9 Management of Clubfoot

In his title "The Language of Love" – Shakespeare writes
"There is language in her Eye,
Nay, her foot speaks,
Her wanton spirits look out at every joint and motive of her body".
– Troilus and Cressida

ANY DEFORMITY HAS A BOW AND BOW STRING BACKGROUD

Correction of Deformity

Principle should be - relax the Bow String or/ and Straighten the Bow—either by non-operative or operative method.

The philosophy behind any ailment and correcting any deformity or disfigurement trickles from the very aptly said words of the great medical philosopher Tristram Englehardt – **Medicine is the most revolutionary of human technologies. It does not sculpt statues or paint paintings. It restructures man and man's life.**

The management of clubfoot may not appear to be that demanding and may not require aggressive urgent intervention, but we should certainly develop the philosophy of considering a neonate with clubfoot as an orthopaedic emergency from treatment point of view. Treatment should be started as soon as possible, since most of the clubfeet are functionally and cosmetically correctable and that too by non-surgical means. The main modes of management of clubfoot are:

- Nonoperative (Concensus of Opinion—Early Gentle Manipulative Management)
- Minimally Invasive Cast Correction (Pandey)
- Surgery.

Taking all together **more than 85% of idiopathic clubfeet are correctable by noninvasive or minimally invasive techniques** such as corrective massage; taping; physiotherapy; use of various dynamic and static splints; 'functional methods' with passive stretching of contracted soft tissues, active stimulations of peroneal muscles and fixation of foot on maintenance foot plates by adhesive

tapes; repeated manipulations and serial cast applications; minimally invasive cast correction (MICC).

Early treatment methods suggested by Kite in 1939 focused on nonoperative management of clubfoot which remained as the fundamental treatment of clubfoot more or less even today, of course with certain variable modifications. Ponseti (1996), though differed from the Kite only on certain points (such as initial focused pressure on talar head, supinating the forefoot and then abducting it, etc.) also stressed on nonoperative management of clubfoot.

On the whole properly nonoperatively managed clubfeet are functionally superior. However, over the years surgical philosophy has grown especially with emergence of resistant, relapsed and neglected cases. Ober's (1915) and Brockman's writings signalled the advent of surgical treatment. The contributions of workers like Turco (1971, 1979); McKay (1982, 1983), Carroll (1978), Crawford (1982), Simons (1985) brought a wave of operative management of clubfoot, which is fortunately gradually dwindling. Operative management has definite role, but on which clubfoot, when to operate upon, what procedure to be adopted—the answers to these questions are not unanimous.

On the clubfeet which require surgery, initial plaster cast applications also help. Initial manipulation and corrective casts stretch the contracted soft tissues, prepares the neurovascular bundle to withstand the trauma of stretching, avoids stretch-induced possible neurological paresis and vascular spasms, softens the skin and prepares it to be more adaptable to the corrected position. In neglected cases, especially in walker clubfeet in developing countries, the initial plaster, besides the above advantages, softens the callosities on dorsolateral aspect of foot, helps in healing the cracks/fissures on soles and heels of barefooted walking clubfeet, and further keeps skin (both on dorsum and sole) uncontaminated.

During the period from **1970 to 1990 (the so-called modern clubfoot treatment era)** much emphasis has been laid on extensive surgical releases and new incisions. However, on long follow up several of the same old problems, as were seen after the older surgical procedures have been observed such as marked adhesions, scarring, stiffness, atrophy of muscles, residual deformity, recurrence of deformity, incomplete correction, overcorrection, changes in length and width of foot–these may not be obvious on short follow-ups.

When surgery has to be done for correction of clubfoot, the surgeon has obligations to answer to himself certain questions – such as:

1. What type of clubfoot he/she has?
2. Is it right age/time to operate upon?
3. What type of surgery should be done on this patient?
4. Does the patient require costly investigation like MRI or colour Doppler?
5. Technique chosen should be suited to the selected clubfoot for operation, not that the clubfoot should be adopted for one's technique or only one particular technique such as all by external fixator; all by Cincinnati incision, etc.
6. Do more extensive procedures have a place in all cases needing surgical release? Perhaps answer should be – NO (only very cautiously selected cases require extensive release.)
7. Is tendon transfer required in this particular case? This should be better preplanned based upon the past experience.

Timing of surgery remained controversial. Surgery should not be done in neonate. Soft tissue surgical release should be considered after three months, if the non-surgical managements have failed to deliver the expected results. However, if the manipulations and casting are started immediately after birth, by 6 weeks the resistant clubfeet start being apparent which will

later require surgery. Surgical soft tissue release should be considered between 4 to 6 months of age. Extensive soft tissue surgical release, though recommended by selected surgeons, should be avoided in young children.

MANIPULATIVE CORRECTION OF CLUBFOOT

Principles Involved are:

- Reassurances
- Manipulative massage
- Corrective splintage – Manual locking, Dynamic correction
- Adhesive strapping – Maintenance splintage
- Serial POP casting – Maintenance splintage/ Tarso-Pronator Boots

Main Methods of Serial Plaster Casting are:

- Hiram-Kite's method (1930)
- Ponseti method (1963) needs tenotomy of tendo-Achilles in almost all cases.

Management of Clubfoot in Newborn Children

Manipulative correction of clubfeet must began in the neonate period. The best person to administer the management in this age group (up to 2 to 3 weeks of age) is the mother, grandmother, or the masseur. This should be done in four sittings along with the general oil massage of the newborn done with the loving care. The mother/grandmother/masseur should be demonstrated the procedure to be followed:

1. The child is fed and made comfortable for oil massage.
2. The mother holds the heel with one hand who's thumb rests and gently presses on the talar head region and index and middle fingers around the heels.
3. With other hand the forefoot is held with the thumb on the dorsal aspect and index and middle finger on plantar aspects.
4. By the hand holding the heel, the heel is pulled down and almost simultaneously the hand holding the forefoot mildly supinates, abducts, and gently everts the forefoot (which helps in reducing the navicular over the talar head and the dome of talus into the ankle mortice, and also stretches the tight Achilles tendon alongwith posterior ankle and subtalar capsule) in rhythmic fashion repeatedly for 5 to 10 minutes in each sitting—4 to 6 sitting a day.

By 2 to 3 weeks, with aforesaid repeated maneuvers, the foot starts becoming comparatively supple, the skin becomes tough enough to withstand the pressure of strapping or plaster cast and neurovascular bundle also becomes accustomed to withstand the stretching.

Role of Strapping in Correction of Clubfoot

Roberts Jones suggested this method of managing the clubfoot. On the whole it is not suitable in tropical weather as in temperate climate because of chances of maceration and allergic reaction of the tender skin with rashes, erythema, itching, blister formation, swelling of toes, etc. However, it can be done, specially in those clubfeet which can be fully corrected by passive manipulation (all mild and few moderate type). Strapping corrects the deformity dynamically every time the child kicks and passively when the feet remain stationary. Mild clubfeet are fully corrected. Moderate and severe ones can be made variably supple to facilitate for further management.

Step of Strapping

- Gently, the surgeon manipulates the forefoot in abduction with thumb and index finger and heel is also turned into eversion.
- Two felt strapping (felt is used to protect the skin) are applied to maintain the correction.
- The first tape is applied from the dorsum of the forefoot, taken medially—then under the

sole and then up the outer side of the leg over the knee (thus keeps the foot into abduction) which remains flexed little more than 90°.
- The second tape encircles the leg above the ankle to secure the first tape to the leg.
- The tapes are changed at few days (3–6 days) intervals till full correction.

Instead of using non-elastic adhesive taping, the purpose of strapping can be well achieved by using moulded low thermoplastic sheet in different sizes for the feet of the infants. These splint can be moulded and remoulded to maintain the progress of correction.

Commercial clubfeet splints are also available usually in five different sizes from one months onwards.

CAST CORRECTION OF CLUBFOOT

In manipulative cast correction of clubfoot the **principles (reset the deforming contracted soft tissues and the bones will be automatically taken care of)**, methods, and plastering techniques remain more or less same, with certain variations. Now it is almost agreed all over that the correction should be undertaken soon after birth (earlier it was 2 to 3 months after birth). The interval of manipulation and casting sittings vary from one week to three weeks with different reasonings. The extent of plastering is, agreed upon, to be above knee. It helps in relaxing gastrocnemius, prohibits slipping out of cast from the leg and foot, corrects (?) the internal torsion of tibia. A short safe anaesthesia always helps in correction—the child remains cooperative; the child does not wriggle the foot; hence the chances of denting of plaster within is avoided; relaxation of muscles yield more correction; number of sittings of manipulation and casting decrease. On the whole it facilitates the repositioning of the joints (and thus the foot as a whole) in more and more corrected position without using untoward force.

Most of the surgeons, managing the clubfoot by manipulative castings, with passage of time and based on their experience, develop their own modification on the basic Kite's technique, and do achieve fairly good results, however, variable number of cases do resist full correction, do relapse, and do require surgical correction in different series.

In recent years Ponseti's technique of cast correction is gaining popularity, especially in the younger orthopaedic surgeons. Decidedly, Ponseti has categorised the steps of manipulation and casting clearly what others are doing as such inherently. The stress has been always to correct the varus, cavus and adduction deformities earlier to the correction of equinus. By holding the forefoot (toes and metatarsals) for correcting the varus and adduction deformities by one hand while the other hand holds (grips) the hindfoot with thumb on the dorsolateral aspect of foot (which automatically presses upon the head of talus) and index finger on the back of the heel and lower part of leg (which automatically lies behind the lateral malleolus) and the ring finger lies on the medial aspect of the calcaneum. In the initial manoeuvre itself the cavus element gets corrected with varying amount of correction of varus and adduction along with some stretching effect on tight heel cord. In each sitting almost the same holding points and manoeuvres are repeated with more and more corrections. Thus, all the deformity elements are corrected gradually simultaneously in 5 to 7 sitting at 2 weeks intervals. The resisting equinus (tightness of heel cord) requires surgical lengthening (closed or open). What Ponseti has termed tenotomy is perhaps never a total cut, varying amount of tendon fibres, paratenon and sheath do remain intact along which the tendon regenerates.

In manipulative correction of clubfoot, it is safer to achieve over correction of the deformities in the last plaster cast. The standard of

overcorrection should be 45° of abduction, 20° of eversion and 20–30° of dorsiflexion at ankle and 15° of heel valgus.

After full correction maintenance of the correction is mandatory till 3 to 5 years by:

- Regular physiotherapy
- Passive stretching
- Maintenance orthotics

Physiotherapy

The dorsiflexor-evertor (peroneus tertius) and plantarflexor-evertors (peroneus brevis and longus) remain weaker (not paralysed) in clubfoot and they need to be developed by trickling the sole (on the region when the child does dorsiflexion and eversion) repeatedly by which these weak movements do improve.

Passive Stretching (Figures 9.1A to E)

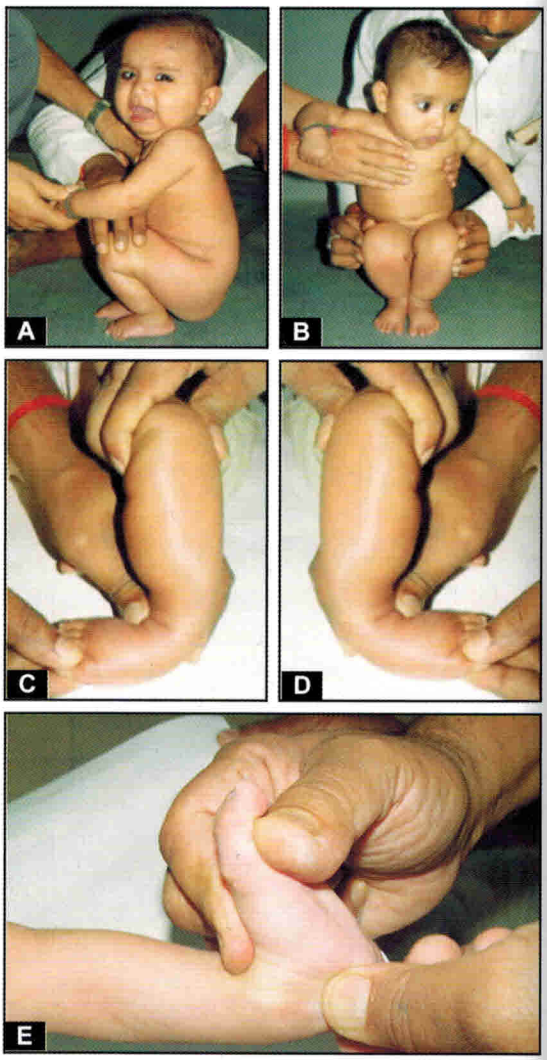
The mother should be trained (which requires only few sittings) to continue the stretching of earlier tight structures. Her one hand holds the heel and lower part of leg to stabilise it, while her other hand holds the forefoot (metatarsals and toes) and abducts and gradually dorsiflexes the foot several times—say 20 to 30 times in one sitting and three such sittings daily.

- The child is made to squat passively for 2 minutes – 6 times in each sitting – and 3 such sittings.
- The child is made to stand on an inclined plank or surface on which the heel remains down and toes up.

Maintenance Orthotics

The basic principles involved in preparing such orthotics are:

1. It should keep the foot in abduction, tarso-pronation and dorsiflexion.
2. It should be more a dynamic orthotic than the passive support. The dynamic element is



Figures 9.1A to E: The mother should be trained for following maintenance exercises: The child is made to squat ensuring that heels properly sit on the floor with full dorsiflexion at ankles—if needed mild intermittent pressure should be applied over the fully flexed knees (A and B). While pressing on the anterolateral aspect of ankle and proximal portion of dorsolateral aspect of foot by one hand the foot is abducted by holding the toe with other hand repeatedly (C and D). By holding the heel static the foot on the whole is passively dorsiflexed (E)

through the various straps, while static element is through the support of certain wedge to keep the foot in corrected position, such as tarsopronator wedge from toes to heel. In the walking stage this wedge helps in developing the weak dorsiflexor and evertor with each step.

3. The heel should be off so that automatically the tendo-Achilles gets stretched with each stepping.

The orthotic on the whole is **Ankle Foot Orthoses with tarsopronator effect on insole, heel off and dynamic dorsiflexion and eversion assist straps** (Figures 9.1F to I).

Figure 9.1F: Tarsopronator clubfoot boot—front view

Figure 9.1H: Tarsopronator clubfoot boot—side view

PONSETI TECHNIQUE OF CAST CORRECTION OF CLUBFOOT

In 1940, seeing the rigid, weak and painful feet on long follow-ups of various surgically treated clubfeet, Ponseti started working on the functional anatomy of tarsals and biomechanics of clubfoot and ultimately evolved his technique of plaster management of clubfoot (1996). He observed that the **basic pathoanatomy is the rotation of tarsals around the head of talus**, hence if the foot (thereby tarsals) is derotated

Figure 9.1G: Tarsopronator clubfoot boot—back view

Figure 9.1I: Child is using tarsopronator clubfoot boot to maintain the correction

around the head of talus, all elements of the deformities are more or less automatically get corrected. This occurs during the cast correction in gradual steps.

Ponseti insists for **starting the cast correction soon after birth (7 to 10 days)**, definitely before 9 months of age. He advocates for **weekly manipulation followed by cast correction** (Figure 9.2). He observed that if properly done most of the average clubfeet (about 90%) get corrected by 6 to 7 plaster cast changes (Figure 9.3). The stiff and rigid one will require more sitting of plaster changes and even then few may not be completely corrected. Broadly, after brief manipulation, the casting is done each time. After about five casts, the adductus and varus are corrected. Almost all clubfeet need percutaneous tendo-Achilles tenotomy for complete correction of equinus. After the tenotomy the last cast is left for 3 weeks, followed by fitting with a foot abduction brace (Figure 9.4), especially in the night, which is continued for 3 to 4 years. **The clubfeet managed by Ponseti technique has been claimed to remain strong, flexible and pain free** (Figure 9.5).

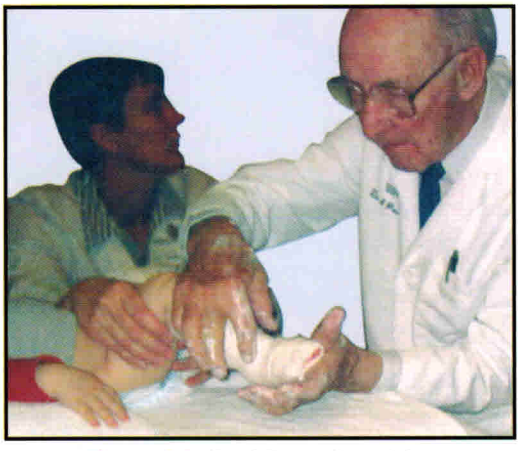


Figure 9.2: Prof. Ponseti applying plaster cast on a clubfoot

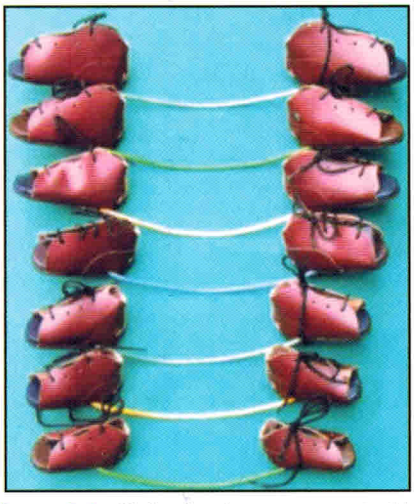


Figure 9.4: Abduction brace suggested by Prof. Ponseti

Figure 9.3: Serial POP cast for the correction of clubfoot by Ponseti technique

Figure 9.5: Pre- and post-manipulative correction of clubfoot in a 3 months old baby by Ponseti's technique

Manipulation and casting are done without anaesthesia. The child is made comfortable by feeding during manipulation and casting.

Although the whole foot looks to be in extreme supination, the forefoot is pronated in relation to the hindfoot and this leads to cavus deformity, the first metatarsal being in more plantar flexion than the lateral metatarsal. The first element to be corrected is this cavus by positioning the forefoot in alignment with the hindfoot. By supinating the forefoot and dorsiflexing the first metatarsal to the extent which visually brings the plantar surface of the sole to nearly normal arch, the cavus element is almost corrected.

Next step is location of talar head and abduction of the foot beneath the stabilized talar head.

For the right clubfoot, the manipulator's left hand holds the hindfoot with the thumb moderately pressing over the talar head in front of the ankle mortis (to stabilise it) and index finger behind the lateral malleolus while the toes and metatarsals are held in right hand. After correcting the cavus the foot is manipulated by abducting it in supination as far as it is tolerated by the infant. The manipulation is maintained for 60 seconds, then released and repeated few times. The forefoot is not pronated.

While the foot is maintained in maximum corrected position (by the above noted procedure) a thin layer of compressed cotton roll is applied followed by a thin layer of plaster cast wrapped over the manipulator's fingers to allow ample space over the toes. First the plaster cast is applied below knee. While the plaster is setting it is moulded over the head of talus by the thumb and the index finger above the calcaneum while holding the foot in the corrected position. The dynamic moulding is continued till the plaster hardens avoiding static pressure which may produce sore under the hardened plaster.

The plaster cast is extended above the knee, with knee in flexion of about 90°.

The manipulation and casting are changed every week. With every change the correction improves and the lateral movement of navicular and anterior part of calcaneum also increases accordingly. By fourth to fifth plaster casting most of the clubfeet get sufficiently corrected, but

for the equinus, which is finally corrected by percutaneous tenotomy. The percutaneous tenotomy should be done when the foot can be sufficiently abducted, which is clinically indicated by possibility of palpating anterior process of the calcaneum. After tenotomy the equinus is completely corrected and foot can be easily taken to 20° of dorsiflexion. With the full correction of the clubfoot, the foot can be easily abducted under the head of the talus achieving about 60° of abduction in relation to the frontal plane of tibia.

The correction is maintained by physiotherapy, stretching and foot abduction brace (especially in the night) for 3 to 4 years (Figures 9.1 to 9.4).

In the process of managing the clubfoot by manipulative serial plaster cast, ultimately the equinus element of clubfoot resists correction in several cases, especially in comparatively late presenting cases. However, this also remains the problem in even early presenting cases. In Ponseti technique this problem is tackled by tenotomy of tendo-Achilles in almost all cases. In comparatively late presenting cases lengthening of tendo-Achilles should be preferred without or with posterior capsulotomy of ankle and subtalar joints. Forceful correction of equinus must be avoided, since it may result in certain deformities such as, rocker bottom foot, flat talar top, etc.

SURGICAL MANAGEMENT OF CLUBFOOT

Surgery in Past

Various surgical treatment have been suggested depending upon the proponent's view of aetiology and pathoanatomy.

Surgery on Tendon and Soft Tissue

- Lorenz (1782)
- Sartorius (1812)
- Delpech (1832)

} Subcutaneous tenotomy of tendo-Achilles

- Stromeyer (1838)
- Little (1839)
- Brockman (1903)

} A two stage soft tissue correction

- Codvilla (1906)

} Soft tissue operation with lengthening of tendo-Achilles at about three years age

Surgery on Bone

- Solly 1857 - Removed cuboid to correct clubfoot deformity
- Lund 1872 - Talectomy to correct clubfoot
- Phelps 1890 - One stage soft tissue release with lengthening of tendons + osteotomy of talar neck + wedge resection of calcaneum

- Duval 1890
- Arbuth Not Lane 1893

} More or less same as above

- Ogston 1902
- Denis Brown 1937

} Osteotomy of talus

- Elmslie 1920 - Osteotomy of calcaneum + division of talonavicular joint capsule and plantar fascia + tendo-Achilles lengthening

MODERN ERA

- Attenborough (1966) - Early posterior soft tissue release
- Turco (1971) - Posteromedial soft tissue release with K-wire fixation
- Carrol (1978) - Posteromedial and Lateral release
- Crawford (1982) - Cincinnati comprehensive incision—extensive release
- Simons (1985) - Complete subtalar release

- Pandey (1995) - Posteromedial double–incisional–release

SURGERY

Broad outline of surgery needed according to the age of presentation of chapter:

- Early Cases - Soft Tissue Release
- Neglected, Resistant and Relapsed cases (> 3 yrs upto 6 yrs) Soft Tissue Release with or without bony procedure
- Neglected, Resistant, and relapsed cases (> 6 yrs upto 20 yrs) Soft Tissue Release with or without bony procedure
- Adult and Elderly – mainly bony procedure/ no treatment

The surgical treatment of clubfoot evolved from the minimal surgery of Achilles tendon lengthening (Little 1839) to the most radical complete soft tissue release (McKay 1983; Simon 1985). Brockman reported in 1930 and 1937 his extensive soft tissue release procedures in two stages. Earlier Bradford (1892) and Codivilla (1906) had already introduced the, so to say, modern principles of surgical treatment of resistant clubfoot. Attenborough (1966) stressed the need of early surgical release of contracted soft tissue in clubfoot to avoid the bony deformities. Turco's one stage radical soft tissue release proved to be the turning point in surgical treatment of the clubfoot, and it was adopted widely. Carroll et al (1978, 1988) introduced the concept of release of the lateral tether in the process of surgical release through two incisions. Crawford et al (1982) introduced the Cincinnati incision as a comprehensive circumferential approach for extensive surgical soft tissue release. Mukhopadhaya and Mukhopadhaya (2007) have reported about their modified posterior release with satisfactory results.

Based upon the understanding of the pathological anatomy and deviation of bones (mainly talus, calcaneum and navicular) in clubfoot several surgical approaches have been evolved. The surgeon is frequently confronted with the problems of obtaining adequate operative exposure of the posterior, medial, plantar, lateral, posteromedial and posterolateral aspects of ankle and foot, while avoiding the complications of incision itself. The main aim has been of releasing the soft tissue contractures (mainly the subtalar, peritalar and lateral tethers) and restoring the position of tilted/rotated calcaneum, navicular and talus without jeopardising the surrounding structures.

A good surgical approach for the soft tissue release in clubfoot should have the following qualities:

1. It should be as much as possible in the line of skin creases
2. It should have clear access to the structures that are at fault exposing clearly the pathological tissue
3. It should not disturb the integrity and functions of the surrounding normal tissues and structures
4. It should be possible to extend the incision to gain further exposure if needed
5. After completion of the planned surgery, the skin closer should be possible without any tension, lest it will risk necrosis
6. The healed scar should not interfere with the wearing of the normal shoes.

Unfortunately all the above can not be achieved totally in any of the incisions / approaches described hitherto in the English literature.

The main approaches described are:

1. The posteromedial release of Turco (1979)
2. The posteromedial and lateral release with two incisions (PML R2) of Carroll (1978)
3. The posteromedial and lateral release (PMLR) utilising the Cincinnati incision (McKay 1983 and Simons 1985)
4. The posteromedial and lateral release through double incision (DIR) of Pandey (1995).