plaster-cast method devised by Dr. Ponseti in the late forties, should be sought to start correcting the deformity soon after birth, (7-10 days).

How often do the manipulations need to take place to correct clubfoot in otherwise normal children?

Most clubfeet in otherwise normal children can be corrected with manipulations every 5 to 7 days followed by plaster-cast applications. If the deformity is not corrected in 5 to 7 plaster-cast changes, the treatment is most likely faulty.

What is metatarsus varus or metatarsus adductus?

A foot deformity called metatarsus varus or metatarsus adductus is often confused with the clubfoot deformity. The metatarsus adductus is a mild turning in of the foot which often corrects by itself. The heel is never in equinus (unyielding plantar flexion). In more severe cases it can be easily corrected with two to three plaster-cast applications. Some doctors believe they have corrected clubfeet when they have

corrected metatarsus adductus.

What is the manipulative treatment of clubfoot deformity based on?

The manipulative treatment of clubfoot deformity is based on the inherent properties of the connective tissue, cartilage, and bone, which respond to the proper mechanical stimuli created by the gradual reduction of the deformity. The ligaments, joint capsules, and tendons are stretched under gentle manipulations. A plaster cast is applied after each manipulation to retain the degree of correction and soften the ligaments. The displaced bones are thus gradually brought into the correct alignment with their joint surfaces progressively remodeled yet maintaining congruency. After two months of manipulation and casting the foot appears slightly overcorrected. After a few weeks in splints however, the foot looks normal.

Proper foot manipulations require a thorough understanding of the anatomy and kinematics of the normal foot and of the deviations of the tarsal bones in the clubfoot. Poorly conducted manipulations will further complicate the clubfoot deformity. The non-operative treatment will succeed better if it is started a few days or weeks after birth and if the orthopaedist understands the nature of the deformity and possesses manipulative skill and expertise in plaster-cast

applications.

What does a foot look like in an adult born with unilateral clubfoot deformities that was treated with the Ponseti Method?

In all the patients with unilateral clubfoot, the normal foot was slightly longer (mean 1.3 cm) and wider (mean 0.4 cm) than the clubfoot. The limb lengths, on the other hand, were the same, but the circumference of the leg on the normal side was greater (mean 2.3 cm).

Where can I find more information about the Ponseti Method?

The Ponseti method, which more and more doctors are becoming acquainted with, is described in detail in his book *Congenital clubfoot. Fundamentals of Treatment* (Oxford University Press), 1996. *Congenital Clubfoot: Fundamentals of Treatment* (Oxford University Press), 1996. Available through Dept. of Orthopedic Surgery, University of Iowa Hospitals and Clinics, Iowa City, Iowa 52242. E-mail [ignacio-ponseti@uiowa.edu](mailto:ignacio-ponseti@uiowa.edu). Or read it online. Click [here](#) to register to read the Ponseti Book.

Another informative publication is *Clubfoot: Ponseti Management*. Global-HELP Publications. Web site: [global-help.org](http://global-help.org)

What is the incidence of clubfeet in children where one or two

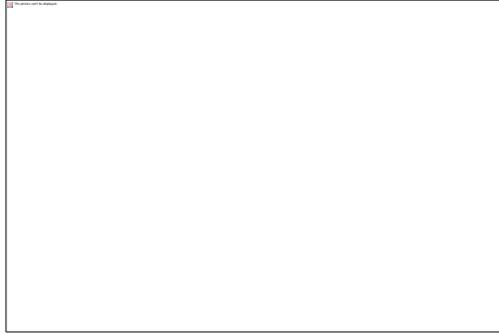
parents are also affected?

When one parent is affected with clubfoot, there is a three to four percent chance that the offspring will also be affected. However, when both parents are affected, the offspring have a 15% chance of developing clubfoot.

How to recognize the Ponseti Method

Approved by Jose Morcuende (Ponseti International Association), MD, PhD, April, 2008

Many physicians claim to be proficient in the Ponseti method, but they are not. It is not because they are "bad" doctors; it is because the Ponseti method is not taught in medical school, so the only way to learn is through a training program. Also, there are casting methods that predate the Ponseti method, and many doctors do not understand the difference. Below are the basics of the Ponseti method and if your physician is deviating, without a good reason (for instance, if your child is 2 or older there may be some deviations to the method), please contact PIA.



Toe to groin cast

The Ponseti casts are long leg casts. They should be over the knee (from toe to groin) and well molded onto the foot. Casts should be removed only before a new cast is put on to guard against relapse. Plaster casts are the best material for making Ponseti casts. Some doctors will use soft fiber, that is okay, but it is harder to get the well-molded casts using soft fiber, and there is scientific evidence that the results are worse.

For newborns, unless the foot is very stiff, only about 5-6 casts should be used (95% of the cases). If the doctor has to use more than eight casts, their method is probably not well perfected. Each time a new cast is used the outward rotation of the foot should change by about 10-15 degrees. The last cast should be set to about 70 of abduction (external rotation).



From left to right, these casts show the increase in outward rotation as prescribed by Dr. Ponseti.

Most children treated with this method will need a heel cord tenotomy (clipping of the tendon). This is the only invasive part of treatment, though it is much less invasive than surgical treatment. It is typically done before the final cast is put on (almost never before). The reason for this procedure is that the heel cord is resistant to stretching. The tenotomy used is called a percutaneous tenotomy, and is different than an open incision, z-lengthening tenotomy or heel cord lengthening. This procedure will most likely be done under local anesthesia and takes about 10 minutes to perform. The physician will use a very thin knife and cut the heel cord. No stitches are necessary after this process. The last cast, put on after the tenotomy, will be left on for two and a half to three weeks to help with healing.

The brace should be used the same day the last cast is taken off. Do

not wait a few days to get it. It will result on an early relapse. For more information on the brace, read our bracing instructions.

Relapses and Bracing for Children Treated with the Ponseti Method

Approved by Dr. Morcuende, Ponseti International, and Orthopedic Surgeon at University of Iowa Hospitals and Clinics

Relapses are a common occurrence among children with clubfoot up to the age of six years. The following is the rate of relapse for discontinuing brace-wearing at the age designated: 1st year 90 percent, second year 70-80 percent, third year 30-40 percent, 4th year is 10-15 percent, subsequent years are about 6 percent. Bracing is an essential part of the treatment of clubfoot and prevents relapses very effectively. Severity of the deformity at birth is not a reliable indicator of the odds of relapse, therefore almost all clubfoot patients are held to the same bracing protocols in order to provide them with the best protection against regression.

Bracing protocol needs to be tailored to the individual child based on the age, the relapse rate associated with that age, and when the correction was finished. For example, bracing hours will be longer for

a new born that was corrected in three weeks as opposed to an older child that is already walking when correction is achieved. Importantly, the underlying cause of clubfoot is a muscle developmental and growth problem, so it is very important that children who are using the brace maintain some degree of mobility.

The foot abduction brace is used only after the clubfoot has been completely corrected by manipulation, serial casting, and possibly a heel cord tenotomy. The foot abduction brace, which is the only successful method of preventing a relapse, when used consistently as described is effective in > 95% of the patients. Use of the brace will not cause developmental delays for the child.

A Foot Abduction Brace (also commonly mis-labeled a Denis Brown Bar or DBB) consists of an adjustable length aluminum bar with adjustable footplates onto which shoes attach. It is recommended that an adjustable bar is used instead of a fixed length bar because the child will quickly outgrow the fixed length bar. The orientation of the footplates to the bar is set by the orthotist as recommended by your doctor. Typically, the shoes are set at 60-70 degrees of external rotation. The last cast applied by the doctor must also have been rotated to the 60-70 degrees of abduction (external rotation), otherwise the brace will be uncomfortable for the child. There should be a bend in the bar or the mounting of the footplates to obtain 10-15

degrees of dorsiflexion. The shoes are straight last, meaning there is no curvature, so they can go on either foot. If the bar does not have a quick-release mechanism, the shoes are oriented with the buckles on the inside, so that you do not have to turn the baby over to tighten the strap and laces. Importantly, the distance between the inside edges of the heels of the shoes is equivalent to the child's shoulder width. This distance is the most comfortable for the child and prevents knee or hip problems. If you lay the brace on the floor with the shoes facing upward, the child's shoulders should fit snugly in between the shoes. Children go through major growth spurts, so if your normally agreeable child is suddenly waking and fussing, it is appropriate to check the length of the brace to see if an adjustment needs to be made prior to their next follow up appointment with the doctor. The FAB holds the foot in the proper abduction (external rotation) and dorsiflexion (forefoot lifting up toward the calf) to keep the foot properly stretched.

#### Wearing Schedule:

Use the brace once the last set of casts is removed. DO NOT wait to get the brace after the cast is removed since there is a high chance of regression that can lead to discomfort and non-acceptance of the

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brace. If the brace is not ready, a holding cast should be applied to maintain final correction. It is also important not to end treatment early; if you are unsure about a recommendation contact UI Orthopedics at (319) 356-3469 or (319) 384-0841. Or send an email to [info@ponseti.info](mailto:info@ponseti.info). This e-mail address is being protected from spam bots, you need JavaScript enabled to view it This e-mail address is being protected from spam bots, you need JavaScript enabled to view it.

The following schedule is recommended:

- A. For young babies with clubfeet corrected in the first few months of life:
  - i. 23 hours for the first 3 months.
  - ii. Then wean down to 16 hours per day and progressively decrease the bracing time for the goal of 12-14 hours per day by age 1. After 1 year of age, down to 10-12 hours of brace wear daily. The time in the brace does not need to be consecutive, but try to have the bulk of the time while the child is sleeping nights and naps to encourage mobility during the waking hours. If your child attends a daycare, consider leaving the brace on in the morning and instructing the daycare as to what time each day that the brace should be removed, or if your daycare providers are confident and willing, instruct them how to

remove and reapply the brace for nap times.

iii. As the child grows and is walking full time, maintain night-time wearing of the brace for 12-14 hours per day up to age 4-5 years.

B. If the final correction is achieved after 8-9 months of age and the child is ready for crawling or walking, it is important to allow some mobility to help in the development of the weak muscles.

i. Therefore, it is recommended to start initial bracing with 18-20 hours a day for 2 months, then go to 16 hours a day for 3-4 months, and then to the standard maintenance protocol of 12-14 hours to age 4-5 years.

C. Some children with clubfoot (about 2 or 3 percent) may also have loose joints.

i. In these cases, the abduction (external rotation) of 60 to 70 degrees may lead to flat foot, usually presenting when the patient starts walking at 10-16 months of age and after. These children should set the shoe to 30-40% abduction. Do not stop using the brace as there would be risk of relapse.

D. If the child has atypical/complex clubfoot.

i. After correction the shoe used for the affected foot should be set to 20-30 degrees. There should not be bending on the bar unless

there is 10-15 degrees of dorsoflexion with the last cast. As the foot becomes more normal looking the abduction (extended rotation) of the shoe should be changed to 40-50 degrees.

E. For those children who are treated 2 and older at the time of correction please refer to Dr. Morcuende at UIHC at (319) 356-3469 for specific instructions.

Wearing instructions:

1. Always use cotton socks that cover the foot everywhere the shoe touches the baby's foot and leg. Your baby's skin may be sensitive after the last casting, so you may want to use two pairs of socks for the first two days only. After the second day only use one pair of socks. Pull the toe of the sock out lightly if the seams are pressing on the child's toes.
2. If your child does not fuss when you put the brace on, you may want to focus on getting the worst foot in first and the better one in second. However, if your baby tends to kick a lot when putting on the brace, focus on the better foot first, because the baby will tend to kick into the second shoe.
3. Place the foot into the shoe, bend the child's knee and push down slightly to make sure the heel is seated and then press gently on the top of the foot (where the leg meets the foot) with your thumb, to

make sure that the foot is all the way in, and tighten the strap first (for the Ponseti/Mitchell-style sandal, tighten the middle strap first). The strap helps keep the heel firmly down into the shoe. You can mark the hole on the strap that you use, but because the leather will stretch with use, and because your child's foot will grow, you will have hole adjustments after some time, so make new marks as necessary.

4. Check that the child's heel is down in the shoe by pulling up and down on the lower leg. If the toes move backwards and forwards, the heel is not down, so you must retighten the strap. A line should be on the insole of the shoe, indicating the location of the child's toes; the toes will be at or beyond this line if the heel is down. Again, the line in the shoe may need to be redrawn with time.

5. Lace the shoes tightly. Do not cut off circulation.

6. Run your finger under the baby's toes to ensure that they are straight and none of them are bent under.

Setting up the Brace:

The brace can be set-up by following the recommendations of your doctor or by the personnel at your doctors office, but you may be

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responsible for changing the shoes and widening the bar as your child grows. Your doctor should verify that the brace is set up per his/her instructions. New shoes are needed when the baby's toes completely curl over the edge of the shoe. The forefoot adduction usually does not recur, so if the front of the foot is not completely in the shoe, it's not a concern for regression as long as the rest of the shoe is still fitting well. If you do not know what sizes of shoes were used on the bar, measure the length of the shoe and contact your brace provider. New shoes will typically be two sizes larger than the current shoes to allow for growth. Screws are used on the bottom of the shoes to attach the shoes to the footplate on the bar. For children who are wearing the quick release shoes the shoe clicks on the piece that is screwed to the bar. Mark the joints on the bar with a permanent marker before changing the shoes to ensure a return to the proper alignment. Attach the shoes with the buckles toward the inside. You should check the width of the bar and adjust it as needed. Measure the distance between the outside of the shoulders, set the length of the bar so that this length falls somewhere between the following: the narrowest setting would be equal to the distance between the center heel screws in the shoe and the widest setting equal to the inside edges of the heels of the shoes (baby's shoulders fit between the shoes). The difference between the narrow and wide points will

increase over time as the size of the shoe increases resulting in the attachment point being farther away from the heel. You may need to play with the settings to see what is most comfortable for your child. Mark a line for the location of the toes the first time the shoes are worn, to indicate that the heel is down. Note that if a child was recently casted, it is normal for the foot to have some initial swelling, so the line may not be accurate just a few days later.

#### Helpful Tips:

1. Expect your child to fuss in the brace for the first 2 days. This is not because the brace is painful, but because it is something new and different. They may have sore muscles and skin sensitivity as a result of the casting. If your child is completely inconsolable and you believe that they are in pain, contact your doctor right away.

2. Play with your child in the brace. This is a key to getting over the irritability quickly. The child is unable to move his/her legs independent of each other. You must teach your child that he/she can kick and swing the legs simultaneously with the brace on. You can do this by gently flexing and extending the knees by pushing and pulling on the bar of the brace. Try making a game of the motions,

singing and or talking to your child in an encouraging manner.

3. Make it a routine. Children do better if you make this treatment a routine in their life. When the child is only wear the brace at night and naptime, put the brace on any time your child goes to the “sleeping spot.” They will figure out that when it is that time of day they need to wear the brace. Your child is less likely to fuss if you make the use of this brace a part of the daily routine, just like putting on their pajamas, brushing their teeth, and reading books at night. The brace should be a non-negotiable part of your child’s routine, just as you make them sit in a car-seat. Some parents have made a brace for the child’s favorite stuffed animal or doll to wear. Show your child pictures of other children with clubfoot wearing their brace and use rewards and incentives to help your child understand the importance of the brace. For older children, as your doctor to talk to the child at their follow up appointments about their brace and how it helps them keep their feet perfect.

4. Pad the bar. A bicycle handle bar pad, or foam pipe insulation covered with fabric or tape works well for this. By padding the bar you will protect your child, yourself, and your furniture from being hit by the bar when the child is wearing it. Placing a sleep sack (gro-bag)

on the child at night will also help with padding and keep the baby from pulling at the straps and laces with their hands.

5. Never use lotion on any red spots on the skin. Lotion will make the problem worse. Some redness is normal with use. Bright red spots or blisters, especially on the back of the heel, usually indicate that the shoe was not worn tightly enough. Make sure that the heel stays down in the shoe. If you notice any bright red spots or blistering contact your physician.

6. If your child continues to escape from the brace try the following: (check after each step to see if the heel is down, if not proceed to the next step)

a. Tighten the strap by one more hole

b. Tighten the laces

c. Remove the tongue of the shoe (Use of the brace, without the tongue, will not harm your child)

d. Try lacing the shoes from top to bottom, so that the bow is by the toes.

e. Check the width of the brace and widen if necessary.

f. If you think the foot is regressing, talk to your doctor about the possibility of additional casting.

g. Some clubfoot are classified as atypical and are best held in the Ponseti/Mitchell FAB due to cavus issues. Talk to your doctor about this specific condition that is most commonly identified by a short, fat foot with a deep medial crease.

7. Periodically tighten the screws on the bar. Tools have been provided.

"Parents of infants born with clubfeet may be reassured that their baby, if otherwise normal, when treated by expert hands will have normal looking feet with normal function for all practical purposes. The well treated clubfoot is no handicap and is fully compatible with normal, active life." Ignacio Ponseti, M.D.

Ponseti International Association, in collaboration with the Patient Education Institute, created easy to understand interactive educational tutorials about clubfoot for patients, parents, and providers. Click on the following links to learn more about clubfoot.

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### What is clubfoot?

Clubfoot is a congenital deformity of the foot that occurs in about 150,000-200,000 babies each year worldwide. Clubfoot results from

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the abnormal development of the muscles, tendons, and bones in the foot while the fetus is forming during pregnancy. While researchers have been unable to pinpoint the exact cause of clubfoot, both genetic and environmental factors are thought to play a role. Clubfoot is about twice as common in boys and occurs in both feet about 50% of the time. Clubfoot in an otherwise normal child can be corrected using the Ponseti method of manipulation and plaster cast applications, with minimal or no surgery. Minimal surgery includes tenotomy (clipping of Achilles tendon in about 80% of the cases) and anterior tibial tendon transfer (ATT in about 25% of the cases). The procedures are described in detail in the Ponseti Method Book.

How is clubfoot treated?

Clubfoot in an otherwise normal child can be corrected using the Ponseti method of manipulation and plaster cast applications, with minimal or no surgery. Ideally, the treatment should begin in the first week or two of life in order to take advantage of the elasticity of the tissues that form the ligaments and tendons in the foot. However, beginning treatment at a later age produces good results as well.

The Ponseti method to treat clubfoot

More than 50 years ago, Dr. Ignacio Ponseti developed an innovative, non-surgical treatment for clubfoot that involves the gentle, manual

manipulation of the child's foot and the application of toe-to-groin plaster casts. Over the course of several weekly sessions, the ligaments and tendons of the foot are gently stretched and then a cast is applied to keep the foot in its new corrected position. This method is repeated for five to eight weeks, and gradually, the displaced bones are brought back into alignment. Before applying the last plaster cast, which the baby will wear for approximately three weeks, the Achilles tendon is often cut to complete the correction of the foot and by the time the cast is removed, this tendon will regenerate to a proper length. In order to prevent relapse following the casting process, the child will be fitted with a splint consisting of a bar with high top, open-toed shoes attached. The child will need to wear this splint full-time for the first 2-3 months and then at night for 2-4 years.

Talk to other parents

The most adamant supporters of Dr. Ponseti and his method to treat clubfoot are the parents of children who have recovered from this condition. Dr. Ponseti regularly receives thank you letters and photos from former patients and many families are eager to share their stories with other parents. There are numerous websites and online support groups for parents of children with clubfoot.

What is the future of children with clubfoot?

Babies treated using the Ponseti method will have normal looking feet, with good mobility and function throughout life. The long term outcomes from this technique have far exceeded those of surgical treatments. Patients treated surgically develop stiffness, pain, and other physical disabilities.

Will my child be able to play sports?

Follow-up studies of clubfoot patients treated using the Ponseti method show that children and adults with corrected clubfoot may participate in athletics like anyone else. In fact, there are several well-known athletes that were successfully treated for clubfoot as infants including Troy Aikman (former Dallas Cowboys quarterback), Mia Hamm (professional soccer player), and Kristi Yamaguchi (figure skating gold medalist).

What about surgery?

Surgery does not cure clubfoot. Although the foot looks better after surgery, children will experience stiffness, weakness and pain, and during adolescence this pain often becomes crippling. Dr. Ponseti developed this method to treat clubfoot as an alternative to surgery after his research revealed very poor long term results among surgical patients.

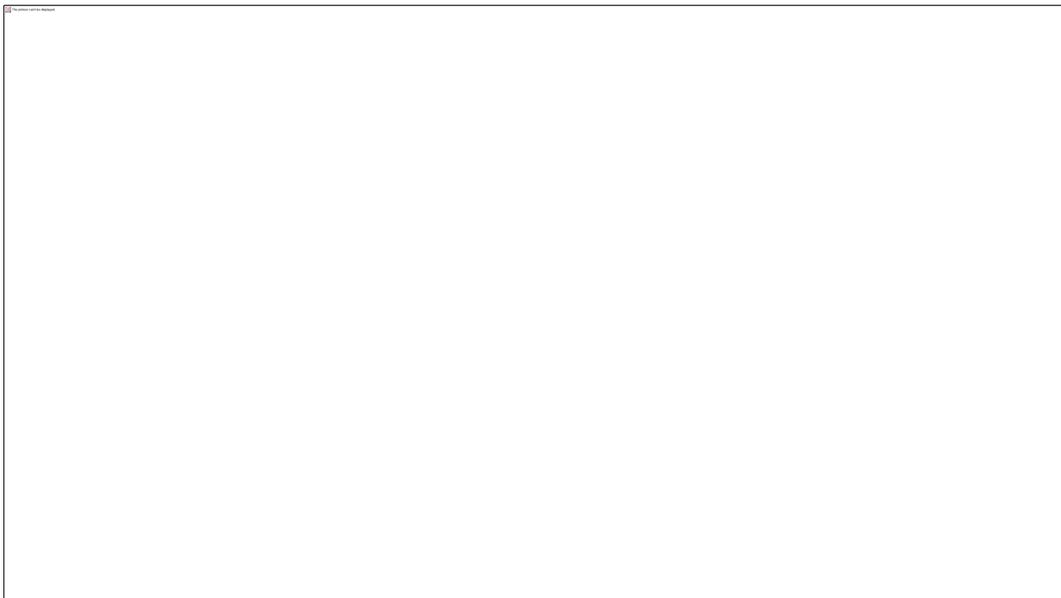
If you are unsure about any of these recommendations, or have a question about bracing that has not been addressed please contact Dr. Morcuende at UI Orthopedics by calling (319) 356-3469 or (319) 384-0841. Or send an email to [info@ponseti.info](mailto:info@ponseti.info). This e-mail address is being protected from spam bots, you need JavaScript enabled to view it.

## Treating Older Children

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### Important Information for Parents of Older Children with Clubfeet

approved by Dr. Morcuende M.D., P.h.D, Ponseti International Association



Getting older children from here.....to here

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For many years, many Ponseti trained doctors were unsure about the effectiveness of the Ponseti method for treatment of children 2 and older. However, recent research has shown that this method can be effective for children with neglected clubfoot and children who have had failed surgery. The oldest child successfully treated with the Ponseti method for failed surgery was 10 at the time of treatment. Ponseti trained doctors have now treated dozens of older children. Listed below are some modifications of the Ponseti method for older children as well as other information to be aware of.

**If you have a child 2 or older with neglected clubfoot or failed surgery, talk to your orthopedic surgeon about what might be different about treatment.**

**Important information to be aware of:**

According to research done by several Ponseti trained physicians the **average number of casts for older children is about 10**. The doctor should also spend more time manipulating the foot during visits (about five to ten minutes) to allow for greater stretching of the soft tissue. Each cast needs to be worn for a longer period (about two weeks) than for younger children. Because there will be some side effects of long periods of casting, it is advisable to allow the child to walk on the cast and also in each visit to the clinic after the cast is

removed. This will reduce stiffness and muscle atrophy.

**The doctor will also correct the foot to 30 to 40 degrees abduction** (30 to 40 degrees away from the midline of the body) as opposed to 70 degrees for younger children. This does not limit the effectiveness of the Ponseti method for treatment of older children.

**After treatment, all children need to wear a brace to prevent relapses.** A brace is kind of like a retainer for your foot; it keeps the foot from turning back inward. In general, it is used as in younger kids until the age of 4 years. After that age, some doctors will recommend a muscle transfer to balance the foot, therefore, allowing not using the brace.

**Physical therapy is a very important tool used to help older children maintain correction** as it helps improve muscle strength. Ask your doctor about where to find physical therapists in your area.

Parents' Websites

About ten years ago parents of children with clubfoot began corresponding about the Ponseti Method through health groups on yahoo.com and other forums. This communication has been instrumental in making the Ponseti Method more widely known and utilized. Here is a list of some communication forums and websites, and non-for profit groups which actively support the Ponseti Method.

U.S. based

Contacts for parents near you:

<http://ponsetikids.freesevers.com/home.html>

Discussion groups:

Nosugery4clubfoot (a yahoo group first started in the mid ninties).

Familiiy Websites:

[http://members.tripod.com/ponseti\\_links-ivil/id7.html](http://members.tripod.com/ponseti_links-ivil/id7.html)

<http://six-feet.com/>

Ponseti around the world

Brazil

discussion groups:

<http://br.groups.yahoo.com/group/petorto/>

Bulgaria

<http://equinovarus.hit.bg/>

France

<http://piedbot.ifrance.com/index.htm>

Germany

[www.ponseti-fuesse.de/](http://www.ponseti-fuesse.de/)

Ireland

discussion website:

[www.talipestogether.com](http://www.talipestogether.com)

Italy

[piedetorto.editarea.com](http://piedetorto.editarea.com)

Laos

[www.ponseti.info/laos](http://www.ponseti.info/laos)

Lithuania

Family websites:

<http://www.sleivapedyste.projektas.lt/>

Philippines

[www.ponseti.info/phiippines](http://www.ponseti.info/phiippines)

Portugal

support groups:

<http://peboto.grupos.com.pt/>

Uganda

Uganda Sustainable Clubfoot Project:

[www.ponseti.info/uganda](http://www.ponseti.info/uganda)

United Kingdom

[ponseti.org.uk](http://ponseti.org.uk)

[www.steps-charity.org.uk](http://www.steps-charity.org.uk)

South Africa

[www.clubfoot.co.za](http://www.clubfoot.co.za)

Spain

Family Websites:

<http://piezambo.com/>

## Resources

Supplies:

Braces:

U.S. based:

<http://www.mdorthopaedics.com/>

Europe based:

<http://www.c-prodirect.co.uk>

## Clubfoot Glossary

Approved by Dr. Jose Morcuende, M.D. P.h.D., Ponseti International Association

**Abduction:** Movement of a limb away from the midline (middle) of the body.

**Achilles Tendon:** The tendon that joins the bone of the heel to the calf muscle.

**Adhesion:** Abnormal union of bodily tissues restricting movement.

**Anterior:** At, or towards the front.

**Bilateral clubfoot (BCF):** Both feet are affected.

**Calcaneus:** Heel bone.

Clubfoot (also known as talipes equinovarus):

When clubfoot occurs the foot is twisted inward and down, and this condition occurs during development in the womb. Physicians have observed that fetuses that develop clubfoot start with a normal foot and then the foot begins to turn inward around the third month. Most children born with clubfoot are not missing any bones, muscles, or connective tissue. It is a congenital condition, meaning that when it occurs it is always present at birth. It is one of the most common congenital deformities. One or both feet may be affected and the affected feet can range from relatively flexible to stiff and rigid. The condition is not painful for the new born, though when a child gets to walking age, walking with an uncorrected clubfoot can be very painful and difficult, if not impossible.

Congenital: A condition that is present at birth.

Deformity: A condition where some part of the body is drastically different from normal in terms of size, or shape.

Dorsal: Top of foot.

Dorsiflexion:

When referring the ankle, dorsiflexion is the ability to bend at the ankle, and move the foot upward.

Eversion: Turning the sole of the foot outward.

Foot Abduction Brace (FAB): A Foot Abduction Brace (also commonly mis-labeled a Denis Brown Bar or DBB) consists of an adjustable length aluminum bar with adjustable footplates onto which shoes attach. It is recommended that an adjustable bar is used instead of a fixed length bar because the child will quickly outgrow the fixed length bar. The orientation of the footplates to the bar is set by the orthotist as recommended by your doctor.

Idiopathic: Of unknown cause.

In Utero: When the baby is in the womb.

Inversion: Turning the sole of the foot inward.

LCF (left clubbed foot): The left foot is affected with clubfoot.

Ligament: Connective tissue binding bone to bone.

Maceration: Skin softened by soaking. Maceration can occur if a child's skin becomes wet under the cast. The skin breaks down and this process is painful.

Manipulation: Manually stretching the foot into an over-corrected position.

Orthopaedics: A medical discipline concerned with correction of skeletal deformities.

Orthosis: Brace or splint used for support.

Osteotomy: Surgical operation that cuts through the bone.

Plantigrade: Walking flat on the sole of the foot.

Plantar Surface: Sole of foot.

RCF (right clubbed foot): The right foot is affected with clubfoot.

Relapse: When the foot returns to being a clubfoot after being corrected.

Tenotomy: Surgical procedure that slices the tendon to lengthen the muscle.

Tibia: Shin bone.

Unilateral clubfoot: Only one foot is affected by clubfoot.

Valgus: Directed away from the midline of the body.

Varus: Directed towards the midline of the body.

Special Thanks Again To Iowa University for Allowing Us To Use Their Web-Site Information For Our Course.

## Metatarsus Adductus

This forefoot deformity is also called metatarsus varus. Metatarsus is an adduction (toward the median plane of body) or varus (angled or turned inward toward the body's midline). The anterior part of the foot, including all metatarsals (concerning the arch of the foot) is adducted as well as supinated (rotated outward) this is associated with a tibial torsion deformity. The incidence is approximately two per 1,000 births and is usually bi-lateral. Metatarsus adductus is one of the causes of a pigeon-toed gait.

Treatment for a minimal deformity consists of stretching exercises five to six times daily by parents with attention given to sleeping posture. Sleeping with the feet turned in aggravates the deformity.

Treatment, if not minimal would be casting to gradual reduction of the deformity. After six to 12 weeks, a boot splint is worn nightly. This splint will be worn for several months to maintain the correction. This also treats the internal tibial torsion. Corrective shoes are worn during awake hours for the first year.

This deformity becomes more rigid each month, especially without treatment. When walking begins, a child will trip over their own feet. Untreated severe metatarsus adductus may need a soft-tissue release surgery, or an osteotomy might need to be performed.

Nursery and OB nurses play a big role in early detection and referral of an affected child. Nurses can help parents understand the importance of

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regular cast and splint changes. Parents should be instructed to observe for signs of circulatory impairment. It may also be the nurse's role to demonstrate care measures of the application and removal of the splints. Make sure to work with the parents for the best possible results for a child with Metatarsus Adductus.

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## Pes Planus: Flatfoot

An infant has “baby fat” in the arch area, and will present with flat feet. As the infant grows, the child may develop an arch as the fat is reabsorbed over time. As a child grows, watch for walking changes like tripping, falling or turning in of feet.

Developmental and congenital conditions including, Pes planus (flatfoot) a common complaint from parents to a primary care physician. It can be referred to as Pes Plannus, Pes Planovalgus, Valgo Plannus or Pronation Syndrome. Flatfoot is commonly described as a foot without an arch. Approximately 97% of newborn feet are visually flat. Flatfoot is normal in children under three years of age. It presents with minimal or no medial longitudinal arch and is common in children up to age 7, flat foot occurs in 10 out of 235 of the general population.

The two basic forms are:

1. Flexible flatfoot: The foot appears normal when the child is sitting. The arch collapses when the child bears weight on the foot. This form is less severe and more common.
2. Rigid flatfoot: The arch appears flat when the child is sitting.

The child has a presence of an arch while also toe-standing or sitting. Children who report pain after activity may benefit from rigid arch support. In young athletes, excessive pronation which may increase risk of ankle injury and correction orthotics may decrease this risk.

Flat feet that are painful should be imaged to rule out anatomical variants including tarsal coalition and vertical talus or accessory navicular. Achilles contracture may result in progressive flat foot deformity or pain. Rigid flat feet have an absence of the arch during toe-standing and sitting and have limited motion at the subtalar joint.

Causes of rigid flat feet include anatomic variants such as tarsal coalition and arthritis of the subtalar joint.

Once past the toddler years, it is a good idea to see a pediatric podiatrist who will evaluate the entire lower extremity for weakness and pain. By this time, a child could be complaining of pain in their foot or ankle. A child with clubfoot may also be clumsy and may have a decrease in activity. It is common for children to fall and cry of the foot pain. Night pain to legs might indicate stress on legs from flattening of the feet. X-rays will be taken to evaluate the joints and bone alignment at this time.

A tight calf is common in all flatfoot patients. Children will start early with physical therapy to learn stretches and exercises that target the calf muscles.

Children with flat feet may have abnormal shoe wear. Normal shoe wear would be on the outside of the back heel and inside the toe. Too much wear on the inside of the heel, arch area or toe may indicate additional pressure in these areas.

Orthotic treatment is the treatment of choice for treating flatfeet. The custom shoes will assist with foot function. Orthotics are custom made and are designed to address each child's specific foot structure and underlying

foot problems. Bracing may be used in addition to the orthotics. The goal is to prevent the flatfoot from progressing and hopefully reduce the current pain.

Surgery is a last resort treatment after all conservative treatment has been exhausted. Surgery is only done if a child continues to have pain and disabling fatigue. For children who have bones in their foot that are fused, their condition may improve significantly with a surgical procedure to correct the deformity.

In cases where the child's flat foot is flexible, an implant can be placed in the rear part of the foot. One type of implants is the hyprocure. The procedure is very fast, taking only about 7 minutes, and is done through a very tiny incision. This implant causes an immediate arch and is rarely ever removed. This procedure is done in children with severe pain in the arch, and because the arch is so collapsed it leads to arthritic conditions as the child grows older.

Remember, it is better to treat children with flat feet with the symptoms of foot pain and fatigue immediately and on a conservative basis around the age of three, or it becomes more difficult to correct.

## Pediatric Foot Epiphyseal Injuries

Foot pain is common in the pediatric population. Pain can usually be localized to the forefoot, midfoot, hindfoot or ankle. Painful conditions are usually related to skeletal maturity and are fairly specific to the age of the child. These issues can be related to skeletal maturity. With the pediatric

population there may not be a clear history of a traumatic event. With this population there are many, non-traumatic diseases that present as injuries.

The fore foot includes: metatarsals, phalanges and sesamoids.

The midfoot includes: tarsal bones (navicular, cuboid, and three cuneiforms).

The hindfoot includes: talus, and calcaneous.

The Lisfranc joint includes the five metatarsophalangeal (MTP) joints and separates the midfoot and forefoot.

The talonavicular and calcaneoboid articulation (chopart joint) separates the midfoot from the hindfoot.

**Imaging:** radiograph

Foot X-ray series are only necessary if there is pain in the mid-foot zone and including:

1. Bone tenderness at the base of the 5<sup>th</sup> metatarsal.
2. Bone tenderness at the navicular bone.
3. Inability to weight bears both immediately and in the emergency room department.

An important fracture that happens in children is an epiphyseal fracture of the foot or ankle in children, because it can disrupt growth. Growth plate injuries occur in girls until about the age of 16 and boys till about 18 years of age. Treatment of an epiphyseal fracture of the foot or ankle should be individualized and should be followed at regular intervals for two years or to skeletal maturity if the physeal is disturbed.

An epiphysis comes from the Greek word epiphyses, which means “a growing upon”. Epiphysis in an infant or child during development has a secondary bone forming center which is called an ossification. Ossification is

the formation of bone matrix. Ossification can also be the replacement of other tissue by bone as seen in fetal development.

Endochondral ossification is the formation of bone in cartilage, as in the formation of long bones. This involves the destruction and removal of cartilage, with the formation of osseous tissue in the space formerly occupied by the cartilage.

Epiphyseal disk or plate is the growth plate that determines the length and shape of a mature bone. The plate is found in children and adolescents. The growth plate is the weakest area of the growing bone. When growing has stopped, this plate is replaced by an epiphyseal line. When the disk or plate is interrupted a child's growth can also be stopped by this interruption and growth deformities can happen. Most growth Plate in fractures heals without permanent deformity. However, a small percentage has complicated growth arrest and subsequent deformity.

Thorough knowledge of the functional growth plate anatomy and physiology of the foot and ankle is vital to the proper management of epiphyseal foot and ankle injuries. The ability to classify a foot or ankle fracture according to the Salter-Harris anatomic and radiographic classification system provides prognostic information that aids in proper treatment of the fracture.

The Salter-Harris anatomic and radiographic classification for growth plate fractures:

The Salter-Harris Classification Chart Type I – Type V.

1. Salter-Harris type I- A complete physeal (growth plate/disc) fracture with or without displacement. On radiograph the fracture may not be seen. It is however common to see a widened physeal.

2. Salter-Harris type II- A physeal fracture that extends through the metaphysis. This produces a chip fracture, usually of the metaphysis. This may be very small.
3. Salter-Harris type III- A physeal fracture including the physis and epiphysis that extends through the epiphysis.
4. Salter-Harris type IV- A physeal fracture including a physis, epiphyseal and metaphyseal fracture.
5. Salter-Harris type V- A compression fracture of the growth plate caused by a compression injury to the physis. An absent physeal area between the metaphysis and the epiphysis on the radiograph.
6. Salter-Harris type VI- Include injury to the perichondral structure, however these are rare.
7. Salter-Harris type VII- Isolation injury to the epiphysis only.
8. Salter-Harris type VIII- Isolated injury to the metaphysis.
9. Salter-Harris type IX- an injury to the periosteum which could interfere with membranous growth.

Types III, IV and V fracture usually require anatomic reduction with internal fixation to avoid growth arrest. Salter-Harris type V has the poorest prognosis and the greatest impact on bone growth and development, leading to potential deformity. The rate of growth disturbance is approximately 30%. Only 2% of Salter-Harris fractures lead to significant functional disturbance according to [www.parkhurstexchange.com](http://www.parkhurstexchange.com). These patients must be followed long-term to assess for growth problems.

### **Common fracture of the feet:**

Stress fractures due to failure of bone homeostasis. This is caused by four main mechanisms:

1. Repetitive muscle contraction leading to bony overload.
2. Increased bone stress following muscle fatigue.
3. High repetition of low stress activity.
4. Increased loads on hard surfaces.

Possible other factors include poor arch support from footwear, including improperly fitting footwear. Running on hard surfaces also increase risk of stress fractures. Treatment is discontinuing activity for 8-16 weeks or longer to return to full athletic activity. Apophyseal injuries are a common overuse injury and the cause of pain in the adolescent athlete.

Other factors that can also lead to stress fractures include poor nutrition and females with amenorrhea. In these cases the second and third metatarsal are most commonly injured. Injury to the metatarsal may include injury to the tarsal metatarsal (Lisfranc) joint and stress fracture may result in non-union. Proximal fifth metatarsal stress fractures also have a high rate of poor healing. Navicular stress fracture is uncommon, and extremely important to recognize due to tenuous blood supply and poor healing.

Stress fractures of the Navicular, proximal second metatarsal and proximal fifth metatarsal require sports medicine or orthopedic review.

Apophyseal avulsion fractures include the base of the fifth metatarsal in the foot. Athletes usually describe pain and a popping sensation during running, jumping, kicking or stretching. Patient will have tenderness over affected apophyseal area and limited Range of Motion (ROM). Radiographs will usually show the avulsion fracture. Treatment is often needed and if

apophysis is greater than 2cm, then open reduction internal fixation (ORIF) may be needed.

Iselin's disease refers to traction apophysitis of the tuberosity of the fifth metatarsal. The apophysis is within the peroneus brevis tendon insertion site. The second centre of ossification fuses by age 11 in girls and 14 in boys. Pain and tenderness over the metatarsal and pain with resisted eversion is common. Radiographs will differentiate Iselin's disease from Avulsion fracture. The avulsion fracture as the apophysis is parallel to the long axis of the fifth metatarsal and the fractures are usually transverse.

Fractures at the metaphyseal-diaphyseal junction (Jones fracture) are significant and are non-weight bearing immobilization and orthopedic referral.

Sever's disease, also known as calcaneal apophysitis, is a traction apophysitis located on the heel of the foot. It is most common in pediatric athletes ages 9-14. It can be bilateral, as in about 60-80 percent of the cases. Patients present with calcaneal tenderness around the Apophysis, and the heel pain worsens with activity. Calcaneal radiographs may show fragmentation or sclerosis. Usually an open growth plate will be seen. Treatment could be heel cups, heel cord stretching, ice, NSAIDS, and modification of activity.

Other toe fractures include tarsometatarsal fractures/dislocations which are rare but have serious complications if missed. Injury usually follows inversion stress to the ankle with the force transmitted to the midfoot. Children with fractures or fracture/dislocations present with tenderness and swelling over the dorsum of the foot at the base of the second metatarsal and are not able to put weight on their foot. Suspicion of Lisfranc injury should prompt podiatry or orthopedic consult. Treatment will include non-weight bearing immobilization and possible surgical intervention.

**Salter-Harris Classification for growth plate fractures:**

Robert B. Salter and W Robert Harris described fractures I-V in 1963. The more rare types were subsequently added later. Dr Salter (Dec 15, 1910) was a Canadian Surgeon who pioneered in pediatric orthopedic surgery. Dr. Harris (Dec 19, 1922- 2005) also Canadian, was not only an orthopedic surgeon but also demonstrated Histology. Mercer Rang added Type VI in 1969, and JA Ogden added type VII in 1982.

The Salter-Harris Classification Chart Type I – Type V. See chart 1.1

### **CHART 1.1**

Type I      Type II      Type III      Type IV      Type V

A Salter-Harris fracture is a fracture that involves the epiphyseal plate or growth plate of a bone. It is a common fracture or injury in children and occurs in approximately 15% of the long bone. The Salter-Harris classification for growth plate fractures is a tool for doctors to use in order to help doctors diagnose the severity of a fracture or injury to the fracture.

X-rays will be taken in order to see the fracture; a plain radiography is preferred. CT or MRI may be considered.

**SALTR** can also be used as a nemonic with this classification to help remember the 5 most used types.

1. Type I- **S**: Same (or straight across) or slipped. This is a fracture of the cartilage involving the physis (growth plate). With incidence 6% of the time.
2. Type II- **A**: Above. The fracture is above the physis. With incidence of 75% of the time.
3. Type III-**L**: Lower. The fracture is below the physis in the epiphysis. With incidence 8% of the time.
4. Type IV- **T**: Through. The fracture is through the metaphysis, physis and epiphysis. With incidence 10% of the time.
5. Type V-**R**. Rammed (crushed). The physis has been crushed. With incidence 1% of the time.

Other Salter-Harris Fractures or injuries less commonly used are:

1. Type VI: This is an injury to the perichondral structures and is very rare.
2. Type VII: Isolated injury to the epiphysis only.
3. Type VIII: Isolated injury to the metaphysis.
4. Type IX: An injury to the periosteum which could interfere with the membranous growth.

When all types of Salter-Harris fractures are considered, the rate of disturbance is approximately 30%. Only 2% of these fractures have a significant functional disturbance.

Growth plate fractures of the foot include: Lisfranc, Jones, March, and Calcaneal. Fractures of the ankle and leg include: Fibula (maisonneuve), Le Fort fracture of the ankle, Bosworth, Both Trimalleolar and Bimalleolar.

## Tarsal Coalition

**Tarsal coalition** happens when there is a failure of complete segmentation between two or more tarsal bones, during fetal development. This abnormal connection can be of bone, cartilage, or fibrous tissue. It occurs in 1% of the population and affects boys twice as often as girls. About 50 percent of the time it happens in both feet. Calcaneonavicular and talocalcaneal is often bilateral. Tarsal Coalition can run in families. Less common causes are infection, arthritis, or a previous injury to that area.

The tarsal bones include the calcaneus (heel bone), talus, navicular, cuboid and cuneiform bones. Together these bones provide motion necessary for normal foot function by working together.

Pain and symptom usually occurs at the time of ossification when tarsal coalition is usually discovered. This happens between 8-12 years for the calcaneonavicular and 12-16 years for talocalcaneal coalitions.

Signs and symptoms are:

1. Pain (mild to severe) when walking or standing
2. Tired or fatigued legs
3. Muscle spasms in the leg, causing the foot to turn outward when walking
4. Flatfoot in one or both feet
5. Walking with a limp
6. Stiffness of the foot and/or ankle
7. Frequent ankle sprains

In addition to examination, the physician will order X-rays, and additional diagnosis may include imaging tests such as CT scan or MRI.

The non-surgical treatment goal is to relieve the symptoms and reduce the motion of the affected joint. Depending on the severity of the condition one or more of the options below may be used to help with Treatment includes:

1. Oral medications may help reduce pain and inflammation; these include non-steroidal anti-inflammatory medications (NSAIDs) such as ibuprofen.
2. Physical therapy may include range-of-motion (ROM) exercises, ultrasound therapy and massage.
3. Orthotic devices such as custom molded shoe inserts (orthotics) can help alleviate pain. By distributing the weight away from the joint and limiting the stress on the area of the coalition.
4. Immobilization is given to rest the affected area. The foot may be placed in a cast or cast boot to achieve this. Crutches are used to keep weight off of the affected foot.
5. Injections of steroid medication or anesthetic have occasionally been used to decrease inflammation and relax spasms.

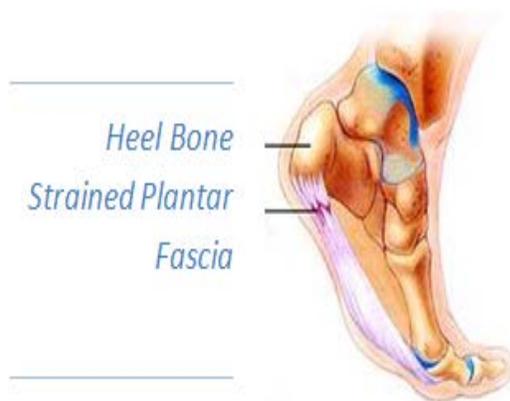
Even with this treatment, the end results still may need surgery. Surgery may include removal of abnormal connection or fusion (permanent, complete stiffness) of the joint. The pediatric specialist will decide the best surgical approach taking into account the patient's age, condition, arthritic changes and level of activity. Even with all the treatments the patient may still have limited motion and pain in the feet.

## Pediatric Plantar Fasciitis:

Although heel pain is a common childhood complaint, Plantar Fasciitis is **not** as common in children and adolescents as it is in adults. Heel pain is considered a symptom and should not be ignored to see if it will go away. In children, signs and symptoms are:

1. Pain in back or bottom of heel
2. Limping
3. Walking on toes
4. Difficulty participating in usual activities or sports see figure 1.2

**FIGURE 1.2**



Plantar fasciitis, also known as the heel spur syndrome, is used to refer to heel and arch pain caused by inflammation on the bottom of the foot. Plantar fasciitis is an inflammation of the connective tissue called plantar

fascia. Plantar fascia stretches from the base of the toes, across the arch of the foot, to the point that inserts into the heel bone.

Children unlike adults with Plantar Fasciitis, usually report increased pain in the plantar heel with activity in addition to pain in the morning experienced more by adults.

Pediatric heel pain is diagnosed by the patient's medical history, and any recent activities that may have contributed to this issue. Examination of the feet may reveal tenderness usually localized to the medial calcaneal tubercle with the foot in dorsiflexion. X-rays may be used as a diagnostic tool to eliminate Plantar Fasciitis when pain is involved. Diagnostic imaging may include not only X-rays but also to see if erosive enthesitis (inflammation at the site of attachment of the bone to a tendon, ligament, or joint capsule). Along with Diagnostic imaging, these may be used:

1. Magnetic resonance imaging (MRI)
2. Computerized tomography (CT or CAT) scan
3. Bone scan

Laboratory testing might be ordered to help diagnose other less prevalent causes of pediatric heel pain if Plantar Fasciitis or other injuries are ruled out.

Patient education that the nurse can do with the family is:

1. Reduce activity: have the child stop, or at least reduce the activity that causes them pain.
2. Cushion the heel: for moderate heel pain use temporary shoe inserts to soften the impact of the heel while standing, walking or running.

The pediatric surgeon may include these in the treatment options:

1. **Medication:** Anti-inflammatory, nonsteroidal drugs (NSAIDs), such as ibuprofen to help reduce pain and inflammation.
2. **Physical therapy:** stretching and/or physical therapy modalities are sometimes used to promote healing of the inflamed tissue. To help with stretching exercises, patient education is a great time to show the family that they can make this time seem like its family time with their children.
3. **Orthotic devices:** Custom orthotic devices prescribed by the podiatric surgeon help support the foot properly. It is important for the nurse to stress the important of the child and parent being compliant to allow for the orthotics to have a chance to work. For severe heel pain, more aggressive treatment may be required.
4. **Immobilization:** Crutches may be needed by some patients to avoid all weight-bearing on the affected foot. Pediatric heel pain in severe cases may need to be casted to promote healing. Immobilization will include the foot and ankle in the cast.
5. **Follow-up measures:** After casting and immobilization, the follow up care may include the use of custom orthotic devices, physical therapy or strapping (foot strapping is explained below).
6. **Surgery:** Last resort to all other treatments in some instances may be surgery to try and correct the problem.

Foot strapping or arch support strapping helps to provide lift needed for the arch and can help relieve the pain and possibly reverse Plantar Fasciitis, heel spurs and flat feet. Foot strapping is a commonly wide practice used by athletes, because it allows the tension to be transferred through the skin. Several examples of how to do foot strapping can be seen on [www.youtube.com](http://www.youtube.com) . Athletic tape is often used or elastoplast. Material needed is 1.5 inches of adhesive tape and either 3 inches of elastoplast or

athletic tape. The adhesive tape is attached to the sides of one's foot, going around the back of the foot (heel) where the side of the foot meets the sole of one's foot. Make sure tape has no wrinkles and has no pressure on the foot. Bring the tape all the way to the ball of the foot. The recommendation is to do this process twice, overlapping the first piece by ½. The elastoplast or athletic tape then goes under the foot across the sole of the foot, back to the middle of the heel. An important point is making sure neither one's skin nor the tape has any wrinkles. Wrinkles can lead to blisters. This could take several pieces to cover this area. Take two more pieces of adhesive tape to cover the ends of the elastoplast or athletic tape. It may take several tries to find the way to best strap one's own feet and if strapping is done incorrectly, it can cause more injury from exercising with strapped feet.

Reduce possible pediatric heel pain by:

1. Avoiding obesity.
2. Choosing well-constructed, proper fitting, supportive shoes that are appropriate to the child's activity.
3. Avoiding or limiting wearing cleated athletic shoes.
4. Avoiding activity beyond what your child's ability is.

Symptoms may return after being treated, because in children the heel bone is still growing. This does not mean it is the same problem, it still should be checked out again in case it is a different issue. Long-term care includes preventative measure such as, maintaining an ideal weight, wearing supportive shoes and using custom orthotic devices.

Medial and syndesmosis sprains:

Injury to the medial deltoid ligament is not as common as a lateral ligament sprain. This type of sprain is usually by an eversion stress to the ankle. The deltoid ligament is a very strong ligament and injury may be accompanied by a lateral complex injury or possible fracture. A high ankle sprain refers to an injury of the anterior inferior tibiofibular ligament and syndesmosis. If the ankle was forced into dorsiflexion and external rotation (which causes pain) an X-rays should be obtained with possible referral to a sports medicine specialist. If a fracture has occurred, an ORIF of the ankle maybe needed. Treatment of a sprain could take up to 6 weeks or longer. A disruption of the ankle mortise as well as other fractures may require an ORIF.

Tendons in the ankle may also be included in injuries and pain.

Tendinopathies in the tendons crossing the ankle may be a secondary injury to a microtrauma from repetitive overuse. This may also be caused by a direct trauma, and happen in cases of juvenile idiopathic arthritis (JIA). Tendon and muscle issues may arise due to altered anatomical alignment change in activity level and rapid growth causing an imbalance. Movement of the muscle-tendon complex, active use and palpitation of tendinopathies are painful.

Runners can experience an extensor tendinopathy. This can also be caused by extremely tight shoe laces. Children will present with pain over the tibialis anterior tendon as it crosses the ankle or aching in the dorsal midfoot with dorsiflexion.

It is the nurses' responsibility to reinforce education around the patient's recovery process. Here are a few guidelines to follow:

1. Control pain and inflammation using Price:

Protect, Rest, Ice, Compression and Elevation

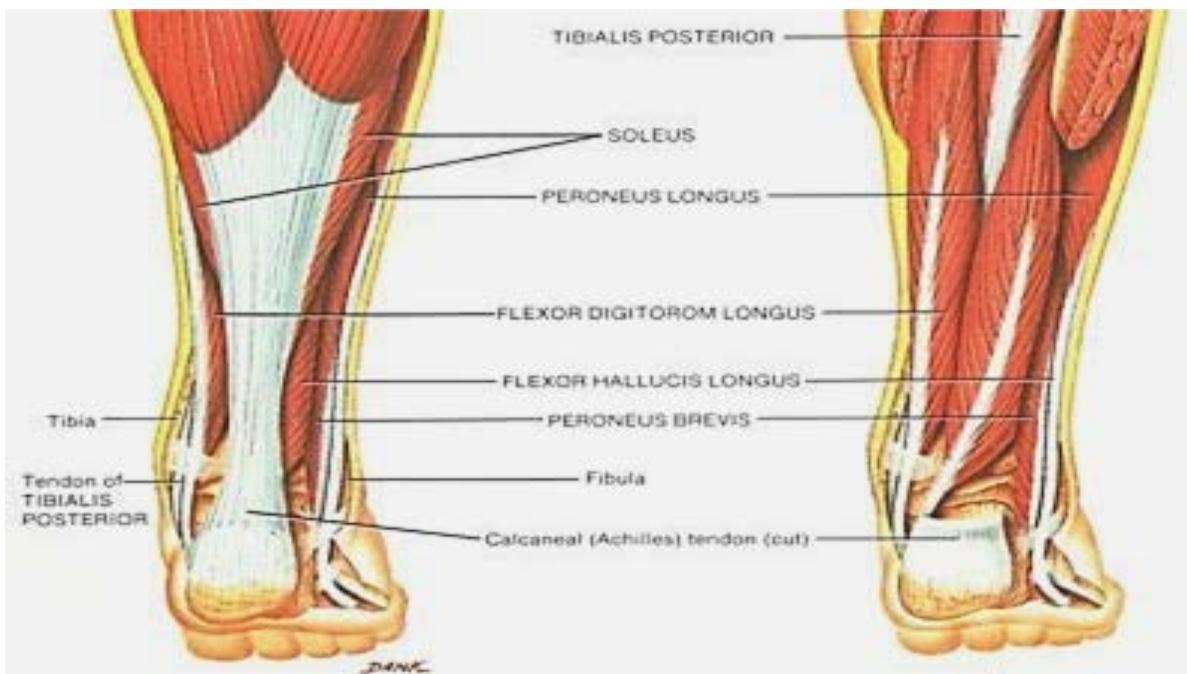
2. Optimize Range Of Motion: Active and passive exercises.

3. Optimize Strength: Isometric (static muscle contraction without joint movement, Isotonic (Constant muscle contraction with joint movement), dynamic and core strengthening exercises.
4. Optimize proprioception: Balance.
5. Functional and sport specific skills: Running, jumping, pivoting and more.
6. Return to usual activities or sport: Practice before competitive play.

### Achilles Tendon Injuries in Children:

The Achilles tendon is the largest tendon in the body and is located in the heel. It is a thick, fibrous, connective tissue that attaches the calf muscles to the calcaneus (heel bone). When the Calf muscles contract the Achilles tendon is tightened, pulling the heel, this allows a person to point their foot or stand on their tiptoes.

**FIGURE 1.3**



It is named for a hero from the Trojan War in Greek mythology, Achilles who died from a small wound to his heel, which was the only part of his body that was not invulnerable. This coined the term “Achilles heel”.

The Achilles tendon can withstand 1,000 pounds of force, and is the most injured tendon of the body. The most common injury to the Achilles is tendonitis, which is an overuse injury that occurs when the tendon is subjected to excessive stress. An overuse injury could be caused by repetitive running or jumping and can lead to swelling and small tears in the tendon. This could lead to pain, stiffness and weakness and if not treated properly, a weakened tendon is at risk for a rupture or progression to tendonopathy. Tendonopathy is a condition which leads the tendon to become thickened and irregular, leading to chronic pain and stiffness.

Both children and adults are susceptible to a type of tendonitis called enthesitis. “Enthesis” means an attachment to a bone of a tendon or ligament. Enthesitis is an inflammation at the site of attachment of bone to a tendon, ligament or joint capsule. This usually happens because of trauma to the area.

Developmental issues can affect the Achilles tendon. Tightness occurs in the Achilles tendon with foot disorders. In rare cases, pediatric flatfoot coincides with a shortened Achilles tendon. Surgical bone shortening and Achilles tendon lengthening corrects the deformity and relieves the painful symptoms.

Sever’s Lesion is a common cause of heel pain in children over the age of 10 during years of excessive growth. This includes microtrauma to a child’s growth plate that is located in the heel and causes pain. This condition is created more with high speed sports and causes the Achille’s tendon to pull the bone away from the growth plate.

Neurological issues like cerebral palsy, spina bifida, poliomyelitis, and muscular dystrophies are included in neurological associations of Achilles tendon problems in children. A child's normal walking gait requires three rocker positions of the ankle and foot. The Achilles tendon is required for proper push-off during gait. In spina bifida and cerebral palsy, surgical lengthening of the Achilles tendon is required. In polio, certain muscles are paralyzed and tendon transfer surgeries are recommended. Progression of muscular dystrophies may require both surgical tendon transfer and lengthening.

Causes for Achilles tendon pain may include improper warming up before running or running on an incline, running up a stairway hill, sports like track and field, cross-county running, gymnastics and dance. It could be as simple as flexing the calf muscle too frequently or strenuously. Contributing factors can be not enough rest between activities, training hard on hard surfaces, poor or worn out shoes. A person's own foot shape and alignment could also be a factor.

Pain in the heel could be an early symptom of tendonitis. The pain can appear to be random; it may start during or after exercise. Walking and using stairs can be painful. The pain can be persistent and chronic (all the time) or sporadic (short intervals). If the joint and heel area are swollen and the leg feels sluggish, then there is a possibility of injury to the Achilles. It can affect one or both heels.

To diagnose Achilles issues, imaging studies may be used including X-ray and MRI just to rule out other possible causes if diagnosis is unclear.

Treatment for most tendon injuries is to restrict movement of the tendon; this is the only way to allow the injury to heal. Refraining from activity and resting the tendon is the best. While doing an activity, a brace may be worn. Compression with an elastic bandage around the lower leg and ankle with elevation may help. NSAIDs or over the counter nonsteroidal anti-

inflammatory medication and ice can also be used to treat the pain as the tendon heals. Ice should be applied for 15-20 minutes at most every few hours. Avoid using heat because it can increase swelling.

Physical therapy can be prescribed to help correct the imbalances in the flexibility and strengthening in a muscle. Specific eccentric strengthening exercises for the calf muscle might help strengthen the Achilles tendon and reduce the risk of re-injuring the tendon. Shoe inserts may help with foot shape and alignment possibly eliminating contributing factors.

Avoiding Achilles tendon injuries in children can be prevented by:

1. Wearing comfortable and proper fitting shoes. Try to use shoes that are made for a specific activity. Replace all worn out shoes.
2. Performing a proper warm-up which could include things like calisthenics, light jogging, or cycling before a strenuous activity. This helps to warm up the muscles, making them more pliable and less stress will be transmitted to the tendon.
3. Stretching of the foot, calf and legs several times a day including before and after exercise. Stretching after exercise is actually better. Hold each stretch for a recommended 30 seconds and don't bounce.
4. When exercise is performed, it is important for children to increase their pace and the intensity of the activity. Avoid sudden increases in training frequency, intensity and/or duration. Make sure children cool down after exercise.
5. Do not play through the pain; it is a sign of injury, stress and overuse. Make sure to tell children if a coach is pushing them too hard while having pain to inform a parent. If the pain does not resolve in a few

days, seek medical attention, for sooner treatment. This will create a situation of shorter healing time and a faster return to activity.

6. Avoid wearing high-heeled shoes; this can lead to calf muscle tightness and shortening of the Achilles tendon. Achilles may have to be stretched if high-heeled shoes are worn as shoe of choice.

Achilles tendon rupture is a partial or complete tear of the Achilles tendon. A complete tear is more common than a partial. A complete tear of the tendon usually occurs about 2 inches above the heel bone and is called an Achilles tendon rupture. Sudden and severe pain may be felt at the back of the ankle or calf.

Symptoms may include:

1. The sound of a loud pop or snap.
2. A gap or depression seen in the tendon about 2 inches above the heel bone.
3. Initial pain, swelling and stiffness and may be followed by bruising and weakness.
4. The pain may decrease quickly and smaller tendons may retain the ability to point the toes. It is harder to point the toes without use of the Achilles tendon.
5. Standing on tiptoes and pushing off when walking is not possible.

Do not delay treatment; early results usually result in a better outcome.

Treatment methods include:

1. Allow time for healing and protect the Achilles from being reinjured.
2. Moving the foot and ankle is necessary to prevent stiffness and loss of muscle tone.

3. Surgery to repair the tendon may be needed. Non-surgical treatment may include a cast with 2-4 weeks of slowly stretching the tendon back to its normal length.
4. A heel lift may be needed, with regular physical therapy.

Surgery is used to suture the ends of the tendon back together. Even with surgery, there is an incidence of re-rupture. Surgery does allow for returning to activity sooner and usually at a higher level than a non-surgical patient. Surgical risks are infection, skin breakdown, scarring, accidental nerve injury and possible blood clots in the leg. This does not include all of the surgical complications that can happen with all surgeries.

## Open Reductions and Internal Fixations of the ankle:

An open reduction refers to opening the skin to allow the surgeon to see the bone and be able to reduce (fit a fractured bone back together) it. Internal means inside the body. Fixation refers to fixing the bone with some type of metal to hold the bone in place while it heals.

An Open Reduction Internal Fixation (ORIF) refers to the surgery (surgical implantation) of implants for the purpose of repairing the bone. This concept has been around since the mid-19<sup>th</sup> century. Internal fixators include pins, bone screws, metal plates, rods, Kirschner wire and intramedullary devices (nails and interlocking nail). These can be made of stainless steel or titanium.

A surgeon performs an ORIF in order to guide the healing process of a bone, by seeing the reduction process, by setting the bone in place. By placing a fixation over the fracture, it prevents micromotion across the lines of the

fracture to allow healing and prevent infection. ORIF is used in serious fracture cases or in cases where a fracture will not heal.

Complications and risks of a surgery are bacterial colonization of the bone, infection, loss of range of motion, non-union, malunion (healed wrong), compartment syndrome before and after surgery, damage to muscles, nerve damage and palsy, arthritis, tendonitis, chronic pain and deformity, audible popping and snapping and possible future surgeries if hardware needs to come out. Post-op complications, including pulmonary embolism, is also a possible complication of an ankle fracture. Hardware failure is also a post op complication. Another risk is possible anesthesia complications such as heart attack, stroke and death.

Special considerations that may delay an ankle fracture would be the status of the soft tissue, infection and medical instability. It is best to perform the surgery before true swelling or blisters develop. Make sure the operative site is marked before surgery and pre-operative antibiotics are hanging to be given in the operating room.

Supplies nurses may need to prepare include: a bump under ipsilateral (on the affected or same side) hip, and an eggcrate to pad all bony prominences and extra webril for padding under the tourniquet.

A second option may be a Closed Reduction Internal Fixation (CRIF), which is reduction without “open” surgery and internal fixation. It is an acceptable alternative in unstable lateral condylar fractures of the humerus in children. However if the fracture still exceeds 2mm displacement after reduction, an ORIF is recommended.

The average time until a patient is able to bear full weight on the fractured ankle is about 7 weeks. A working teenager can return to work after about 8 weeks.

Here is an example of an ankle fracture:

**FIGURE 1-4**



If your patient has diabetes, make sure to bring it to the attention of the surgeon. Patients who have diabetes have a more difficult time after surgery may need physical therapy.

## Ankle fractures and injuries in children and adolescents

Every year in the United States, approximately 30 million children and adolescents participate in organized sports. This brings an increase to pediatric sport injuries such as ankle fractures. Medical personnel need to become more familiar with treating the pediatric patient's injuries, including those from sports.

Pediatric ankle pain is usually associated with minor trauma or repetitive stress combined with abnormal biomechanics. Toddlers are more likely to limp or refuse to put weight on an affected leg. Older children may be able to point out a specific site of pain. There are also numerous non-traumatic diseases that masquerade as injuries, and further work up may be needed to diagnose them.

Skeletally, children and adolescents are immature and unique because of the effects of growth on the musculoskeletal system. They are not only at risk for many of the injuries that happen to adults, but they also are at risk for injuries to the growth plates, apophyses and joint surfaces. A thorough knowledge of functional growth plate anatomy and physiology is extremely important to properly diagnose and manage an epiphyseal ankle injury as well as other injuries.

The main functions of the ankles are to provide stability for weight bearing and to allow mobility of the foot. The ankle is a simple hinge joint including the:

**Tibia**: The inner and larger bone of the lower leg, between the knee and the ankle. It articulates with talus.

**Fibula**: The outer and smaller bone of the lower leg, between the knee and the ankle. The fibula articulates with the tibia and the talus. It is also one of the longest and thinnest bones of the body.

**Talus**: The ankle bone, and is an irregular, stubby cylinder that articulates with the tibia, fibula, calcaneus, and navicular bone. The body has a saddle-shaped articular surface.

**Calcaneus**: The heel bone that articulates with the cuboid bone and the talus.

**Navicular**: Scaphoid bones in the tarsus.

**Articulate**: To join two bones together in a joint.

**Articulation**: A joint with two or more bones. In this case a moveable joint. Cartilage or fibrous connective tissue lines the opposing surfaces of all joints.

Movement in the ankle occurs in triplanar patterns:

**Dorsiflexion**: To bend a joint toward the dorsum, or posterior aspect of the body. Dorsiflexion of the foot means to move backward.

**Plantar flexion**: is the extension of the foot so that the forepart is depressed with respect to the position of the ankle.

Ligaments also play a big role in giving the ankle its ability to handle its job. Static (at rest, in equilibrium; not in motion) stability is provided by the lateral ligament complex. This complex includes: Anterior (before or in front of) talofibular ligament: concerning both the talus and fibula.

Calcaneofibular ligament: Concerning both the calcaneus and fibula.

Posterior (located toward the rear) talofibular ligaments: concerning the talus and the fibula.

Peroneus brivis: This muscle arises from the distal two thirds of the lateral fibula and attaches to the styloid process of the fifth metatarsal. The peroneus brevis assists in plantar flexion of the foot and eversion (turning outward) of the ankle.

Longus (anatomically long structure) muscles laterally: Everts (to turn outward) foot.

Ankle fractures in children and adolescents usually involve the distal and fibular epiphysis. The growth plate injury is unique to childhood, and in most such fractures, they usually heal without permanent deformity. In adults who are no longer growing, the plate is replaced by an epiphyseal line.

However, unless ankle fractures are immediately and correctly treated, these fractures may be associated with many complications. These complications include limb discrepancy and angular deformities due to growth arrest, including arthritis due to joint involvement. Fractures of the distal tibial epiphysis are classified according to the type and mechanism of injury. The ability to classify an ankle fracture according to Salter-Harris

anatomic and radiologic classification is a very useful tool in which prognostic information that may affect treatment. Salter-Harris Type 1 and 2 fractures of the ankle have good prognosis, and can be treated by closed reduction.

Salter-Harris Type 3 and 4 fractures involving the medial malleolus require surgical treatment since they usually result in compression of the physal plate and cause angular deformities. External rotation of the foot may result in juvenile Tillaux fractures and triplane fractures of the distal tibia. The transitional period occurs during which asymmetric physiologic closure of the distal tibia. These are combinations of Salter-Harris Type 2, 3 and 4 fractures, consisting of two or three fragments. Even though these are not associated with growth arrest, they may lead to arthritis due to joint involvement. The presence of residual displacement of more than two millimeters necessitates surgical treatment of an Open Reduction Internal Fixation (ORIF) of the ankle.

Imaging is very important when diagnosing fractures. Standard ankle views include the anteroposterior (AP), lateral and mortise projections. The mortise view is taken anterior to posterior with the leg internally rotated 10-20 degrees to allow visualization of the talus and joint space of the ankle.

The Ottawa Ankle Rules were developed in Canada in 1992 for patients over the age of 18, but studies have suggested that can be used on patients as young as 10. This may decrease the need for ankle x-rays.

#### Ottawa Ankle Rules:

An ankle x-ray is only necessary if there is pain in the Malleolar zone, and if any of the following:

1. The inability to walk four steps.
2. Tenderness over the fifth metatarsal.

1. Bone tenderness at the posterior edge or tip of the lateral malleolus, or
2. Bone tenderness at the posterior edge or tip of the medial malleolus, or
3. Inability to weight bear on affected side, both immediately and in the emergency department (emergent care appointment).

Any of these warrant radiographic examination.

Computed tomography (CT) is also an excellent way to assess fractures. Many bones may not be completely ossified so CT is often needed to give added bony and cartilage detail. CT can find subtle trabecular irregularities associated with bone necrosis where plain X-rays may not find this. CT can also help in finding bony tarsal coalition (fusion) also not seen on a regular X-ray.

Magnetic resonance imaging (MRI) is useful in diagnosis of ankle pain when anatomical localization with a clinical exam is performed. MRI is a very sensitive, high-signal T2. T2 weighted (MRI) imaging relies on local dephasing of spins following application of transverse energy pulse. Weighted bone marrow changes can be found in both bone marrow edema and normal hematopoietic marrow.

Technetium Bone Scan is a simple bone scan which uses technetium as a tracer in order to detect tumors and small fractures in the body.

Technetium was discovered in 1925. The term has been derived from a Greek word "*Technetos*", which means 'artificial'. It was the first chemical element that was produced in an "artificial" manner. TBS can also identify areas of increased osteoblastic activity, and can help localize subtle areas of bone injury; an example of this would be early stress fractures. It is, however, difficult to localize the signal of a particular bone. The doctor will

put in a small amount of radioactive tracer in the body and a scan will follow.

The Dias-Tachdjian (Lauge-Hansen) mechanistic classification system for pediatric ankle fractures provides useful information about the extent of osseous and soft tissue injury.

Lateral malleolar pain is very common following ankle injury. Inversion is the mechanism of injury for most ankle sprains. The Anterior Talofibular Ligament (ATFL) is the most commonly injured ligament. The calcaneofibular (CFL) and posterior talofibular (PTFL) are involved in more serious injuries. On exam, there may be swelling and bruising with tenderness over the lateral ligaments. There may also be instability, and inability to bear weight. Bone tenderness and inability to bear weight suggest a possible fracture.

The treatment of a sprain follows the principles of PRICE:

**Protect:** the ankle from further injury.

**Rest:** stay off the ankle as much as possible while it heals.

**Ice:** according to the Doctor's instructions.

**Compression:** this may include a functional brace for early immobilization, for up to 6 months.

**Elevation:** keep the ankle up to help reduce swelling.

**ICE THERAPY** is one of the simplest, safest, and most effective self care techniques for injury, pain or discomfort that can occur in joints and muscles. During an initial injury, there can be uncontrolled swelling from tissue damage and if one can ice immediately, the amount of swelling and tissue damage is decreased. Ice therapies may also decrease, muscle spasm, pain and blood clot formation. Ice works best when it is used for 20 minutes with a 45 minute rest period between applications. The first 48 hours is the

most important, but can be applied in later stages of rehabilitation of the injury.

Ice enhances the flow of nutrients into the area of initial injury and aids in the removal of metabolites (waste products), increases strength and promotes healing. This process is not related to age, sex or circumstances of injury.

### **CHART 1.5                      FOUR STAGES IN ICE THERAPY**

COLD	Initially constricts local blood vessels and decreases tissue temperature.
BURNING/PRICKING	
ACHING	This stage can sometimes hurt worse than the pain.
NUMBNESS	Most important, once reached remove Ice.

This technique can be as simple as using a bag of Ice, a hot water bottle, chemical cold packs, or frozen vegetable usual preference peas. Apply a dry terry cloth to skin with the ice applied over the terry cloth. Ice massage can be accomplished by simply using a foam cup filled with tap water and placed in the freezer. Once frozen, peel back a small amount of the top portion of the cup to expose the ice. Apply the ice to the area of pain using constant circular motion. Never hold the ice in one area for more than three minutes because this will cause **Frostbite**.

Chronic ankle instability may require physiotherapy exercises that work on proprioception (the awareness of posture and movement, including changes in equilibrium) and balance. The Journal of Sports Rehabilitation reported a study on the ankle to see if Ice should be used on an injured ankle before exercise. The findings showed decreased temperature reduced

mechanoreceptors sensitivity and altered joint position sense, allowing the ankle to be exposed to further injury. Ice therapy is better severed after physiotherapy exercises and should be a part of this treatment.

Types of ankle fractures are included in the chart below.

1. Supination-external rotation (Dias), External Rotation (Ashhurst): The foot and ankle are externally rotated on the leg. The distal tibia
2. epiphysis and posterior metaphysic move the distal fragment as a result of the firm attachments of the antero-fibular ligament.
3. Pronation-eversion-external rotation (Dias), Abduction (Ashhurst): The pronation (or Abduction) mechanism of injury is self-evident from x-ray.
4. Supination-inversion: Resulting in subsequent growth abnormalities. Younger children sustain this type of fracture; and with considerable growth remaining.
5. Supination, plantar flexion: Produces a posterior metaphyseal fragment with closed reduction often successful.

### CHART 1.6

#### COMPARISON OF CLASSIFICATIONS

<u>Dias-Tachdjian</u>	<u>Gerner-Smidt, Karrholm</u>	<u>Ashhurst</u>
Supination-external rotation (SER)	Supination-eversion	External rotation
Pronation-eversion-external rotation (PEER) (PA)	Pronation-abduction	Abduction

	Pronation-eversion (PE)	
Supination-plantar flexion (SPF)	Supination-inversion Stage III	_____
Supination-inversion (SI)	Supination-adduction (SA)	Adduction
	Supination-inversion (SI)	
Axial Compression	-----	Axial compression
Juvenile Tillaux	Supination-eversion, stage 1a	External rotation
Triplane	Supination-eversion, stage Iva	_____

## Other Pediatric Foot Issues

**Freiberg's disease** is an osteonecrosis of the metatarsal head. It commonly affects the second and third metatarsals and is more common in athletic adolescent females. This could lead to surgical intervention for those failing conservative strategies which could last from 2 to 3 years.

**Osteochondritis Dissecans (OCD)** is a lesion of bone and cartilage resulting in avascular (Lacking in blood vessels or having poor blood supply, said of tissues such as cartilage) bone necrosis (Death of cells, tissues, or organs), and loss of continuity with subchondral (below or under a cartilage) bone. This could include complete or partial separation of articular (movable)

cartilage, with or without involvement of subchondral bone. Osteochondral lesions of the talus may cause chronic ankle pain. Adolescents present often with activity-related pain, swelling and weakness. The patient may feel a clicking or complains of a catching or locking if a loose body is present. When a history is taken, often a macro-trauma of an inversion ankle sprain has occurred. Repetitive microtrauma could also be the cause. On an exam limited ROM, pain over anterolateral or posteromedial talus and not over the lateral ligament complex. X-ray will show a radiolucent lesion, subchondral fracture, potential separation with subchondral bone and loose body. Talar OCD lesions are best seen on mortise (a depression, groove or hole into which another anatomical structure fits) view, but can be missed on routine X-rays. MRI may show cartilage changes earlier. OCD lesions can be characterized by radiographic appearance.

The Berndt and Harty classification describes:

1. Stage 1 lesion as a small area of compression.
2. Stage 2 as a separate fragment.
3. Stage 3 as a detached, but hinged fragment and
4. Stage 4 as a detached fragment

The early stage lesions have the best outcomes, and treatment depends on the stage of the lesion.

Treatment includes:

1. Modified activity with or without weight bearing
2. Immobilization
3. Cryotherapy

4. Anti-inflammatories
5. Drilling of subchondral bone to improve vascularity
6. Reattachment or removal of loose bodies

Cryotherapy is a more sophisticated way of saying “Ice Therapy”. Since the Ice age, mankind has used cryotherapy. The newer systems have advanced to microchip controlled personal cooling units. These units range from ice water pads which continually re-circulate through a cooling device to keep a consistent cooling temperature on injury. The newer systems are designed for each possible application including knee, shoulder, lower back, hip, elbow and ankle. There are several companies that have different designs for these products.

**Tendo-Achilles bursitis** is a condition of inflammation and of fluid-filled sac (bursa) located between the Achilles tendon and the heel bone. This can occur from an injury to the heel or certain diseases as in juvenile rheumatoid arthritis. Poorly cushioned shoes can also cause tendo-achilles bursitis.

**Sesamoid disease** includes inflammation, sprain or fracture to the bipartite sesamoid. Injury is seen in young athletes who repetitively push off the ball of their feet during the activities of jumping or ballet.

Bipartite or multipartite sesamoids are present in 10-to-33 percent of feet. Children and adolescents complain of forefoot pain when they bear weight while walking. Exam will show localized tenderness and possible swelling. Treatment includes RICE, NSAIDS, modified activity, special footwear and physical therapy.

Rice is Rest, Ice, Compression and Elevation.

**Hyperhidrosis** can also become a social issue for a child. Treatments may include powder, creams and antiperspirant sprays, may. The prescription topical medications help to prevent sweating at a cellular level.

Change socks and possibly shoes often. Air out shoes and shoe inserts nightly. Always have the child wear socks, as this can help to prevent the spread of infection and odor. Synthetic cotton or poly blend sock may be more ideal for this problem.

**Tinea pedis or Athletes Foot** affects children usually after puberty, with prolonged use of closed toed shoes. Hot, sweaty feet help to promote fungal growth. Athlete's foot appears as scaly, itchy areas on the soles with possible cracks in between the toes. Treatment includes an anti fungal or topical medication and in severe cases both. Parents should observe their child using the medication as directed, and do not stop medication as soon as symptoms are gone.

**Tumors**, benign and malignant are rare causes of foot and ankle pain. Symptomatic benign bone lesions include osteoid osteoma and non bacterial chronic osteomyelitis. Benign include synovial tumors or hemangioma.

Malignant bone tumors include Ewing's sarcoma a local osteosarcoma, or metastases from neuroblastoma or leukemia and malignant synovial tumors (including sarcomas).

Foot and ankle pain is common in the pediatric population. Clinical history and physical exam may help to diagnose the problem. If not further evaluation, imaging or possibly referral may be needed to diagnose a child.

**Summary:**

One of the most widely accepted myths about bone is that it is dead. On the contrary, it is constantly changing on a daily basis as new bone cells replace old ones. The healing of bone starts with the break, as a jacket of cells forms around the fracture (broken bone) called a callus. The callus only forms to protect the bone from infections and to help the bone to start the healing process. However this does not protect the bone from further damage if the fracture is not stabilized by either splinting, casting, CRIF or ORIF.

Even though bone cells do reproduce quickly and are able to repair a fracture, keep in mind it still takes a long time for the bone to completely heal. In young children, while the bones are still developing, repairs and healing are completed quickly. Adolescent bones are hardened to a more complete phase. At the time when a fracture is healing, if it receives the right TLC, time and nutrients, the fractures of the bone may not even be seen with an x-ray.

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