Options for Management Choice Evidence-Based Treatment of Cavus Foot Deformity

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Abstract

Background:Cavus foot encompasses a wide range of deformities, from a subtle flexible deformity to severe rigid cavus foot. The prevalence of cavus foot is reported to be 10 to 25% of the population or as common as flat foot. With increasing awareness of the milder or subtle cavus, the whole disease entity may be more prevalent. The term "pes cavus" or "cavus foot" is used to describe a wide spectrum of foot shapes that have an abnormal elevation of the medial longitudinal arch. High arch of the foot is frequently associated with hindfoot varus, forefoot adduction and plantar flexion, and ankle equinus. The etiology is most frequently attributed to the neuromuscular disorders involving brain, spinal cord, or the peripheral nerves. Two thirds of adults with symptomatic cavus foot have an underlying neurological condition. Among them, Charcot-Marie-Tooth (CMT) disease, a hereditary sensory motor neuropathy, is most frequently reported. The probability of a patient who has bilateral cavovarus feet being diagnosed with CMT is 78%. The surgical procedures are combinations of bony reconstructions and soft tissue procedures. As for the joint-sparing corrective osteotomies, calcaneal osteotomy, 1st metatarsal base dorsiflexion osteotomy (1MTDFO), and midfoot dorsal closing wedge osteotomy at cuneiform-navicular and cuboid level are considered. As for the soft tissue procedures, mainly plantar fascia release, Achilles' tendon lengthening, and peroneus longus to brevis tenodesis are most frequent surgical procedures performed.

Keywords: Cavus Foot,Anti Leukotriene, Osteotomy

Pes Cavus:

Pes cavus is an increase of normal plantar concavity, where the anterior and posterior weight-bearing areas of the foot are brought closer together. A wide spectrum of foot deformities includes a plantarflexed first ray, forefoot pronation and adduction, and hindfoot varus or high calcaneal pitch[1,2].

Cavovarus deformity can be classified according to the severity of malalignment ranging from a subtle and flexible cavovarus foot to a severe and fixed cavovarus deformity. There are many aetiologies of unequal frequency that account for cavovarus foot deformities. Traumatic causes are rare (improperly treated fracture or subluxation of the tarsal bones or scarring from a burn of the sole of the foot). Cavovarus deformity has been long associated with neurological disease such as cerebral palsy, Charcot-Marie-Tooth (CMT) diseases or other hereditary sensory and motor neuropathies (myelodysplasia, Friedreich ataxia, etc). CMT disease results from defects in the genetic code for the protein of the peripheral myelin sheath and is classified into subtypes varying in progression. CMT IA is the most common form including peripheral nerve myelin degeneration and decreased motor nerve conduction. In most cases, the disease process is progressive rather than static; therefore, the deformities worsen and surgical treatment must be considered to prevent the progression to a fixed and symptomatic deformity[3].

However, in recent years, a mild variation of the cavovarus deformity has been increasingly observed to exist without an identifiable underlying deficit. This is called primary pes cavus (idiopathic) which is diagnosed by elimination in more than half the cases and most authors believe that it is the consequence of a latent neurological disorder. Thus, neurological disorders must be looked for in the family history and clinical and electrophysiological evaluation of the patient is necessary to eliminate any very subtle neurological lesion[4].

Cavus foot mechanics

Clinically it is an abnormal elevation of the medial arch in weight bearing. Biomechanically, ‘‘cavus’’ is defined as a varus hindfoot, high calcaneal pitch, high-pitched midfoot (defined by the navicular height), and plantarflexed and adducted forefoot. When the talo-calcaneal angle is narrowed, the navicular moves to a position superior to the cuboid instead of medial to it. This makes it difficult for the Choparts joint to function. During the gait cycle, the foot remains locked in hindfoot inversion and forefoot varus throughout the stance phase, causing less stress dissipation. This can result in metatarsalgia, stress fracture of the fifth metatarsal, plantar fasciitis, medial longitudinal arch pain, and ilio-tibial band syndrome and instability[1].

This locking and unlocking of the Choparts joint is a critical element in the cavus foot. The talus is the connector of the foot and the ankle. Ina neutral or flat foot, the foot rotates around the talus. The cuboid follows the calcaneus. In a neuromuscular cavus foot, the calcaneus is rotated internally beneath the talus resulting in a narrow anterior-posterior talocalcaneal angle. Since the cuboid follows the calcaneus, the cuboid is plantar to the navicular, not beside it. This locks the midfoot and overloads the lateral side of the foot [1]**(Figure 1)**.

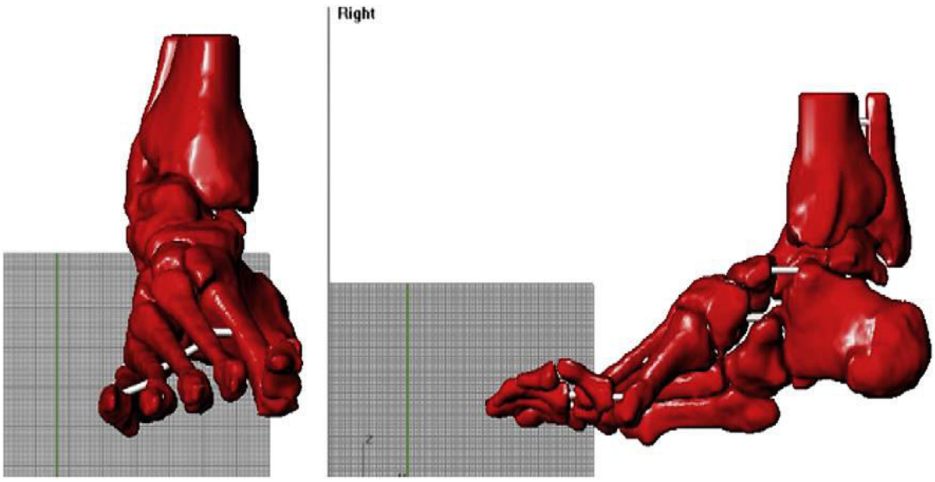

Fig. 1: The front view of a three-dimensional model of a cavus foot, left, shows the rotation of the foot, the varus of the forefoot, and the narrow talo-calcaneal angle. The lateral view on the right shows the navicular perched on the superior surface of the cuboid. This prevents flexion of the midfoot. The foot is in varus and the fifth ray is overloaded.**[5]**

Another way to look at Chopart function is to view the foot from the front with the forefoot removed **(Figure. 2)**. If an axis drawn through the two joints is parallel to the ground, there will be relatively free flexion. The more the axis approaches a vertical orientation, the less flexion will be possible[5].

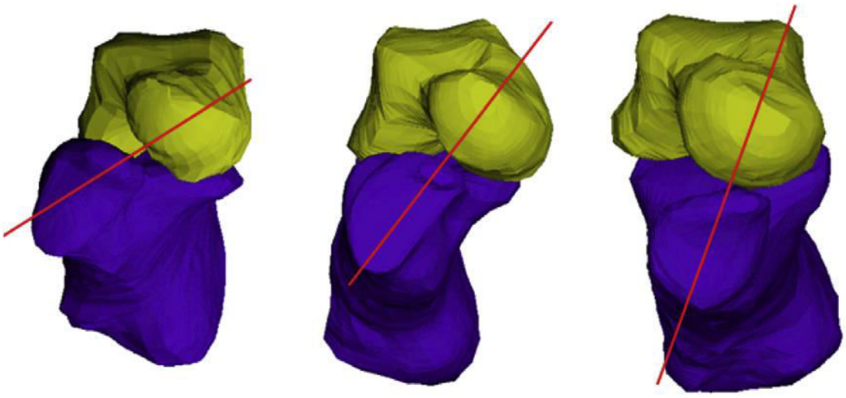

Fig. 2: A view from the front (ventral) into the Choparts joint from three patients. A volume has been generated from the talus (in green) and calcaneus (in blue) of (from left to right) a flexible flat foot, a neutrally aligned foot, and a cavus foot. The tarsal and metatarsal bones have been removed. The red line indicates an approximate axis of the combined axes of the talo-navicular and calcaneo-cuboid joints. Note that the cavus foot (right) has an axis that blocks chopart joint motion[5].

Diagnosis and Evaluation

Clinical Presentation

The patient with a cavus foot may be asymptomatic, with the parents bringing the patient in simply for evaluation of a high arch; however, foot pain is a common complaint. Patients may initially complain of pain in the arch, but as the deformity progresses pain will be seen over the metatarsal heads (or "ball" of the foot) and the heel because more pressure is placed on these areas in the cavus foot[5].

The patient may have calluses over the heel and the metatarsal heads because of unequal weight distribution. As the heel goes into more varus, the patient may experience recurrent ankle sprains. It must be noted that the absence of pain does not rule out serious underlying pathology[6].

The patient first faces the examiner and stands with feet parallel and 6 inches apart. In a normal foot, the medial aspect of the heel should not be visible when the foot is viewed from the front. When there is a varus alignment, the heel sits medial to the ankle and the medial aspect of the heel is visible from the front. This is described as a "peek-a-boo" heel and can be a sign of a subtle cavus deformity. Care should be taken to ensure that the foot is not externally rotated at the time of examination, as this may cause a false-positive "peek-a-boo" sign[6].

Fig. 3: Clinical image showing a "peek-a-boo heel" (medial aspect of the heel is visible when the foot is viewed from the front)**[6]**.

Radiographic evaluation

Plain film radiographs are essential in surgical planning, not only to identify the site of the deformity but also to quantify the degree of correction that is required and to decide whether to perform an osteotomy or an arthrodesis. The apex of the deformity can vary. Usually the deformity is located in the mid-foot at the transverse tarsal articulation or at the naviculocuneiform joint[5].

Weight-bearing radiographs of the foot include at least three views:

1. A lateral view of the weight-bearing ankle and foot allows the cavus to be demonstrated and measured.
2. A frontal view of the ankle (Meary view or Salzman view) demonstrates the frontal deformity of the hindfoot[7].
3. A dorsoplantar view of the forefoot shows adduction of the forefoot and opening of the metatarsal plate.

Numerous geometric measurements have been proposed on lateral weight-bearing radiographs to quantify cavus deformity. In France, the angle of the medial arch is widely used (Djian-Annonier angle) and in pes cavus foot it is less than 120°. A Hibb's angle (angle between the long axis of the calcaneum and first metatarsal) of more than 45° indicates cavus[8].

The intersection point between the first metatarsal axis and the sagittal axis of the talus corresponds to the apex of the deformity which is important when considering osteotomies. The cavus foot is defined as a Meary's angle (the angle between the long axes of the talus and first metatarsal) greater than 5°. In posterior cavus foot, the calcaneal pitch angle is greater than 30°. An associated equinus deformity of the ankle is characterised by a tibio-talar angle greater than 105°[8].

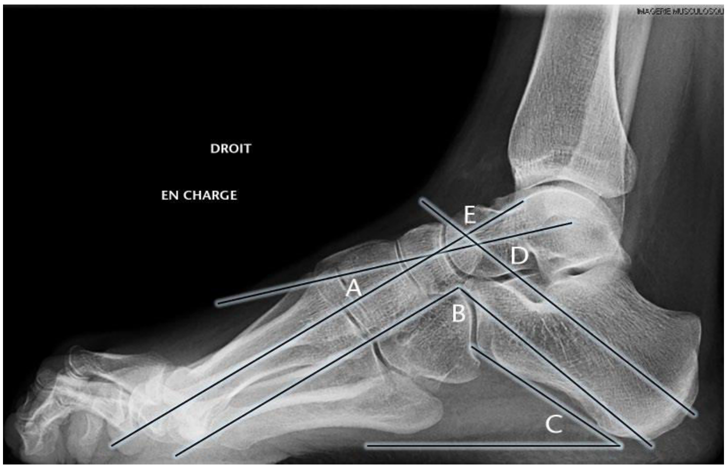

Fig. 5: Radiographic angles on lateral standing radiograph. a) Talo-first metatarsal angle (Meary's angle); b) Djian-Annonier angle less than 120° in cavus foot; c) calcaneal pitch; d) talocalcaneal angle; e) first metatarsal-calcaneal angle (Hibb's angle)(6).

Options for Management choice Evidence-Based Treatment

1) **Flexible Pes Cavus**

In flexible Pes cavus deformity, joint-sparing surgery (purely of soft tissues or with bony surgery also) can be performed, with the intent of preserving joint function. The primary outcome of interest is a pain-free mobile plantigrade foot and, in the longer term, preservation of joint function without degenerative change. Chan et al. performed a useful study in this regard(16), investigating foot pressure distributions before and after surgical correction in nine children with CMT who had joint sparing surgery. Although surgery improved all radiological parameters, the pressure distributions remained abnormal. They concluded that pressure distribution normalization depends on achieving a balanced foot and a correct heel position.

Roper and Tiberwal(9) reviewed the results of soft tissue surgery at a mean follow up of 14 years in ten CMT type I patients (mean age at surgery 14 years, but age range 5–36 years) who underwent open tendon Achilles lengthening (TAL), split transfer of Tibialis anterior tendon (TAT), plantar fasciotomy (PF), claw toe release with flexor-extensor transfer and modified Robert Jones procedure for claw hallux correction. Jones originally proposed Extensor Hallucis Longus (EHL) tendon transfer to the first metatarsal neck for claw toe correction(10).

Subsequent modification involved the fusion of the hallux IP joint. Unfortunately, the authors did not indicate the severity of Pes cavus, nor the flexibility of the hindfoot varus; in fact, one patient underwent calcaneal osteotomy for "very severe varus". Outcomes of interest were subjective, including function, appearance and symptoms. Global outcomes were classified as excellent, good, fair or poor. There were no complications. Two patients had recurrent deformity that required repeat soft tissue surgery. All patients had satisfactory results and were able to walk "unlimited distances" on latest review(11).

In an informative level IV study, Ward et al.(12)described the results (at a mean follow up of 26 years) of joint-sparing surgery in 25 patients with CMT who had a flexible hindfoot [mean age at surgery 15.5 years (8.7–25.1)]. The authors developed an algorithmic approach to flexible Pes cavus management. All patients underwent PF (to reduce the cavus deformity) and transfer of Peroneus longus (PL) tendon to Peroneus brevis (PB) (to remove the deforming force on the first ray). Most patients also underwent first metatarsal osteotomy (DFO), if the foot was deemed not plantigrade following the initial procedures. If there was clawing of the great toe patients underwent Extensor Hallucis Longus (EHL) recession. Those with pre-operative power of at least grade IV in Tibialis anterior underwent TAT transfer to the lateral cuneiform to supplement eversion strength; the transfer of the TAT was not part of the authors' initial practice but was subsequently included, and three patients underwent secondary tendon transfer. Overall, effectively deviating from the latterly advised protocol, TAT transfer was performed to the cuboid or the middle cuneiform in nine patients (14 feet). Some patients had other additional surgery (hallux IPJ fusion – 6 feet, TAL – 1 foot). Seventeen patients (29 feet) had both clinical and radiological assessment. Seven patients (8 feet) required 11 subsequent operations of which there was one calcaneo-cuboid fusion and one ankle fusion. Eleven patients required orthosis at follow-up. General health (SF- 36) score means were 49.8 (mental component score) and 37.7 (physical functioning score). Foot function was assessed using the Foot function index (FFI), having three sub-scales of pain, disability and activity limitation (maximum score is 100 with higher scores indicating worse function). Mean scores in the three sub-scales were 35, 40.5 and 22.1, respectively. Twenty-one patients had some degree of hindfoot varus although cavus correction was well maintained. Osteoarthritis (OA) was seen most commonly at the medial cuneiform-first metatarsal joint; 11 joints in 8 feet demonstrated OA(13).

Chatterje and Sahu reported the results of midfoot osteotomy in 18 adolescents [mean operative age 11.3 years (range: 8.6–15 years); mean follow-up 5.4 years, with no loss to follow-up] who had unilateral Pes cavus (all but one following poliomyelitis; the other having meningocoele). Patients were treated with the Japas osteotomy (midfoot osteotomy with the apex placed over the navicular) after initial open PF release. Thirteen patients required additional TAL; two patients had a rigid hindfoot. No radiological parameters were presented. Outcome was subjective, being graded as "very good", "good" or "poor" based on completeness of deformity correction. Four patients had poor results necessitating further surgery: two underwent triple fusion and two underwent calcaneal osteotomy(14).

Leeuwesteijn et al. reported a series included 33 patients with CMT [mean operative age was 28 years (range: 13–59 years); only five patients were adolescents (<16 years); mean follow-up was only 57 months], with flexible hindfoot deformity. All patients underwent DFO of the first metatarsal; additional surgery consisted of hallux IPJ arthrodesis (34 feet), percutaneous TAL (28 feet), claw toe correction (28 feet), Peroneus longus to Peroneus brevis transfer (27 feet), EHL transfer (15 feet), Tibialis posterior tendon transfer due to drop foot (six cases), PF release (1 foot)(12).

The authors chose to transfer EHL to the Tibialis anterior or Peroneus tertius tendons (rather than the neck of the first metatarsal), thinking that this transfer regime resulted in a lower incidence of hallux elevatus. There were no major complications. Outcomes were assessed using the FFI and patient satisfaction score: there was a statistically significant improvement in pain (from 29.3 to 14.8) and disability (from 37.8 to 23.5) components of the FFI. Ninety percent of respondents were satisfied with the deformity correction but even over this time frame, two patients underwent triple arthrodesis (TA) due to deformity recurrence(12).

The most recent evidence Faldini et al.,(13) presenting the results [mean follow up 6 years (range: 2–13 years)] of 12 CMT 1A patients (24 feet) with bilateral foot deformities treated by PF release, midtarsal osteotomy (MTO), naviculo-cuneiform arthrodesis (NCA), Jones procedure and DFO of the first metatarsal. It is interesting that the authors do not appear to have attempted tendon transfer to balance power. They maintain that elevation of the first metatarsal head would indirectly correct the varus heel in a flexible deformity. It is notable that their pre-operative investigations reveal that 17 and 16 feet (of the 24) had 5/5 power in Peroneus brevis and Tibialis anterior, respectively; this may be why their regime was successful, in spite of the absence of tendon transfers. Five patients required additional surgery for claw toe correction. Outcomes were assessed using the Maryland foot score (MFS), rated as excellent (100–90 points), good (89–75 points), fair (74–50 points), or poor (<50 points). Mean score improved from 72 to 86 and 12 feet reported excellent results. Two feet had superficial wound dehiscence. There was no recurrence or subsequent surgery(13).

2) Joint Sparing Surgery for Management of Rigid Pes Cavus

For a rigid deformity, earlier procedures attempted only uniplanar or biplanar correction. More recently, techniques have focussed on achieving multiplanar correction. Most of these operations involve a midfoot osteotomy that heals either by arthrodesis, pseudoarthrodesis or bony union. Technically. these may not be joint-sparing surgery, but most preserve the Chopart joint complex(14).

Sammarco and Taylor reported the results of superolateral sliding calcaneal osteotomy and dorsolateral closing wedge metatarsal osteotomy in 15 patients (mostly adults; mean age was 33 years; range, 15–61 years) with underlying neurological abnormality (ten with CMT). Patients were assessed using the Maryland foot and AOFAS scores, demonstrating improvement post-operatively. Additionally, there was radiographic improvement of both cavus and adductus. There were two delayed unions and three non-unions. One patient developed midfoot OA. The youngest patient had recurrence of heel varus and the authors felt that this procedure should be used with caution before skeletal maturity.All patients were satisfied with surgery and brace-free at final follow up(16).

Wicart and Seringe reported on 26 children (mean age at surgery, 10.3 years; mean follow up, 6.9 years) with an underlying neurological condition (16 had CMT). Surgery consisted of selective PF release, plantar opening wedge osteotomy of the cuneiform bones and Dwyer opening wedge osteotomy of the calcaneum, if necessary [32 feet (89 %) had hindfoot stiffness requiring Dwyer osteotomy]. Additional surgery included first metatarsal osteotomy (22 feet), medial soft tissue release (17 feet), lateral column shortening (seven cases) and tendon Achilles' lengthening (two cases). One patient had deep infection. Assessment was both clinical and radiological. The authors used an unvalidated, self-devised ‘global score’ for patient outcome assessment. Seventeen patients had recurrence of varus deformity; 11 patients were deemed to have poor results; 12 patients required TA(18).

Weiner et al. treated 89 patients (86 feet developing Pes cavus after clubfoot; mean operative age, 9.7 years; mean follow-up, 7.6 years) with the Akron dome multiplanar midfoot osteotomy. Some patients also had PF release but the numbers were not given. There were no major complications. Outcome assessment was subjective, with the authors reporting that 106 cases (76 %) had satisfactory results. Recurrent deformity (33 patients) was treated with repeat midfoot osteotomy. Twenty-nine patients required TA. The authors performed a sub-group analysis between patients who were younger or older than 8 years at the time of surgery, finding that older children had better results, possibly because they reached skeletal maturity quicker (with less time/growth available for deformity recurrence)[18].

Mubarak and van Valin treated 13 children with cavovarus feet [multiple aetiologies, predominantly neurological; mean operative age, 11 years (SD 3 years); mean follow-up, 4 years] with joint-sparing surgery. Their rationale was to correct the deformity near its apex, and to spare transgression of the midtarsal joints. Hindfoot flexibility was assessed using the kneeling method. The authors used a sequential method to correct foot deformity, initially performing opening wedge osteotomy of the medial cuneiform and closing wedge osteotomy of the first metatarsal to correct the cavus[17].

This was followed by a closing wedge osteotomy of the cuboid (for additional forefoot correction) and lateral displacement closing wedge calcaneal osteotomy for residual varus. They also performed Peroneus longus to Peroneus brevis transfer to balance the foot; 25 % of cases also underwent PF release to correct residual tightness. There was significant improvement in both Meary and Hibb angles. A subjective grading system assessing patient outcome, based on correction of forefoot cavus, hindfoot varus and patient satisfaction suggested only one foot had poor results. The authors recommended that a balancing transfer of Peroneus longus to Peroneus brevis should be performed alongside osteotomies[15].

Mubarak and Dimeglio treated 11 children [mean operative age, 9.3 years (range: 12 months – 15.3 years); minimum follow-up, 1.2 years] with severe cavovarus deformity, by navicular excision and closing wedge osteotomy of the cuboid. Residual varus was corrected with calcaneal osteotomy in 2 feet. Two patients required “minor” re- operation. All patients had plantigrade and pain-free feet at follow-up. The authors recommended this combination of techniques as a salvage procedure for the stiff cavus foot[16].

Zhou et al. claim to have undertaken a prospective study on 17 patients with rigid Pes cavus [multiple aetiologies; mean age, 16.8 years (range: 12–36 years); mean follow-up 25.3 months; range, 12–48 months] treated by midfoot osteotomy combined with joint sparing internal fixation for treatment of. However, patients were “tracked after treatment” which would suggest that this was a retrospective study. It is unclear if data were recorded prospectively. Patients underwent extra-articular midfoot wedge osteotomy stabilised with cannulated screws. Additional surgery included Tibialis posterior tendon transfer, TAL and claw toe correction. Additional surgery was performed only “selectively in some patients”. There were no major complications, and all patients had bony union. Outcome was assessed using AOFAS and radiological criteria. There was a statistically significant 40-point improvement in AOFAS score. There were also significant improvements in calcaneal pitch, and Meary’s, tibiotalar and Hibb’s angles. The majority of patients (94 %) were very satisfied or satisfied with minor reservations. There was no appreciable worsening of joint degeneration[7].

3) Triple Arthrodesis in Management of Rigid Pes Cavus

Results of Triple arthrodesis (TA) have not been very satisfactoryover the long term. However, these patients are not directly comparable to those undergoing joint-sparing surgery; a less aggressive option may not have been an option. Authors have emphasised that TA should be reserved as a last resort in severe, rigid deformity[15].

Wetmore and Drennan treated 16 adolescents with CMT (Mean operative age, 15 years; mean follow-up, 21 years) by TA. Fourteen patients had poor results and were orthotic dependent. Seven feet (23 %) had recurrence of cavovarus deformity; 23 feet (77 %) had progressive degeneration of foot joints. Outcome progressively worsened with time, and six patients required ankle arthrodesis. In view of the poor results, the authors surmised that TA should only be u0sed as a last resort in limbs with progressive peripheral neuropathy and severe, rigid deformity[18].

Wukich and Bowen reported the results of TA of 22 patients (mean operative age, 16.8 years; mean follow up, 12.5 years) with CMT. Outcome was assessed on the basis of residual deformity, pseudoarthrosis, pain, callosity, and degenerative arthritis: 45 % of patients had residual deformity, and 60 % had claw-toe deformity. Only 11 feet (32 %) had good results. Three patients were brace dependent. Twenty-one feet (62 %) had midfoot OA and 8(24 %) had ankle OA. Seventy percent of patients complained of persistent pain. There were 12 additional surgeries, including three cases of revision TA. The authors advised concurrent PTT transfer to correct foot drop deformity and also emphasized the role of TA as a salvage procedure in severe, rigid deformity[16].

Mann and Hsu treated ten adolescent CMT patients (mean operative age, 13.3 years; mean follow-up, 7.5 years) with TA. Three feet underwent associated Posterior tibialis tendon (PTT) transfer. Only 5 feet achieved fusion and plantigrade status. Three feet developed midfoot pseudoarthrosis but did not have functional limitation. One foot required revision TA and 3 feet required subsequent PTT transfer. Three feet had residual deformities and were asymptomatic. Because of incomplete follow up post-operative OA was not reported[15].

The commonest soft tissue procedure was tendon transfer (28), followed by TAL performed within 8 weeks of TA. Eight feet (12 %) had minor complications; 55 % complained of pain of one or the other joints at final follow-up, with 16 patients (28 %) being analgesic dependent. Thirteen feet had pseudoarthrosis of which ten were painful. Eighteen patients (32 %) had subsequent operations (revision TA: 3). Fifty-two feet had residual hindfoot deformity. All patients had ankle OA of which 34 were moderate or severe; 31 patients had midfoot OA. Only 19 feet (28 %) had good results on final followup. This study had the longest follow up; unsurprisingly, the authors noted that clinical and radiological outcomes worsened with time. The authors did not find any correlation between the degree of joint space narrowing and reported pain/deformity. Fifty- four patients (95 %) were satisfied with the result of surgery at final follow-up. In view of gradual deterioration of results following TA the authors advised appropriate counselling in younger patients[5].

External Fixation in Management of Pes Cavus

The external fixator is an attractive option in Pes cavus correction because there can be gradual simultaneous corrections in all planes, in a minimally invasive fashion without major disruption of soft tissues. This is especially useful where soft tissue coverage is poor (eg multiple previous surgeries), in neglected or relapsed deformity, or with infection or associated limb deformity. Although it has been widely used (and reported) in neglected clubfoot deformity, there are not many reports of its use in paediatric Pes cavus per se. Shalaby and Hefny treated 20 patients with a range of complex foot deformities [aetiology was neurological in 11 patients (two cases of Pes cavus; two cases of hindfoot varus); 12 had had previous surgery and 10 had poor soft tissue condition; mean operative age was 26 years, range: 17–46 years; mean follow-up 25 months] with a V shaped osteotomy and Ilizarov fixation. Mean time in fixator was 15 weeks, followed by 6 weeks in a short leg cast; a plantigrade foot was achieved in all but one case, resulting in "improvement" in shoe fitting. Mean improvement in Meary angle was from 20° to 4°. Four patients had mild residual deformity and two patients experienced mild recurrence. There were seven cases of pin-site infection(18).

The modification consisted of combining it with conventional soft tissue and bony procedures. Nine patients had distraction histogenesis and limited soft tissue release, others required additional osteotomy (calcaneal, mid-tarsal, first metatarsal). The authors also performed tendon transfer to balance the foot in five cases and TA in seven cases. After a mean period of 23 days, the external fixator was removed and patients were casted for 2–5 weeks. Twenty-four feet were corrected to plantigrade position; 19 patients were satisfied with the results of surgery. There were four recurrences (poor outcome) and six complications(17).

Kirienko et al. corrected foot deformity from poliomyelitis in 27 patients (four paediatric patients aged 12–14 years; ten patients had undergone previous surgery; mean followup, 7 years) using the Ilizarov technique. Only six patients had treatment with isolated frame application; others required additional soft tissue or bony procedures including arthrodesis. Nine patients had some degree of Pes cavus deformity. Mean time in foot frame was 4.2 months. A plantigrade foot was achieved in 25 cases without major complication and all patients were satisfied with their post-operative gait. There were two cases of residual deformity and two cases of recurrence(18).

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