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Limb Reconstruction

REVIEW

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Correction of complex foot deformities using the V-osteotomy and the Ilizarov technique

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Abstract Complex foot deformity is a multiplanar deformity with or without foot shortening. It also includes deformed feet with poor soft-tissue coverage, relapsed or neglected cases, and those with acompanying problems such as leg-length discrepancy, lower leg deformity, osteomyelitis and nonunions. Traditionally, correction of these deformities can be achieved by extensive soft tissue releases, osteotomies or arthrodesis with or without internal fixation. This usually involves excision of large appropriate bony wedges and has many disadvantages, including neurovascular injury, soft tissue problems and a shortened foot. We present our experience with a group of severe deformities of the foot that we managed using the V-osteotomy combined with the Ilizarov technique. We present our algorithm of management of complex foot and ankle deformities, together with our prerequisites for patient selection. A detailed description of the operative technique, postoperative care and possible complications is also presented. The combination of the Ilizarov technique and the V-osteotomy offers versatility in foot deformity correction, enabling correction of individual components of the deformity at rates that may be tailored to achieve accurate three-dimensional control.

Key words Ilizarov • V-osteotomy • Complex foot deformities • Gradual correction • External fixation

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Introduction

A complex foot deformity is a multiplanar deformity with or without foot shortening. It includes deformed feet with poor soft-tissue coverage, relapsed or neglected cases, and those with accompanying problems such as leg-length discrepancy, lower leg deformity, osteomyelitis and nonunions. Such deformities are caused by trauma, poliomyelitis, osteomyelitis, burn contractures, neuromuscular diseases or follow resistant congenital contractures like clubfoot [1]. Where the deformities appear in childhood, early correction is advisable before the development of secondary bony changes and fixed compensatory deformities. Persistence of such complex deformities after childhood may imply a highly resistant deformity associated with scars, tight soft tissue structures, pressure ulcers and dense callosities that are unfavourable to further extensive open surgery [2].

Correction can be achieved by extensive soft tissue releases, osteotomies or arthrodesis with or without internal fixation. This usually involves excision of large appropriate bony wedges, which may have disadvantages when the deformity is recurrent or in a scarred, small foot; notably the problems will lie with neurovascular injury, wound healing and further shortening of the foot [3–7]. Moreover, the management of complex foot and ankle deformities that have previously undergone one or more surgical procedures is more difficult [8].

The Ilizarov technique has the advantage of a gradual and titrated correction of individual components of these complex deformities. Forefoot, midfoot and hindfoot corrections can be managed individually through appropriate osteotomy and hinge placement. The ability to preserve foot length and perform simultaneous tibial corrections (angular, rotation, length or otherwise) are additional advantages [1, 9–13].

The V-osteotomy offers versatility in deformity correction when combined with gradual correction in an external fixator. The technique has been previously described but often in conjunction with other types of osteotomies and techniques [11, 14–17]. The aim of this article is to present our experience with a group of severe deformities of the foot managed using the V-osteotomy and the Ilizarov technique. We present an algorithm for the management of complex foot and ankle deformities and a detailed description of the operative technique, postoperative care and possible complications.

Methods

A multiplanar foot deformity distorts the normal relations between the leg, hindfoot and forefoot. There is often a variable combination of deformities but the individual components and associated compensatory bony and soft-tissue deformities need to be evaluated from functional and biomechanical perspectives (Table 1).

Pre-operative assessment (Table 2)

The history often establishes the cause of deformity; this may be congenital, neuromuscular, post-traumatic or a burn contracture. These respond differently during the deformity correction

Table 1 Analysis of the individual components of complex foot and ankle deformities by plane and mechanism of compensation

Deformity	Types	Pl.	Compensated by	NAR (°)
Sagittal distal tibial deformity	Recurvatum	Sagittal	Ankle plantarflexion	45
	Procurvatum	Sagittal	Ankle dorsiflexion	20
Ankle equinus		Sagittal	Proximal (knee recurvatum, hip flexion, exaggerated lordosis) Distal (midtarsal dorsiflexion)	
Cavus	Anterior	Sagittal	Hindfoot dorsiflexion	
	Posterior	Sagittal	Forefoot plantarflexion	
Coronal distal tibial deformity	Varus	Coronal	Subtalar eversion	15
	Valgus	Coronal	Subtalar inversion	30
Hindfoot varus		Coronal	Forefoot pronation	
Hindfoot valgus		Coronal	Forefoot supination	
Forefoot pronation		Coronal	Hindfoot varus	
Forefoot supination		Coronal	Hindfoot valgus	
Metatarsus adductus		Axial		
Metatarsus abductus		Axial		

Pl. plane; *NAR*, normal available range. A higher NAR has more potential for compensation

Table 2 Elements of preoperative assessment

	History	Clinical examination	Radiographs
Factors that should be established	- The cause of deformity - The main complaint - The patient's expectations	- Components of deformity - Ankle joint and subtalar joint ROM - Level of the equinus deformity - Condition of skin and soft tissues	- Condition of the joints - Shape of the talar dome - The magnitude of the overall deformity and its individual component

ROM, Range of movements

process. The patient's main complaint is identified together with their expectations from treatment so that an objective could be established for any proposed surgery. We have recognised 4 main objectives of deformity correction: a plantigrade foot that fits in a normal shoe, a stable foot that allows better gait, a pain-free and a better looking foot.

Clinical evaluation

This includes examining the patient while:

- *Standing*. The patient stands on both feet if able. The foot and ankle are examined from the front, back and sides. Forefoot pronation or supination is determined from the front (Fig. 1). Heel position, in particular varus or valgus, is assessed from the back (Fig. 2). The flexibility of the hindfoot can be assessed using the Coleman block test [18]. From the side it is easy to detect cavus and confirm the relations of forefoot to hindfoot and of the hindfoot to the leg. In nearly all our patients we obtain digital photographs of the foot and ankle in the standing position from the front, back and sides, which serves as a preoperative reference.
- *Walking* (*gait examination*). This allows assessment for antalgic components, foot progression and of the foot rockers. It is also important to establish the stability of the foot during walking.
- *Lying supine*. Callosities and corns depict areas of high-pressure contact. Tender foci need to be sought and referenced to the patient's symptoms. Active and passive ankle joint motion is examined; the ability to reach 15° of active ankle joint dorsiflexion enables normal foot progression with heel strike, foot flat and push off. In the presence of a lack of dorsiflexion, an assessment to differentiate ankle equinus and forefoot plantaris (plantarflexion of 1st and 5th rays across the midfoot) is needed. The angle between the hindfoot and the leg is used to express the degree of deformity if ankle equinus is dominant. The Silverskiold test [19] can differentiate soft tissue contracture of gastrocnemius or gastrocsoleus origin, but a negative test may also point to the contracture arising from an ankle capsule contracture or bony block to movement. Metatarsus adductus or abductus deformity is examined for, as is the alignment of the forefoot in the axial plane (supination/pronation). Finally, the presence of scars, condition of the skin and neurovascular integrity need to be assessed and documented.

Fig. 1 Clinical evaluation from the front with the patient standing. **a** Forefoot supination. **b** Forefoot pronation. *Dotted line* for demonstration of forefoot orientation

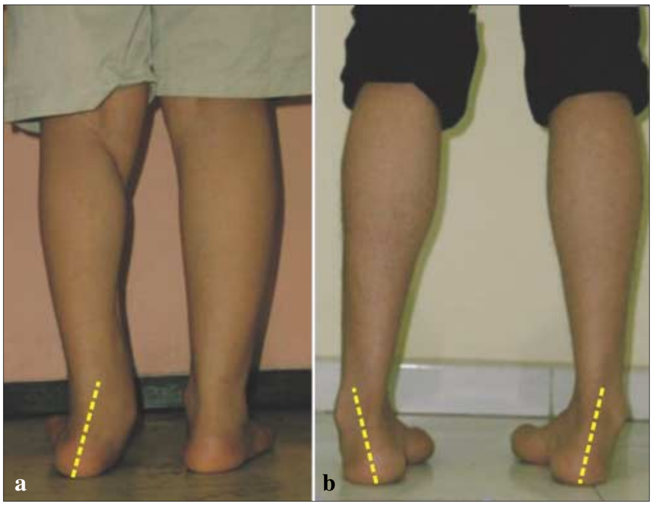

Fig. 2 Clinical evaluation from the back with the patient standing. **a** Hindfoot valgus. **b** Hindfoot varus. Dotted line for demonstration of hindfoot alignment

Radiological evaluation

Five views are performed to allow appropriate preoperative planning and postoperative evaluation. These are standard AP and lat-

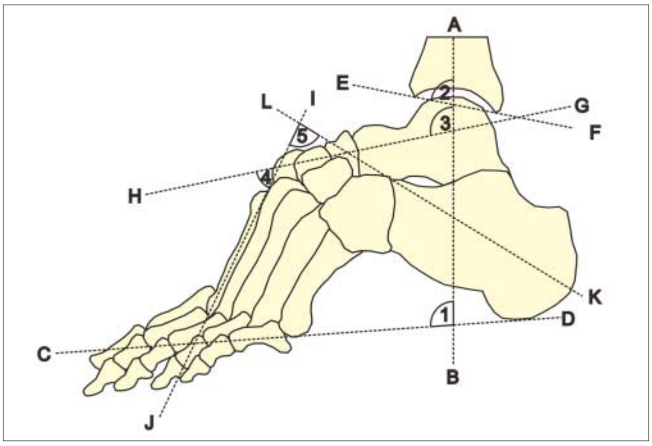

Fig. 3 A diagram of the foot and ankle showing the measurements taken from a standing lateral foot and ankle X-ray. *AB*, tibial anatomical axis; *CD*, line representing the sole from the plantar aspect of the head of the first metatarsal to the plantar aspect of the calcaneus; *EF*, distal tibial joint line; *GH*, axis of talus; *IJ*, axis of 1st metatarsal; *KL*, axis of calcaneus; *1*, tibial–sole angle; *2*, anterior distal tibial angle (ADTA); *3*, tibio-talar angle; *4*, talar–1st metatarsal angle (angle of Meary); *5*, calcaneal–1st metatarsal angle (Cavus angle)

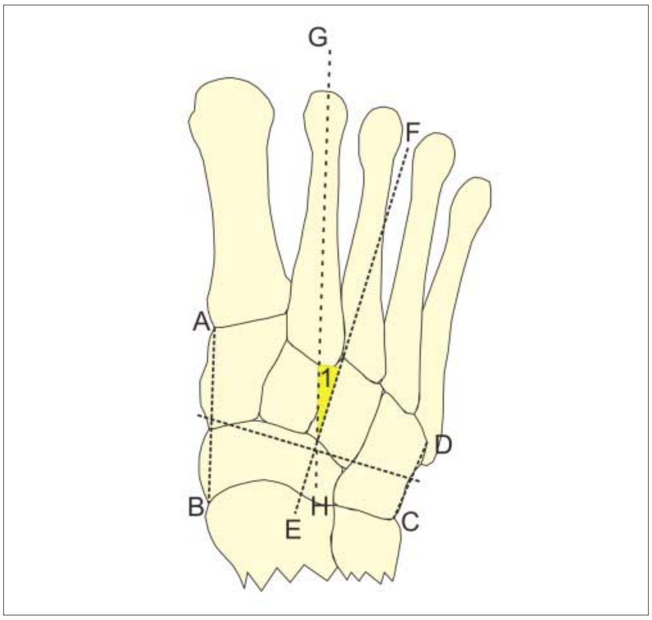

Fig. 4 A diagram of the foot showing the measurements taken from a standing AP foot X-ray. *GH*, the axis of the 2nd metatarsal; *EF*, the axis of the tarsal bones (a perpendicular line on a line joining the midpoints of the medial and lateral tarsal borders; *1*, tarsometatarsal angle

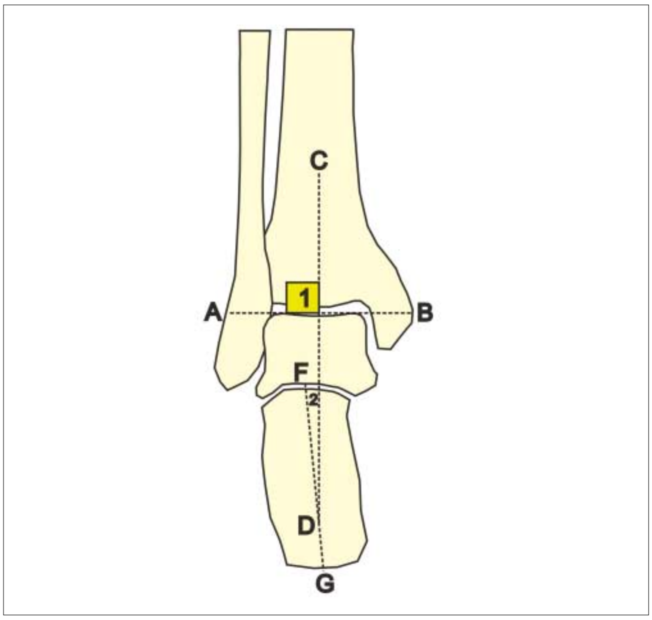

Fig. 5 A diagram of the ankle and foot showing the measurements taken from a standing AP ankle X-ray and axial calcaneal or Cobey's view. *AB*, ankle joint line; *CD*, anatomical tibial axis; *FG*, calcaneal axis; *1*, lateral distal tibial angle (LDTA); *2*, calcaneotibial angle

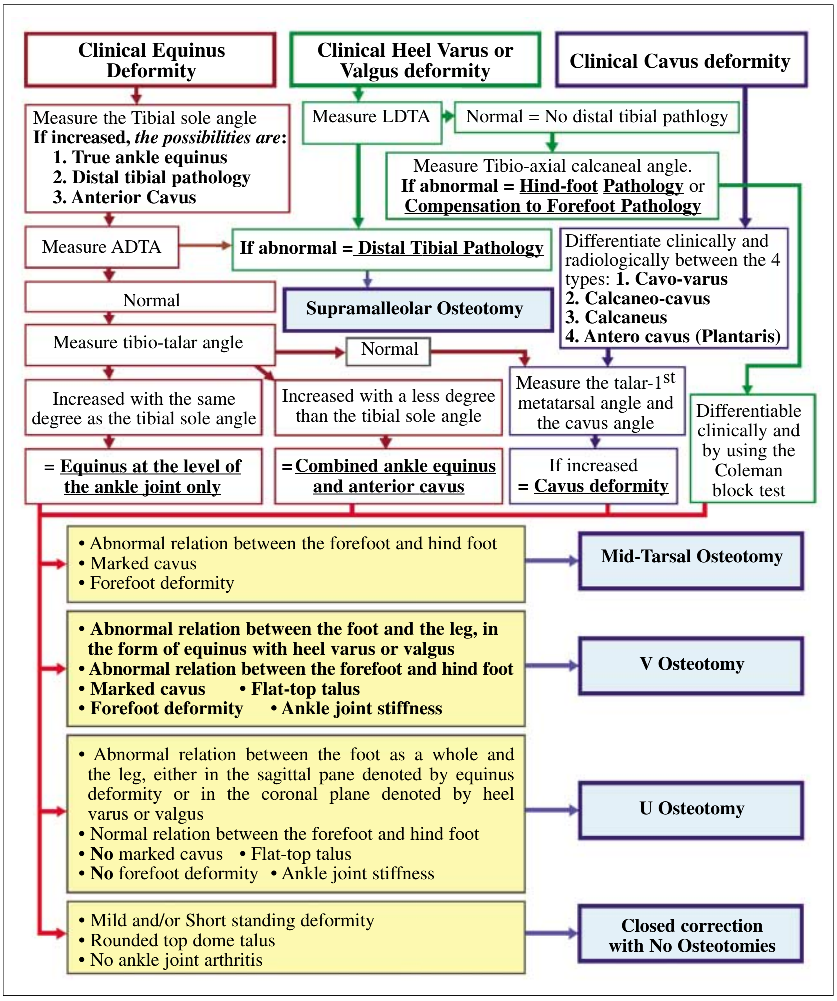

Fig. 6 Algorithm of decision making based on clinical and radiological assessment

eral projection radiographs of the ankle, AP and lateral views of the foot and an axial calcaneal projection. The axial calcaneal projection can be replaced by Cobey's view [20], whereas the lateral projection radiographs of the foot and ankle are taken on the same X-ray film. All X-rays should be performed standing if the patient is capable of tolerating this position.

The site and degree of the deformity are measured from the X-ray films and allow for appropriate surgical planning (Figs. 3–5). The films also depict the condition of the ankle, subtalar and midtarsal joints with regard to degeneration. The AP and lateral X-rays of the ankle are also used to assess the shape of the talar dome; a flat top talus signifies a congruent incongruity at the ankle joint, which makes the deformity unsuitable for correction purely through soft tissue releases.

Decision making regarding the type of osteotomy needed

The findings from the medical history, clinical and radiological evaluation allow the surgeon to enter the treatment pathway as described in Figure 6. This algorithm guides the surgeon to the type of correction strategy needed as well as to the type of osteotomy. A majority of the severe long-standing deformities will fit the criteria for a V-osteotomy.

Surgical technique of the V-osteotomy

It is usually performed under general anaesthesia in the supine position with a sand bag under the ipsilateral buttock. Alternatively the osteotomy is carried out in lateral decubitus to facilitate X-ray imaging before turning to supine for the remainder of the procedure. A tourniquet is used for the osteotomy and deflated after a compression dressing is applied.

The V-osteotomy can be performed either through an Ollier's incision (Fig. 7) or by a minimally invasive approach through the bed of the peroneal tendons (Fig. 8). The limbs of the 'V' start on the plantar aspect of the calcaneum in line with the sinus tarsi. The anterior limb then runs in an antero-dorsal direction through the calcaneum between the anterior and medial facets of the subtalar joint, exiting through the neck of the talus. The posterior limb lies behind the peroneal tendons and is directed to exit on the dorsal surface of the calcaneum behind the posterior facet of the subtalar joint (Fig. 9). The osteotomy is usually performed with a 10–15-mm osteotome, although wider ones can help with osteoclasis through twisting the instrument. It is important to confirm the osteotomy is complete; this can be visualised on X-ray (Fig. 10) or done by palpation. The ability to translate the fragments on either side of the osteotomy assures its completion.

The frame is constructed of a proximal base or leg frame, fixed over the tibia, and a distal foot frame. The base frame is a two-ring construct. Each ring is fixed with two wires or one wire and a half pin. Fibular transfixation is not required. However in some cases it is important to prevent subluxation of the talus in the ankle mortise during the correction process. This is achieved by an oblique wire from posterolateral to anteromedial through the body of the talus, tensioned and attached to the base frame construct.

The foot construct consists of a posterior half ring over the calcaneum and another anterior half ring over the dorsum of the

Fig. 7 Clinical photograph showing the V-osteotomy. **a** Posterior limb and **b** anterior limb, performed through an Ollier's approach, patient positioned supine with a sandbag under the ipsilateral buttock

Fig. 8 Clinical photograph showing the incision used for the minimally invasive approach to perform the V-osteotomy. The peroneal tendons are retracted and the osteotome is placed to perform the anterior limb of the osteotomy. The patient is positioned in the lateral position

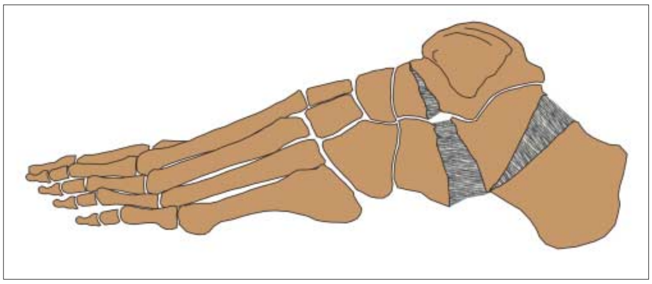

Fig. 9 A diagram showing the V-osteotomy after distraction of the 2 limbs

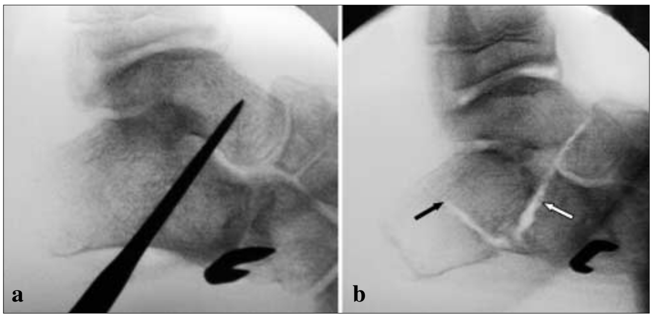

Fig. 10 Intraoperative image intensifier pictures showing **a** the osteotome performing the anterior limb of the V-osteotomy, and **b** the completed osteotomy, anterior limb (*white arrow*) and posterior limb (*black arrow*)

foot. The calcaneal half ring is fixed using 2 crossing olive wires or a transverse wire and a sagittal 5-mm half pin. The position of the wires and/or half pin should be checked using image intensifier to confirm that they do not cross the osteotomy site. The calcaneal half ring should be positioned parallel to the sole of the foot and tilted to match any hindfoot varus or valgus, while the forefoot half ring should be positioned perpendicular to the axis of the metatarsals (Fig. 11). Two to three wires are used to fix the anterior half ring over the dorsum of the foot. At least one of these wires should pass through the 1st metatarsal and another one passes through the 5th metatarsal (Figs. 12, 13). Usually, the 3rd wire is taken at a more proximal or distal level to enhance stability. Wires on the base frame are tensioned to 130 kg and on the foot frame are tensioned to 90 kg.

Both half rings are connected together by medial and lateral connecting rods acting as motors with universal or bi-planar hinges. Two anterior threaded rods are applied between the base frame and the forefoot half ring, and three posterior rods are applied between the base frame and the calcaneal half ring (Fig. 14). The line of pull of the anterior threaded rods should represent a tangent of a circle, the centre of which lies on the dorsal end of the anterior limb of the V-osteotomy. This creates a virtual hinge around which correction takes place through the front limb of the V-osteotomy. Universal or bi-planar medial and lateral hinges connects the medial and lateral posterior threaded rods to the calcaneal half-ring. The axis of these hinges is placed at the sinus tarsi or at the centre of rotation of the ankle joint. This axis however, is purposely dragged plantarwards with the initial distraction of the posterior rods as this compensates for some plantar descent of the anterior segment (by virtue of its correction on the ‘virtual’ hinge).

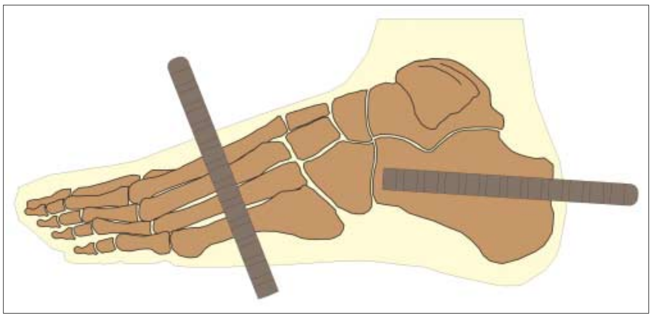

Fig. 11 A diagram showing the ideal position for the calcaneal and forefoot half rings

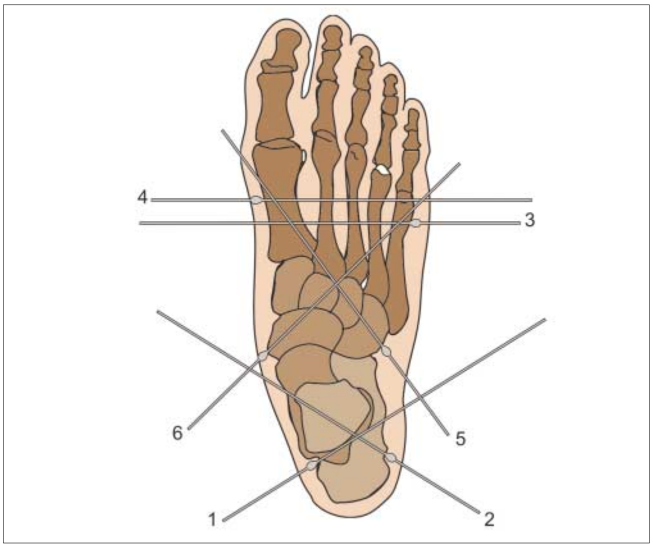

Fig. 12 A diagram showing the wire configuration for the forefoot and hindfoot. Wires no. *1* & *2* are fixed to the calcaneal half ring. Wires no. *3* & *4* are fixed to the forefoot half ring. Wires no. *5* & *6* prevent unnecessary distraction of the midtarsal and tarsometatarsal joints and are fixed to the forefoot half ring without tensioning

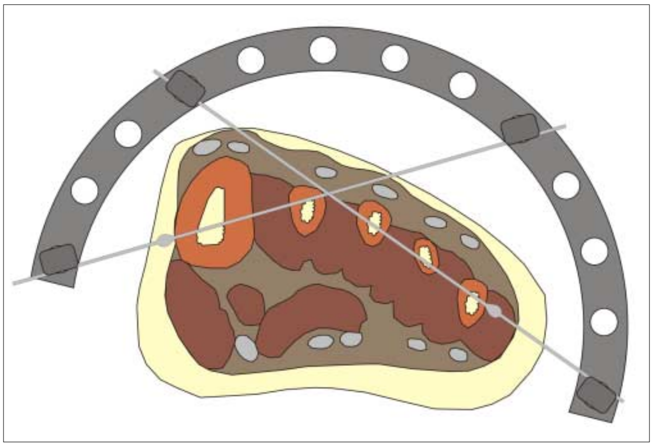

Fig. 13 A diagram showing the wire configuration and half-ring positioning for the forefoot (*cut section*). Note that at least one wire should pass through the 1st metatarsal and another one passes through the 5th metatarsal

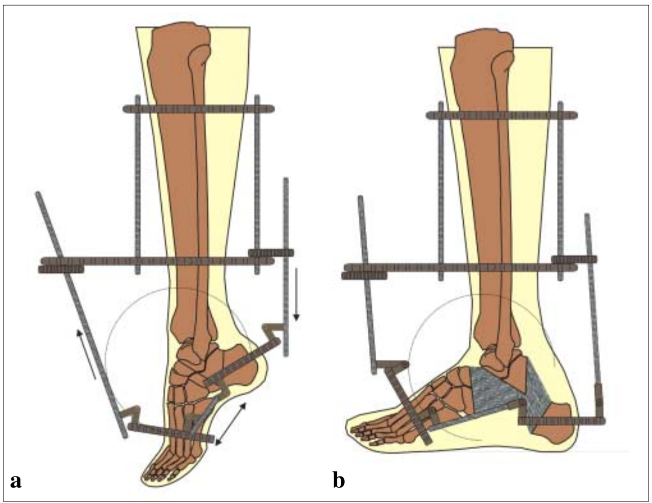

Fig. 14 A diagram showing the correction of an equino-cavus deformity using the V-osteotomy and illustrating the anterior and posterior motors, **a** before and **b** after the correction. Note how the anterior motors are placed in a plane tangential to an imaginary circle centred at the dorsal end of the anterior limb of the V-osteotomy

Other procedures might be needed to assist the correction, such as Jones' procedure for clawing of the big toe, a Steindler release of the plantar fascia and percutaneous Achilles tendon lengthening. If needed, these procedures are done at the same time as the osteotomy and frame application.

Finally, all wires and/or half-pins are covered by chlorhexidine-soaked gauze. Any wounds are covered by dry dressings and crepe bandage is wrapped all over the foot and leg, applying gentle compression to the osteotomy site.

Postoperative care

The majority of the patients receive a sciatic nerve block in theatre immediately after the operation and while still under the effect of the general anaesthesia, for postoperative pain control. In the immediate postoperative period morphine is used through patient-controlled analgesia (PCA). This is gradually substituted by oral analgesia in the form of paracetamol- and codeine-based analgesics. Before removal of the PCA redressing of all the pin sites is performed.

All patients are given 3 doses of IV antibiotics (1 intraoperative and 2 postoperative doses).

All the patients are taught how to perform the pin site care protocol. This is done by cleaning the sites of the wires and half pins using a normal saline solution and applying a compressive dressing of chlorhexidine-soaked sterile gauze. This is performed once per week or more often if there is any evidence of discharge or pin site infection.

The patients are reviewed on the ward by the physiotherapy team, and given instructions for quadriceps exercises and knee range-of-movement, together with passive and active exercises of their toes if they are not fixed by wiring. Patients are encouraged to weight bear as much as tolerated on the operated limb aided by crutches or walkers. This is facilitated by attaching special slippers to their frames using Velcro straps and enabling them to bear weight through the sole of the foot.

Correction of the deformity starts on the 3rd postoperative day at a rate of 1 mm of distraction through the anterior and posterior limbs of the V-osteotomy. Distraction is tailored according to the exact elements of the deformity of each patient, but in general the correction is performed through $^1/_4$ of a turn 4 times daily on all units except the anterior pull-up rods which are shortened at 1 full turn 3 times daily. This achieves a 1-mm distraction rate at the osteotomy site.

After an initial period of distraction of about 5–7 days, the anterior pull-up rods are shortened differentially to correct forefoot pronation and supination, and the posterior medial and lateral rods are distracted differentially to correct the hindfoot varus or valgus. Distraction is also continued through the posterior rod on the calcaneal ring to correct the equinus position of the calcaneus.

For most patients, especially those with multiple elements of the deformity necessitating distraction or compression through different rods, follow-up is every week during the period of deformity correction. Minor frame adjustments may be needed (as in changing of a threaded rod) and are carried out in the clinic.

At full correction of the deformity, the frame is left *in situ* for nearly double the time taken to achieve correction to enable consolidation of the osteotomy sites. By this time the patient should be mobilising full weight bearing.

Frame removal can be done in the outpatient clinic with no anaesthesia or under mild sedation. After frame removal a walking short leg cast is applied for 6 weeks during which the patient is advised to increase their weight-bearing status to as much as possible, and gradually abandon crutches.

In some patients with equino-cavo-varus deformity, correction of the cavus deformity may unmask a dropped first metatarsal. Should this happen, a proximal dorsal closing wedge osteotomy of the first metatarsal can be performed at the time of frame removal. This deformity should not be corrected with the frame by over-supinating the forefoot as this will lead to the patient weight bearing on the lateral side of the foot.

Ethical approval

The board of the Orthopaedic Department at Ain Shams University approved this study from scientific and ethical points of view. This study meets the ethical standards and complies with the national as well as the local standards set within the department.

Results

Demography

Between 2002 and 2005, 20 patients with complex foot deformities were treated using V-osteotomy and the Ilizarov technique. Five patients had bilateral deformities giving a total of 25 feet operated on at our institution. There were 16 males and 4 females. The mean age at surgery was 26 years (range 17–46). The mean fixator time (time from the operation to frame removal) was 15 weeks (range 13–17). All patients had a short leg cast for 6 weeks following frame removal. The mean follow-up period was 25 months (range 19–35).

The aetiology of the deformity was neuromuscular in 12 feet (post-poliomyelitis in 7 patients, postmeningitis in 2 patients and Charcot Marie Tooth disease in 2 patients), a neglected congenital deformity (CTEV) in 4 feet, post-traumatic deformity (calcaneal and Lisfranc fracture dislocation) in 2 feet and post-burn contractures in 2 feet.

Twelve patients had previous operations (range 1–4) in the form of soft tissue releases, internal fixation and removal of metal implants, debridement, skin grafts, toe amputations, bone grafting, and ankle or subtalar fusion. Ten patients had poor skin condition from extensive scarring by trauma or previous operations.

Results

Our objective was correction to produce a stable, painless, plantigrade and cosmetically acceptable foot that satisfied the patient aesthetically and functionally. Aesthetic satisfaction was greatly related to correction of the deformity and achieving a plantigrade foot. Functional satisfaction was, for most patients, related to normal shoe wear and gait improvement but in neuromuscular deformities and an unstable foot, functional satisfaction was related to the improvement in stability and cessation of need for an ankle foot orthosis.

A plantigrade stable foot was achieved in all but one patient. Four patients had mild residual deformity, which did not affect their final outcome. In one patient the correction had to be reversed due to neurovascular symptoms

Fig. 15 Clinical photographs (**a–d**) and X-rays (**e**) showing a 27-year-old male patient, with neglected congenital club foot deformity. This patient had 2 previous debridements and pus drainage due to osteomyelitis of the 5th ray. Finally he had a 5th-ray amputation. He presented with a large trophic infected ulcer on the lateral side of the foot (**d**)

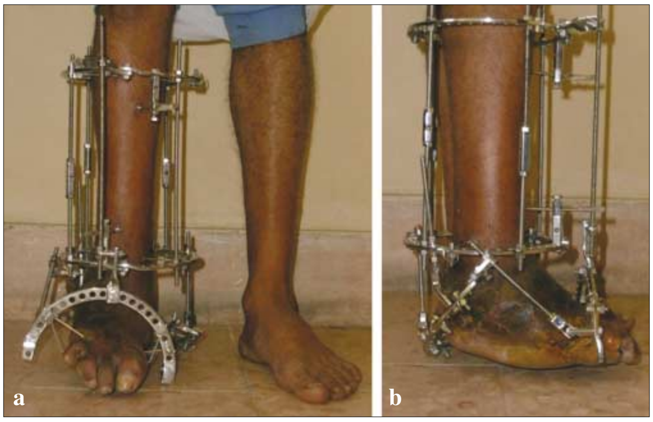

Fig. 16 Clinical photographs showing the same patient during the treatment in the frame

Fig. 17 Clinical photograph showing the same patient 2 years after removal of the frame. Note how the infection resolved and his trophic ulcer healed completely

in spite of a slow rate of distraction. In this case premature consolidation occurred. Apart from this case, all other patients noticed a significant improvement in shoe fitting (Figs. 15–17).

Radiologically, the mean tibial-sole angle improved from 124° to 92° (normal≈90°), the mean ankle equinus (tibiotalar angle) improved from 132° to 106° (normal≈115°), the mean anterior cavus (angle of Meary [21]) improved from 20° to 4° (normal≈0°), the mean overall cavus deformity (cavus angle) improved from 112° to 130° (normal≈130°) and the mean metatarsus adductus deformity (tarsometatarsal angle) improved from 25° to 17° (normal≈15°).

Complications

Pin site infection was the most common minor complication encountered (7 patients in our series). There was an association between the stability of the frame and tension in the wires and the occurrence of pin site infection. Pin site infection was managed by oral antibiotics, regular cleaning of the pin sites with saline and removal/change of the infected wire if persistent.

Skin tethering is also a cause of pain after surgery (1 patient). This is avoided through proper wire insertion technique. If the problem is identified early in the postoperative period, the skin is released under local anaesthesia [22].

The fixator constructs for correcting these deformities are complex. They can be confusing to the patients, especially when multiple elements of the deformity are corrected simultaneously and require adjustments at many rods several times a day. This can lead the patient to turn the nuts in a wrong direction. In our series this problem occurred in 2 patients and was rectified early; it led to a slight increase in the frame period. This potential problem can be avoided through preparation of the patient before surgery and clear marking and labelling of the adjusting rods. It is also important to monitor the correction weekly.

During correction of the deformity there is increasing tension on the long flexor tendons, leading to flexion deformities of the toes. This can be avoided by supporting the toes during the correction phase in a neutral position through toe slings or forefoot supports. Physiotherapy can assist with active and passive toe movements. In severe equinus or cavus deformities, inserting transfixing wires across the interphalangeal and metatarsophalangeal joints before starting the correction regime helps. Toe flexion deformities were encountered in 2 patients; they needed flexor tenotomies and transfixation wires.

On correction the frame should be left in place until full consolidation of the osteotomies. This is followed by application of a suitable orthosis or cast to prevent recurrence, particularly in patients with neuromuscular deformities. In this series 2 patients (one post-burn contracture and one post-polio deformity) had recurrence of some elements of the deformity – mainly heel varus and metatarsus adductus. The recurrence was mild and did not affect the patients' satisfaction, gait or daily activity.

Neurovascular symptoms are usually caused by too rapid a rate of distraction. Limiting the distraction rate to 1 mm/day split over 4 increments will reduce the risk of this problem. These symptoms occurred in one patient; this was a severe post-traumatic deformity, with 2 previous skin flaps and an angiogram demonstrating an absent posterior tibial artery. The distraction was slowed down but had to be reversed. The neurovascular symptoms improved but premature consolidation occurred; the correction and frame had to be abandoned.

Premature consolidation of the osteotomy before full correction is reached is not uncommon with foot osteotomies. In the event, it results in a residual deformity unless a repeat osteotomy is undertaken. This occurred once in the case above. To avoid this problem we start the distraction routinely on the third postoperative day.

Other complications, such as incomplete osteotomy, intraoperative vascular injuries, tendon impingement, pseudo-aneurysm, wire breakage and wire cut-through were reported by some authors [9, 13, 22–28] but were not encountered in this sample.

Summary *Complex multiplanar foot and ankle deformities are a challenge to the orthopaedic surgeon [28]. These deformities occur with congenital conditions (such as clubfoot and congenital vertical talus), neurological lesions (such as poliomyelitis, cerebral palsy, postmeningitis and Charcot Marie Tooth disease), traumatic injuries, osteomyelitis, non-unions or mal-unions, leg length discrepancy, burn and other soft tissue contractures [10].*

These deformities affect gait [29] and can cause compensatory changes in other joints leading to knee, hip and low back problems. The deformities prevent normal shoe wear and in neurological conditions may necessitate specially designed foot and ankle orthoses. The abnormal contact pressures cause skin problems from callosities to skin ulcerations, which in turn can be complicated by infection and osteomyelitis. These problems add to the psychological distress experienced by these patients [10, 11].

The goals are to correct the deformity and offer the patient a stable, painless, plantigrade, cosmetically acceptable and near normal foot that allows normal shoe wear and improves gait and the ability to perform activities of daily living [11]. The classic treatment of these deformities utilises soft tissue releases, tendon transfers, osteotomies or arthrodesis. These have drawbacks in severe deformities and are at risk of neurovascular injury, soft tissue problems and shortening of the foot [1]. The neurovascular structures are at risk of traction injuries from immediate correction. The amount of skin may also be insufficient to achieve a full correction [10]. In the event of large closing wedge osteotomies, so much shortening is produced as to make the correction inappropriate [30].

The Ilizarov method enables correction in all planes at a rate that can be tailored to the type and degree of deformity [31]. It achieves this without shortening of the foot and allows the surgeon to manipulate the rate and direction of correction [1, 10, 11, 25, 28, 29, 32, 33]. This presents an opportunity to treat complex foot and ankle deformities without the constraints of more traditional methods [13]. It offers a degree of versatility in correction of the most challenging deformities, even in the presence of co-morbidities such as infection

and poor skin conditions [10, 11, 14, 17]. However, the technique is difficult and should be performed by surgeons familiar with correction of foot and ankle deformities and fully versed in Ilizarov fixation techniques [32]. A high degree of patient compliance is also crucial [13].
In this article we reported our results using this specific technique and in conclusion believe that the V-osteotomy in combination with the Ilizarov technique is an excellent treatment modality for the most challenging foot deformities.

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