A Review of Talipes Equino Varus

Here’s an update on the latest treatments for clubfoot.

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Talipes equino varus (TEV), universally known as clubfoot, is a deformity that the foot and ankle surgeon will likely encounter in the course of his/her career. It is recognized as the ‘down and in’ foot, often resembling a club-like appearance. All ranges of patients may present with clubfoot, including infants to adults that have been untreated or have failed treatment. Clubfoot may also present in all different shapes and sizes, demonstrating variations around a similar deformity, but at the same time maintaining the basic elements native to it. The reported incidence of clubfoot is 1:1,000 live births, and is considered one of the most common musculoskeletal birth defects in the Western population, and most treatable.1,2 In this article, we

Objectives

1) To recognize the multiple proposed etiologies of Talipes Equino Varus.

2) To learn how to classify a clubfoot according to its flexibility and rigidity.

3) To understand the pathoanatomy in the clubfoot deformity including which joints are involved and the inherent components of TEV.

4) To recognize the clinical features when examining a patient with clubfoot.

5) To be able to interpret and understand specific radiographic findings relevant to a clubfoot.

6) Appreciate the history and development of the non-surgical treatment of TEV.

7) To be able to contrast Ponseti and Kite’s method of serial casting.

8) To understand the indications for surgical treatment of the clubfoot, including the neglected clubfoot.

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will review the proposed etiologies, pathoanatomy, and treatment options pertaining to the congenital and neglected clubfoot.

Etiology

The etiology of congenital clubfoot may best be considered multifactorial, since many considerations have been proposed for its development. These include an array of genetic, intrauterine, and environmental factors. Some theories seem to have more credence than others, but the entire pathology is not totally understood. Historically, Hippocrates believed clubfoot to develop from external uterine compression and oligohydramnios. More recently, Turco disputed this by saying that there is plenty of room during the first trimester as well as equal left to right side deformity, indicating positioning may not be a factor in its development.

Bohm suggested interruption in foot development during the ninth week of gestation. During this period of gestation the foot normally resembles a clubfoot appearance, but eventually de-rotates into a more anatomical external position. It has been postulated that normal fetal development might be delayed or halted by some mechanism, and held in that position. If this is the case, the development of the foot will continue to mature in a clubfoot position.

Handelsman and Badalmente suggested an abnormal muscle ratio in the clubfoot. Histologically, they demonstrated an imbalance between slow and fast twitch muscle fiber groups resulting in a more rigid foot. Other reported etiologies have been genetic predisposition, intrauterine enterovirus, early amnioncentesis altering intrauterine pressures, anatomical abnormalities including neurovascular malformations, primary osseous deformation, as well as others. Clubfoot may be secondary to other primary congenital diseases, such as arthrogryposis, amniotic band syndrome, and myelodysplasias, just to name a few.

Classification

When classifying clubfoot, it is important to obtain a good history from the parents or patient. The congenital type (also referred to as idiopathic) usually involves cases of unknown origin in otherwise healthy patients. If the parent gives a history that the child was born with normal feet that began to develop into a clubfoot after birth, than the suspicion should be raised of a possible spinal tumor or lesion that will need immediate recognition and treatment.

It is important not to assume that every presenting deformity is congenital or idiopathic. Trauma may be another cause for an acquired clubfoot. Once affirming that you are dealing with a congenital origin of deformity, not associated with any underlying disease process, the determination of flexibility or lack of should be evaluated. If the foot is reducible to a corrected position with manual manipulation, it can be labeled a flexible or an extrinsic type of deformity. On the contrary, a non-reducible deformity will be termed rigid or an intrinsic type of clubfoot.

Extrinsic and intrinsic simply refer to the tendinous and ligamentous influences that result in an abnormal position of the foot. Musculotendinous influences from the leg tend to create a more flexible deformity, whereas the intrinsic musculature, ligaments, and capsules create a more rigid-appearing foot, less responsive to correction following manipulation. It should be noted, however, that a flexible-type clubfoot, if left untreated, will develop into a rigid clubfoot as a result of joint contractures and accommodation during skeletal maturity.

Pathoanatomy

TEV typically consists of four basic components. As the name implies, there is an equinus and varus element in addition to adduction and forefoot cavus. These give way to the classic cavovarus attitude that is commonly seen with clubfoot. However, planal dominance of any of these components may result in a foot that shows a completely different attitude. This becomes important concerning the reduction and surgical treatment of the deformity.

When describing the pathoanatomy of clubfoot, a lot of the focus seems to be on the talus. Inspection of the deformity shows that the forefoot and Chopart’s joint are medially displaced around the talus, contrasting this to metatarsus adductus, which involves the deformity at the level of Lisfranc’s joint. A supinatus positioned of the rear foot is present which inherently locks the midtarsal joints. The talo-calcaneal joint is parallel in orientation as a result of supination and most times showing a calcaneal varus attitude, although this is not absolute.

The anterior aspect of the calcanea...
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neus is displaced medially and plantarly due to the ligamentous attachments to the midfoot. The talo-calcaneal-navicular complex becomes subluxed in all planes, with the talus head no longer part of the medial column, and the navicular medially and dorsally with minimal talar articulation. In addition, the talus is locked in equinus within the ankle by a tight Achilles tendon.4

As one of the proposed etiologies, the talar head is often deformed and irregular. Normal talar head and neck adduction is 15-20° and in the clubfoot, 80-90°. Sagittal plane head and neck plantar-flexion is normally 25-30°, and in clubfoot has been shown to be 45-65°. These pathologic values may accentuate the adducted and plantar-flexed position of the foot. Inspection of the forefoot reveals a plantar-flexed first ray giving way to the cavus component.

Clinical Examination

Clinically, when examining the rigid clubfoot, certain characteristics are usually present. On the medial side, the medial malleolus is poorly defined, the talar head is absent, and the navicular abuts the medial aspect of the ankle. On the lateral side, the fibula and sinus tarsi are obliterated, and the talar head now becomes prominent. A shorter foot and extremity is often noted in comparison to the contra-lateral side if it is a unilateral deformity. Deep-seated medial skin creases develop from the severe adducto-varus attitude, as well as the classic bean-shaped heel. Lower leg atrophy seems to be an expected component in the older child or adult.5

In a neglected clubfoot, an adventitial bursa will commonly form on the lateral aspect of the foot once the child begins ambulating. Although the neglected clubfoot appears with great deformity, patients are, in fact, able to ambulate and perform daily activities. Shoe fit often becomes a problem as well as the development of eventual pain secondary to arthritic changes, leading the patient to seek treatment.

It is important to keep in mind that the foot and ankle soft tissues are the main deforming forces in the neonate and infant. Osseous structures are very pliable and are susceptible to deformity from the relatively stronger soft tissue structures. The triceps complex, posterior ankle joint, and subtalar joint capsules are contracted, in addition to the deltoid, short and long plantar, talo-calcaneal in-}

Radiographic Evaluation

Radiographic evaluation is often difficult in the neonate due to patient positioning and lack of ossified structures often creating estimations of angular relationships. The calcaneus, talus, and cuboid are radiographically visible. The talus will show an eccentric ossification, making it difficult to achieve a true bisection. However, radiographic analysis of certain angles pertaining to clubfoot is necessary to differentiate clubfoot from other congenital foot deformities (Figures 1a-d).

On the dorsal-plantar view, evaluation of the talo-calcaneal (Kite’s) angle and talo-first metatarsal angle will show a decrease in the former and increase in the latter. On the lateral view, the Kite’s angle will also be decreased. These angular relationships represent Simon’s rule of fifteen (i.e., Kite’s angle less than 15° and the talo-first metatarsal angle greater than 15°). In the neglected clubfoot angular relationships are more difficult at times because of a rigid contracted foot not amenable to standard positioning. Arthrography, CT, MRI, and three-dimensional reconstructive modeling techniques can give a clear picture of the pathoanatomy of clubfoot including intra-articular relationships.

Prenatal Imaging

Prenatal imaging has evolved over the last decade. It is now possible to visualize a fetus foot inutero with tremendous detail, utilizing three-dimensional ultrasound. The availability of this technology has provided a means for early diagnosis of deformity. Almost no false-negative predictions and a true positive predictive rate of 83% have been reported.6 The main advantage of this is to allow the parents to prepare and understand about the deformity that their child will be born with, as well as learn about treatment op-
The main indication for the Ponseti method is for idiopathic clubfeet, although it may be attempted in syndromatic, arthrogrypotic feet.
the serial casting with manipulation. Dobbs showed that recurrence was not dependent on severity of deformity, the number of casts utilized to obtain correction, or the age of the patient. It is crucial that the parents are willing to participate in the treatment plan in order to prevent a recurrence.

Surgical Correction

Surgical correction of the clubfoot is indicated when unsatisfactory clinical or radiographic correction is obtained in the rigid infant’s foot or in the neglected clubfoot. Selection of the proper surgical procedure will depend on the type of deformity and skill of the surgeon. One-stage procedure is ideal and should be chosen to prevent recurrence. However, despite an adequate correction of the clubfoot deformity, a residual equinovarus, cavovarus, and forefoot adductus may require repeat surgery.

According to Sobel, et al., a second operation should not be perceived as a failure of the first surgery, but more of the natural history or progression of clubfoot. The patient and parents should be made aware of this. When contemplating any surgical intervention on clubfeet, the physician should evaluate the vascular status to the foot. Absence of the dorsalis pedis artery seems to be substantially more prevalent in clubfoot.

In the rigid infant clubfoot, soft tissue releases will predominate as compared to a residual or neglected clubfoot, which will require a combination of osseous and soft tissue procedures. Typically, a posterior medial approach is initiated first. This was originally described by Turco in 1979.

The neglected clubfoot becomes more difficult mainly because there have been years of accommodation and joint adaptation.

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Once adequate reduction of the joints is achieved with soft-tissue releases, the correction needs to be maintained with the use of K-wire fixation. This is usually employed with insertion of a wire through the talo-navicular joint and occasionally the talo-calcaneal joint. These wires will provide temporary fixation and splintage as the soft-tissue structures fibrose into the corrected position. Additionally, casting must be employed to maintain the position and can be serially manipulated to obtain further correction, if needed.

The Neglected Clubfoot

The neglected clubfoot becomes more difficult mainly because there have been years of accommodation and joint adaptation. The anatomy is often skewed...

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Figure 2: Pre-operative showing rigid forefoot supination & adductus

Figure 3: Pre-operative showing rigid forefoot cavus deformity

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The neglected clubfoot becomes more difficult mainly because there have been years of accommodation and joint adaptation. The anatomy is often skewed...
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and very rigid. The main correction of the deformity will rely on osseous procedures in conjunction with soft-tissue releases. These feet tend to have the most problems and poorest results. The patient should be made aware that attaining a perfect foot is unlikely, but results should be improved from the current position into a more anatomical, plantigrade position. The concept of planal dominance is important to keep in mind when deciding the appropriate procedure. In the author’s experience (RJG), a closing calcaneocuboid wedge fusion with an opening talo-navicular joint fusion seems to give consistent, good results when there is a transverse plane dominant deformity.

Soft-tissue release, including a plantar release, is also usually performed. Additionally, an Achilles lengthening will need to be performed. In a review of surgical results of the neglected clubfoot, it was found that removal of rear foot varus, minimal shortening, plantigrade position, and satisfactory cosmesis were achieved.12

Additionally, patients were able to wear commercial shoe gear, walk barefoot, were employed, and performed limited physical activity.12 Salvage procedures that can be used in the neglected or residual clubfoot are triple arthrodesis with wedge resection, and talcetomy (rare) if talo-navicular reduction is not possible utilizing other methods.

Salvage procedures that can be used in the neglected or residual clubfoot are triple arthrodesis with wedge resection, and talcetomy (rare) if talo-navicular reduction is not possible utilizing other methods. As in the infant, the neglected clubfoot will need to be cast as well to maintain the corrected position. An advantage of casting is the ability to wedge the cast to allow further correction in any plane.

Residual or neglected clubfoot can also be corrected utilizing the Ilizarov method, which has become popular over the past few years. The technique of gradual distraction osteogenesis and

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correction utilizing a ring fixator has become useful for recurrent or resistant feet. Complications are possible as in any other procedure, and a learning curve is required. External fixation can also be employed with open procedures as described before and will help to maintain the corrected position as the structures heal. Finally, selecting the right patient is important when utilizing external fixation.

**Case 1**
A two year old female presented with a residual clubfoot deformity to the right foot. Serial casting was performed when the child was an infant. Physical examination of the foot revealed a rigid, non-reducible deformity (Figure 2). There was cavus morphology to the longitudinal arch (Figure 3). Pre-operative work-up including vascular status was within normal limits. The patient underwent surgical reduction of the deformity utilizing a plantar muscle release (Figure 4) and posterior medial release with K-wire stabilization (Figures 5-7). Post-operatively, the patient will require six to eight weeks of casting and orthoses as the child begins to ambulate.

**Case 2**
A 33 year old male presented with a neglected clubfoot deformity to the right foot. The patient was complaining of pain on ambulation that has progressed over the past few years and requested surgical correction. Pre-operative work-up was within normal limits. Physical examination revealed a rigid non-reducible deformity. Vascular status was intact. On gait examination, the patient was walking on the lateral border of his foot with development of painful calluses (Figure 9-10). Minimal rear foot varus was present. The patient underwent surgical correction utilizing a plantar muscle release, closing calcaneo-cuboid, opening talo-navicular joint fusion,
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and posterior-medial release (Figures 12-15). A two-incisional approach was utilized. Post-operatively, the patient was cast for six weeks and given a bone stimulator (Figure 18).

Summary

We have reviewed the etiology, pathoanatomy, clinical and radiographic characteristics of talipes equino varus. A discussion of treatment, including conservative and surgical approaches, has been presented. The goals of treatment include creating a plantigrade, functional, and stable foot. Understanding the pathoanatomy and mechanism of deformity will aid in understanding the concept of proper manipulation when utilizing conservative treatment. The promise of a perfect foot should not be an expectation from the patient or parents. There exists expectation of improvement that affords the patient a better lifestyle as compared to before treatment.

The promise of a perfect foot should not be an expectation from the patient or parents.

References

1) In the treatment of TEV, what is the main goal of treatment whether it is surgical or non-surgical?
   A) Create a stable foot
   B) Create a plantigrade foot
   C) Create a functional foot
   D) All are goals of treatment

2) Following conservative management of idiopathic TEV, recurrence of the deformity has been attributed to:
   A) Too few cast applications
   B) A child greater than seven months old
   C) Severe deformity
   D) Lack of compliance with bracing

3) When classifying clubfoot deformity, extrinsic and intrinsic means:
   A) Position and rigidity of the foot as a result of osseous malalignment
   B) Position and rigidity of the foot as a result of tendons and ligaments
   C) Position and rigidity of the foot as a result of suprastructural joint position
   D) Position and rigidity of the foot as a result of in-utero influences

4) Which of the following is NOT a basic component of clubfoot deformity?
   A) Equinus
   B) Dorsiflexion
   C) Adduction
   D) Varus

5) When evaluating a radiograph of a clubfoot deformity, which joint appears in an abnormal parallel orientation?
   A) Talo-navicular joint

6) The main reason why serial casting improves lengths of tissues is due to:
   A) Property of stress relaxation
   B) Avascularity of ligaments
   C) Ligamentous laxity
   D) Pliability of osseous structures

7) Which of the following procedures can be used to correct a transverse plane dominant neglected clubfoot deformity?
   A) Dwyer osteotomy
   B) Opening talo-navicular joint, closing calcaneo-cuboid joint
   C) Talo-calcaneal fusion
   D) Plantar soft-tissue release

8) Which of the following angular relationships best represent Simon’s rule when evaluating a clubfoot?
   A) Talo-calcaneal angle greater than 15°
   B) Talo-first metatarsal angle less than 15°
   C) Cuboid abduction angle greater than 15°
   D) Talo-calcaneal angle of 0°

9) Which is a fundamental difference between TEV and Metatarsus Adductus?
   A) Presence of rearfoot varus
   B) C-shape to medial aspect of foot
   C) Location of transverse plane deformity
   D) Presence of cavo-adductus deformity

10) When clinically examining a clubfoot, all of the following will be seen on the medial side of the foot, EXCEPT?
    A) Navicular abutting the medial malleolus
    B) Prominent talar head
    C) Deep seated skin creases
    D) Poorly defined medial malleolus

11) Which bone is intimately involved in the pathoanatomy of TEV as well as often showing deformation?
    A) Calcaneus
    B) Navicular
    C) Talus
    D) Cuboid

12) When contrasting Ponseti and Kite’s method, Ponseti:
    A) Performed a series of manipulations with serial casting.
    B) Applied casts in an above knee fashion.
    C) Corrected the adduction and varus first.
    D) Maintains only counter-pressure on the talar head.

13) Maintenance following successful conservative treatment of clubfoot includes which of the following?
    A) Straight last shoes
    B) Denis-Browne bar
    C) Orthosis
    D) All of the above

14) When performing the Ponseti method of serial casting for TEV, which degree of abduction should be achieved in order to safely perform an Achilles tenotomy?
    A) 70°
    B) 60°
    C) 50°
    D) 40°
15) Which of the following are NOT true concerning the pathoanatomy of TEV?
   A) Talo-calcaneal-navicular complex is subluxed
   B) Talar head is not part of medial column
   C) Navicular is lateral and plantar
   D) Talus is in equinus

16) When evaluating the radiograph of a 3 month old baby, which structure is NOT visible?
   A) Navicular
   B) Talus
   C) Calcaneus
   D) Cuboid

17) All of the following incision-types have been classically described for surgical release of a clubfoot deformity, EXCEPT?
   A) Posterior-medial
   B) Plantar-lateral
   C) Posterior-transverse
   D) Medial and lateral

18) Which of the following can be considered a salvage procedure for the neglected clubfoot?
   A) Plantar stripping
   B) Opening talo-navicular closing calcaneo-cuboid joint fusions
   C) Talectomy
   D) Tendo-Achilles lengthening

19) When performing a vascular exam on a patient with clubfoot deformity, which structure shows a high incidence of absence?
   A) Dorsalis Pedis artery
   B) Posterior Tibial artery
   C) Anterior Tibial artery
   D) Peroneal artery

20) The etiology of idiopathic clubfoot may best be described as:
   A) Genetic in origin
   B) Environmental in origin
   C) Intrauterine in origin
   D) Multifactorial in origin

See answer sheet on page 177.
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**EXAM #2/09**  
A Review of  
Talipes Equino Varus  
(Stabile and Giorgini)

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